ACADEMIC PROGRAM REVIEW IN MEDICAL TECHNOLOGY

I. Relationship of the Academic Unit to the College and University Mission

Evaluate the program's contributions to the College and to the University. Tie the program to the College and University's missions.

1. The mission of the College of Applied and Natural Science is, "through excellence in teaching, research, and service, the College of Applied and Natural Sciences prepare students for careers in agriculture, biological sciences, forestry, health care and human ecology. Graduates are expected to be committed to life-long learning, to environmental awareness, and to improving their profession and community." The College is committed to the University's mission of providing "quality in teaching, in research and in public service"

2. The mission of B.S. Program in Medical Technology amplified those of the University and College by:
   a. Providing the highest quality academic and professional preparation of undergraduate majors, in an effort to alleviate the critical shortage of qualified, professionally-credentialed practitioners in Medical Technology (Clinical Laboratory Science) and other related health professions in Louisiana and surrounding states;
   b. Attracting, and then mentoring the exceptional student throughout their education and to job entry;
   c. Developing and assimilating the most current educational concepts necessary to satisfy the cognitive, psychomotor, and affective competencies specified by it’s accrediting agency, the National Accrediting Agency for the Clinical Laboratory Sciences to it’s majors;
   d. Serving as a local, regional and national-recognized resource to industrial, regulatory, professional, educational, and governmental groups on health-related issues;
   e. Recruiting a highly qualified faculty and provide this faculty with those resources necessary to encourage the continued professional development and scholarly pursuits of that faculty to accomplish the above;
   f. Obtaining and judiciously manages the specialized and dynamic support necessary to maintain the instruction, service, and scholarly pursuits of the Program’s faculty and students, and to assure continued Program accreditation through it’s clinical affiliates

II. Relationship to Other Programs

Describe the links between this program and others within the department, the college and the university. Include such issues as shared requirements, interdisciplinary activities, and so on.

The program in Medical Technology is located in the School of Biological Sciences and shares the interdisciplinary administrative goals of the programs in Biology and Environmental Sciences degree programs that have been developed for the School (see missions for these curricula). In addition to these, the program in Medical Technology has a faculty of credentialed health care professionals that are available to provide the other non-health professional faculty in the School with guidance, advice, and practical training so these other faculty can properly mentor the Biology majors interested in a health-related careers.

Discuss the relationship between your unit and other units which may require courses from your unit – for instance, for minors and content courses for teacher training.

The program in Medical Technology provides required courses to the B.S. Program in Health Information Management and elective courses to the degree programs in Biology, Environmental Sciences, and Nursing. It also routinely provides guest lectures to a number of courses in these disciplines. It's faculty serve on program advisory and program accreditation committees in the Department of Health Information Management and Division of
Nursing and visa versa. The Program Coordinator provides technical expertise to the Division of Administrative Affairs on issues of safety and employee health.

Discuss the extent to which students from other disciplines take courses in your field to satisfy GER requirements and how you think these courses are suitable for that purpose.

The program in Medical Technology provides no courses to satisfy General Education Requirements.

III. Student Demographics

For each academic program you offer, describe the students in the program. Describe the quality of their academic preparation for the degree.

Our Medical Technology majors are among the best prepared in this discipline. The Program and it’s graduates meet and greatly exceed all of the ASCP Standards of Excellence and have had a 10 year average pass rate on nationally-recognized certification examinations for Medical Technologists (Clinical Laboratory Scientists) of 99% (100% in the past 5 years), and 100% admission rate of qualified students into the clinical portion of their degree program.

What are the student demand for the program?

The student demand for this Program continues to grow at an increase rate of 5-10%/year. The program has the largest enrollment of any Medical Technology degree program in the United States. All graduates in the past 10 years have gained employment or entered a post-graduate training program within 6 months of graduation.

How is the information on students made available to faculty and used in planning the curriculum?

This Program currently has only 1 full-time faculty member who also serves as Coordinator of the Program. The Coordinator disseminates student information to the faculty at its affiliated clinical sites at annual clinical faculty meetings and quarterly or semi-annual meeting conducted by the Coordinator at each clinical site. The Coordinator monitors the progress of students enrolled in the clinical phase of the degree continually, directly or through the Coordinator located at each site.

Provide five-year enrollment and graduation figures.

The five-year enrollment/graduation figures for the B.S. Program in Medical Technology are:

<table>
<thead>
<tr>
<th>Year</th>
<th>Enrollment</th>
<th>Graduates</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>82</td>
<td>12</td>
</tr>
<tr>
<td>2000</td>
<td>94</td>
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<td>14</td>
</tr>
<tr>
<td>2003</td>
<td>105</td>
<td>14</td>
</tr>
</tbody>
</table>

IV. Program Goals and Curriculum

List the goals, expectations, or desired learning outcomes of the program, telling what students are expected to know and what skills they are expected to demonstrate. For reference, Expected for all Tech Graduates are included on the Curriculum Effectiveness Survey.

The professional goals, curriculum content, and expected outcomes are to provide the student with those cognitive, psychomotor, and affective skills necessary to practice as a professional Medical Technologist (Clinical Laboratory Scientist), and as an active and productive member of society. These are accomplished through 85 semester hours of pre-professional coursework taken on campus and 40 semester hours of professional education that is accomplished at one of the University’s nine clinical sites. The Program is nationally-accredited through it's clinical affiliates by the National Accrediting Agency for the Clinical Laboratory Sciences (NAACLS). All content courses in the
curriculum MUST be designed so students demonstrate those competencies stated in the NAACLS, “Standards for Programs in Clinical Laboratory Science (Medical Technology). These Standards are extensive and are listed at www.naacls.org. These competencies are also reflected in the NAACLS publication, “The Laboratory Professional of the Future”, and the American Society of Clinical Pathologist’s (ASCP) publications, “Developing Medical Technology Curricula” and “Technical Curricula for MT and MLT”. The ASCP publications are listed at www.ascp.org/bor/directors/tech/mt. The course objectives for content courses which develop these competencies are in Appendix A.

Describe how the above goals are communicated to faculty and students – Indicate how faculty are involved in the development of these outcomes and how these outcomes are communicated to faculty and students through courses, presentations, organizations, etc. If external stakeholders are involved in the developmental process, please describe.

NAACLS accreditation is different from most academic disciplines in that accreditation is awarded to the sponsoring clinical site, rather than the sponsoring educational institution. The goals, curriculum content and expected outcomes are communicated to the Program from NAACLS. The Louisiana Tech University Medical Technology Advisory Council is charged with developing the cognitive, psychomotor, and affective learning experiences (courses, etc) to satisfy these goals and to monitor the outcomes as a condition of continued Program accreditation. The Advisory Council is comprised of the Louisiana Tech Program Coordinator; the Program Directors, Laboratory Directors and Medical Directors of the individual clinical programs; a representative of the Department of Health Information Management; a student representative; 3 alumni of the Program; and the School’s Director and Dean of the College as ex officio members. The Program Coordinator, Program Directors, and Laboratory Directors are faculty of the programs and the remaining members are external stakeholders. The goals, and expected competencies of each course in the curriculum are stated in the syllabi for each course (Appendix A). The concept of competency-based instruction and the overall expectations of Medical Technology majors are an integral part of BISC 250-Introduction to Clinical Laboratory Science. Majors take this course during the Fall quarter of their Freshman year. Each major also receives a syllabus at the beginning of each content course and the expectations of the course are discussed with them at that time. Learning experiences in the courses are designed so that the student that is successful in the curriculum has attained these competencies, and can be successful on appropriate certification examinations and in career-entry employment as Medical Technologists.

For each academic program you offer, explain how the curriculum reflects program goals. In your description, focus on the structure of the curriculum, which may include the following items:

. Explain how the major is organized: Are there core courses that all majors take? Does the curriculum have options within it?

. Explain how major-area courses at various levels, freshman, sophomore, junior, and senior – are designed to build on each other and how the content of the courses differ at the four levels. If there are pre-requisites for courses, explain the rationale for those pre-requisites.

. Explain the extent to which students in the program share learning experiences in their major fields. Explain how the program is designed to allow or enable the students to learn together.

. Explain which courses in the major that are designed specifically to address writing skills and knowledge of technology.

. Does the curriculum have a culminating capstone course, comprehensive exam, research project, or dissertation? If so, what is the content and focus?

The B.S. curriculum in Medical Technology is organized as a continuum with the Freshman year devoted primarily to GER courses, and Introduction to Clinical Laboratory Science and to other basic science courses in the curriculum; the Sophomore year, to intermediate-level GER courses and to introductory content courses in the disciplines appropriate to Medical Technology; the Junior year, to upper level content courses in the discipline, to medical management and educational techniques, and to professional and career development; the Senior year as a calendar year of advanced professional education and training in a supervised healthcare setting. All courses in the curriculum are required (no electives). Students who wish to pursue this curriculum to meet the academic
requirements for admission to medical or dental school must take an additional 4 semester hours of introductory biology, 8 semester hours of physics and 5 semester hours of organic chemistry.

The GER courses in the curriculum include: 6 credits of English Composition, 3 credits of college algebra, 9 credits of social sciences, 4 credits of general biology, 8 credits of general chemistry, 3 credits of fine arts appreciation, 3 credits of statistics, 3 credits of history, 3 credits of speech communication, 3 credits of technical writing, and 3 credits of literature.

Intermediate-level foundation courses are 2 credits of introduction to CLS in which the student demonstrate their computer literacy skills, 4 credits of anatomy/physiology, 4 credits of general microbiology, 3 credits of organic/biochemistry, and 3 credits of bioinstrumentation.

Upper level content courses include: 3 credits of hematology, 6 credits of management, 4 credits of medical microbiology/immunology, 4 credits of clinical biochemistry/toxicology, 2 credits of immunohematology, 2 credits of Professional Practices.

The professional component of the curriculum (senior year) includes a total of 40 credits to include instruction in advanced medical microbiology, advanced clinical toxicology, advanced clinical immunohematology, advanced clinical hematology, advanced clinical chemistry/enzymology/endocrinology, advanced clinical immunology, advanced medical management, and advanced medical genetics.

All the learning experiences in the content courses in the curriculum involved group dynamics, and direct “hands-on” instruction and experiences. All experiences are designed so that the student can exercise independent judgment and to further develop their hypothetical-deductive reasoning skills. Adequate scientific writing skills are required in Technology Writing and in most of the upper division courses. These include preparation of scientific papers, development of analytical protocols, and laboratory reports. All learning experiences in the professional setting involved the use and mastery of the most modern instruments and analytical concepts in biology, chemistry, and laboratory medicine. The curriculum actually has two “capstone courses”--- Professional Practices, at the end of the pre-clinical portion of the curriculum and a clinical course ----- Laboratory Administration, at the end of the clinical year that reviews the entire content of the professional curriculum and prepares the student to take their professional certification examination.

All graduates take one or more nationally-recognized certification examinations. Success on one is required for professional practice as a Medical Technologist/Clinical Laboratory Scientists. Federal statutes prevent the use of success on a standardized professional certification exam as conditions for graduation, so student performance on these exams can be and are used as one of the discriminators of Program success.

IV. Documentation

Describe the process used to regularly monitor and assess the quality of the program relative to the overall goals of the program and the learning outcomes. Identify the stakeholders and how and when they are consulted.

The Standards for Accreditation of Programs in Clinical Laboratory Science (Medical Technology) contain detailed requirements for monitoring and documenting the quality of Program accredited by NAACLS. All clinical sites affiliated with the Louisiana Tech University Program in Medical Technology have attained and maintain the highest level of accreditation by this agency which, in itself, is a positive discriminator of program quality. The chief indicators of quality are: (1) the graduate's performance on the American Society of Clinical Pathologist or the National Credentialing Agency for Clinical Laboratory Scientists certification examinations, which are the internationally-recognized certification examinations which these graduates must pass to practice this profession; and (2) follow-up surveys of graduate success with both the graduate and their employers or mentor; (3) an evaluation of graduate performances on the various parts of the certifications examinations; and (4) the requirement for all faculty to have documented continuing educational experiences. Documentation of these discriminators is housed at each clinical site. The Director of School of Biological Sciences also conducts an exit survey and interview with each graduate in an effort to gain "feedback" from them on the quality of their educational experience. The results of these surveys and interviews are housed in the office of the School.
These discriminators of quality are reviewed at each annual meeting of the Louisiana Tech University Medical Technology Advisory Council and at periodic meetings between the Program Coordinator and Program Directors of each individual clinical affiliate throughout the year.

*Present evidence of the extent to which the curriculum/program/major field goals are met. List the sources of evidence, both quantitatively and qualitative; and*

*Critically analyze/review information and data collected about the curriculum. Identify strengths, weaknesses, opportunities for the curriculum. Report strengths, weaknesses, and opportunities identified.*

In 2000, the American Society of Clinical Pathologist published their “Quality Indicators and Benchmarks” for degree programs in this discipline. These are considered the "gold standards" to evaluate program quality and learning outcomes in the field. The Louisiana Tech Program has met and exceeded each one of these indicators of excellence for over 15 years.

Benchmark 1 is, “students admitted to the clinical program have an average pre-admission GPA’s of 3.0” The program's 15 year average is 3.3.

Benchmark 2 is “that the ratio of applicants to number accepted to the clinical phase be 2:1”. The program's 15 year average is 1:1.

Benchmark 3 is “that the class size/clinical site not to exceed 10 students”. The program's 15 year average clinical class size is 8.

Benchmark 4 is “that 90% of the clinical students complete the clinical program”. The program's 15 year average is 98%.

Benchmark 5 is “that there be a 94% success rate in graduates gaining employment or admission to a post baccalaureate degree program”. The program's 15 year average is 99%.

Benchmark 6 is “that 85% of graduate pass their certification examination”. The program's 15 year average is 97%.

Benchmark 7 is that “81% of employers are satisfied with the professional preparation of the graduate”. The program's 15 year average is 100%.

Benchmark 8 is that “the amount of time spent in professional-oriented lecture is a minimum of 349 hours”. The program's 15 year average is 560 hours.

Benchmark 9 is that “the amount of time spent in professional-oriented student labs is a minimum of 394 hours”. The program's 15 year average is 420 hours.

Benchmark 10 is that “the amount of time spent in clinical rotations is a minimum of 948 hours”. The program's 15 year average is 1750).

On the State level, Louisiana Tech has continually maintaining the greatest number of qualified majors in the field, routinely having the highest admission rate to the clinical phase of the Program and has providing more Medical Technologists (Clinical Laboratory Scientists) than any other Program of this type. The Program has been recognized by the Louisiana State Board of Regents as an Academic Program of Excellence.

"S.W.A.T.” analyses are a component of the annual meetings of the Louisiana Tech University Medical Technology Advisory Council. Findings are detailed in Section X of this report.
VI. Prior Assessment and Development of the Program

Describe how assessment results have been used in the recent past to improve the program goals, learning outcomes, curriculum, faculty, or resources.

The Program in Medical Technology is nationally accredited by NAACLS through its individual clinical sites. Each site, in conjunction with the Program’s campus-based faculty, has developed Self-study documents and received on-site inspections within the past 5 years. All sites received full re-accreditation without deficiencies. The relevant comments from these inspections that have been used to improve the Program were to (1) include additional coursework to develop student competencies in managerial principle, supervisory practices, reimbursement methodologies, compliance, education and performance improvement; (2) modify course content to meet new accreditation standards; and (3) increase funding for support of the clinical phase of the Program. These have become the University Assessment Goals and SACS goals and objectives for this academic program. These findings have been communicated to the Director by the Program Coordinator in his annual University Assessment and SACS follow up reports for reconciliation.

Report the implications of the findings, particularly as they relate to needed changes in the curriculum.

The 2000 revision of NAACLS accreditation standards necessitates major modifications in the curriculum and in course content. To seek input on how to address the curriculum changes directed by the new NAACLS standards, a questionnaire was developed and was completed by an estimated 75 external stakeholders (employers, clinical faculty, graduates, current students). The Program Coordinator held hearings on these issues at each clinical affiliate to discuss the results of the survey and collect additional data as to how to proceed. The Louisiana Tech University Medical Technology Advisory Council was assigned the task of evaluating these data and recommending the needed changes. This group met on 3 occasions to complete this task.

Describe how you will use the information you have collected and analyzed, outlining changes to be made based on the evidence collected; such changes might include developing new courses, deleting courses, adding special topics, etc.

The Program Coordinator submitted major curriculum changes to reflect the recommendations of the Advisory Council in 2003. The curriculum was modified to include 2 new courses (HIM 240 and HIM 440) and to revise CLAB 457 to address these new curriculum content issues. The number of hours of organic chemistry was reduced and 2 courses were consolidated (immunology and pathogenic microbiology) to keep the curriculum within the required 125 semester hours. The certification examinations that graduates of this Program take are to reflect these new competencies beginning in 2005. Student success of those portions of these exams shall be monitored as a measure of the success of these additions.

If your academic unit teaches courses used to satisfy General Education Requirements at Louisiana Tech University, describe in adequate detail the measures your unit and/or the University are using to evaluate the skills and knowledge added by these courses.

This academic Program provides no courses used to satisfy General Education Requirements.

VII. Faculty

List the major subject subdivisions in your program, listing the faculty who teach in those areas.

The major subdivisions in this Program are:

General Education Requirement Courses*
ENGL 101/102-English Composition- 6 semester hours
MATH 101-College Algebra- 3 semester hours
STAT 200-Statistics- 3 semester hours
ENGL201 or202-American or British Literature- 3 semester hours
ENGL 303-Technical Writing- 3 semester hours
HIST 101or 102or 201 or202-History Elective- 3 semester hours
ART 290 or HES 280 or MUGN 290 or SPTH 290-Fine Arts Appreciation Elective- 3 semester hours
CHEM 100-104- General Chemistry- 8 semester hours
BISC 130-131-General Biology- 4 semester hours
PSYC or SOCI or ECON or POLS or GEOG- Social Science Electives- 9 semester hours
SPCH 110 or 388- Speech Communication- 3 semester hours

Science Foundation Courses*
BISC 224-226-Human Anatomy and Physiology- 4 semester Hours
BISC 260-General Microbiology- 4 semester hours
CHEM 121-Organic and Biochemistry- 3 semester hours

Pre-Clinical Medical Technology Courses
BISC 250-Introduction to Clinical Laboratory Science with Computer Lab- 2 semester hours**
BISC 226-Instrumentation- 3 semester hours**
BISC 341-Hematology- 3 semester hours**
BISC 344- Clinical Chemistry and Toxicology- 4 semester hours**
BISC 343-Medical Microbiology and Immunology- 4 semester hours*
BISC 445-Immunohematology- 2 semester hours***
HIM 240-Supervisory Management for Health care Professionals- 3 semester hours*
HIM 440-Basic Reimbursement and Compliance for Health Care- 3 semester hours*

Professional (Clinical) Medical Technology Courses***
CLAB 460- Clinical Hematology- 4 semester hours
CLAB 461- Clinical Hematology Lab- 5 semester hours
CLAB 462- Clinical Serology/Immunology- 2 semester hours
CLAB 463- Clinical Serology and Immunology Lab- 1 semester hour
CLAB 464- Clinical Bacteriology- 3 semester hours
CLAB 465- Clinical Bacteriology Lab- 5 semester hours
CLAB 466- Clinical Immunohematology- 3 semester hours
CLAB 467- Clinical Immunohematology Lab-3 semester hours
CLAB 468- Clinical Chemistry and Toxicology- 4 semester hours
CLAB 474- Clinical Urinalysis- 1 semester hour
CLAB 478- Clinical Lab Administration- 1 semester hour
CLAB 483- Clinical Parasitology- 1 semester hour
CLAB 484- Clinical Parasitology Lab- 1 semester hour
CLAB 486- Clinical Phlebotomy- 1 semester hour
CLAB 489- Clinical Chemistry and Toxicology Lab- 5 semester hours

Those courses in the curriculum that are marked by with asterisk (*) are taught by faculty in those respective areas. Their qualifications are indicated in the Academic Program Reviews for those respective academic units. Courses marked with a double asterisk (**) are taught by K.E. Griswold, Professor and Coordinator, Program in Medical Technology; Ph.D. in Biology, University of South Carolina- 1971. Courses marked with triple asterisk (*** ) are taught by the following clinical faculty. These instructors have un-paid clinical academic appointments at Louisiana Tech. All are full-time at the clinical sites and professionally credentialed in Medical Technology and with a minimum of 10 years of practice in the discipline. All exceed the basic NAACLS academic and professional requirements to serve as clinical faculty.
These faculty are:

<table>
<thead>
<tr>
<th>CLINICAL FACULTY</th>
<th>DEGREE</th>
<th>MAJOR</th>
<th>UNIVERSITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sandy Ackerman</td>
<td>M.Ed.</td>
<td>Science Education</td>
<td>Univ. of AR- Littler Rock</td>
</tr>
<tr>
<td>Mary Beene</td>
<td>M.HS</td>
<td>Health Sciences</td>
<td>LSUMC</td>
</tr>
<tr>
<td>Terry Bell</td>
<td>M.D.</td>
<td>Pathology</td>
<td>Ohio State</td>
</tr>
<tr>
<td>Richard Blanchard</td>
<td>M.D.</td>
<td>Pathology</td>
<td>LSUMC</td>
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<tr>
<td>Richard Boatman</td>
<td>M.D.</td>
<td>Pathology</td>
<td>Univ. of OK Med School</td>
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<tr>
<td>C.G. Bowling</td>
<td>M.D.</td>
<td>Pathology</td>
<td>West VA Med School</td>
</tr>
<tr>
<td>James Hair</td>
<td>M.D.</td>
<td>Pathology</td>
<td>LSUMC</td>
</tr>
<tr>
<td>Keith Hariston</td>
<td>M.D.</td>
<td>Pathology</td>
<td>Univ. of AR Med Sci.</td>
</tr>
<tr>
<td>Aubrey Lurie</td>
<td>M.D.</td>
<td>Pathology</td>
<td>Col Med. S. Africa</td>
</tr>
<tr>
<td>Dianne Malveaux</td>
<td>B.S.</td>
<td>Med Tec h + 20grad hr.</td>
<td>In Business(Health Care Mgt) Mc Neese</td>
</tr>
<tr>
<td>George Mc Cormick</td>
<td>Ph.D.,M.D.</td>
<td>Anatomy/ Pathology</td>
<td>Univ. of TN Med Ctr.</td>
</tr>
<tr>
<td>Joyce Nantze</td>
<td>M.S.</td>
<td>Interdisc. Health Sci.</td>
<td>E. TX. State</td>
</tr>
<tr>
<td>David Nash</td>
<td>M.D.</td>
<td>Pathology</td>
<td>UT- SW Med School</td>
</tr>
<tr>
<td>Laine Poe</td>
<td>B.S.</td>
<td>Med Tech + 21 grad. Hr.</td>
<td>Louisiana College</td>
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<tr>
<td>Nancy Smith</td>
<td>M.D.</td>
<td>Pathology</td>
<td>LSUMC</td>
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<tr>
<td>Charles Traylor</td>
<td>J.D.</td>
<td>Health law</td>
<td>LSU</td>
</tr>
<tr>
<td>Dawn Young</td>
<td>M.A.</td>
<td>Psyc.</td>
<td>ULM</td>
</tr>
<tr>
<td>Deborah Zink</td>
<td>M.B.S.</td>
<td>Health care Adm.</td>
<td>Lamar U.</td>
</tr>
</tbody>
</table>

Describe the mechanisms used in your unit to ensure that each faculty member is "providing quality instruction for all classes assigned"

The Program Coordinator is the only campus-based faculty member in the program. He conducts an annual Self Evaluation of his performance and this is followed by an administrative evaluation by the School's Director. The clinical faculty in this Program serves, with the Coordinator and others, as the Louisiana Tech University Medical Technology Advisory Council. This group meets at least annually, as a whole, to discuss curriculum content, course enhancement, integrated learning and other ways to improve the performance of the program's instructors. All faculty, including the Program Coordinator, are REQUIRED by NAACLS to attend a minimum of 12 hours of continuing education per year in effective teaching techniques and other issues related to allied health education. These offerings are usually provided by NAACLS, or the relative professional associations.

The Program Coordinator MUST also meet with the clinical faculty of each clinical site in which Tech majors are matriculating at least each quarter as a condition of the affiliation agreements between the University and these sites. The purpose of these meetings are to insure program quality. The Program Coordinator also communicates electronically with the clinical faculty, four or more times/week for the same purposes. Again, such communication is required as a condition for continuing NAACLS accreditation.

VIII. Faculty/Student Contact

Describe any activities which promote student-faculty interaction, such as organizations, formal meetings, and informal counseling and other contacts.

Chi Lambda Beta is a campus organization that is exclusively for Medical Technology majors. The Coordinator of the Medical Technology program is the faculty sponsor for the organization. The group meets at least monthly with programs that involve professional, social, and service-oriented contacts with clinical based faculty and students, students in other health care disciplines. The Coordinator is available a minimum of two hours each day for the purpose of informal student counseling and faculty-student interaction. Clinical students are routinely involved with
clinical faculty in State and nationally-sponsored activities of the America Society of Clinical Laboratory Scientists and America Society of Clinical Pathologists.

If faculty serves as advisors, describe how faculty are trained to be advisory in the program. If not, describe how advising occurs in the unit.

The faculty advisor for these majors has 37 years experience as a health science educator and has advised and mentored in excess of 2000 health science majors in his tenure. He has extensive training on student mentoring and routinely is called upon to train less experienced faculty in effective counseling techniques. All new faculty also are required to attend university-sponsored workshops on student advisement.

IX. Facilities and Support

Identify the facilities (classrooms, laboratory, studio) and equipment available to the program.

One 25-student laboratory, a combination 25-student classroom/laboratory and a 40 student classroom is available for this Program on campus. Each clinical site has 10,000-15,00 square feet of modern laboratory space and a student classroom for the clinical portion of the program. An inventory of approximately $50,000 worth of basic laboratory equipment is available for pre-clinical education in the campus classrooms/labs. Each clinical site has an inventory of ultra-modern equipment for use by the students valued in excess of $2,000,000.

Report all financial support for the program, including operating funds, travel funds, equipment funds, support from clinical fees, funds for assistantships and fellowships, funds for student workers, and grant/gift income. Provide a three-year summary and a projection for the coming year.

There are no dedicated funds for the Program in Medical Technology with the exception of a $1000/clinical student account that is reimbursed from student fees and budgeted funds to the clinical sites and approximately $3000 in grant funds used for equipment each of the past three and the coming years. Other funding is obtained from the overall budget to the School of Biological Sciences (see the Academic Program Review for Biology for past and projected budget data). Forty-five dollars/biological science lab is assessed from each major. These funds are used to fund the expenses of labs on campus.

X. Program Strengths and Weaknesses

Identify areas of particular strength in program makeup, students, and faculty. Refer to information documented in this report.

The Louisiana Tech University Bachelor of Science Program in Medical Technology is the oldest and largest, in terms of number of majors, of any in this discipline in the U.S. Enrollment in the Program has grown from 91 majors in 1994 to 136 today. It is a traditional “3 + 1” health science program in which majors take 3 years of pre-professional course work on campus and their senior year of professional (clinical) course work in a Louisiana Tech-affiliated School of Medical Technology located in a medical center in the region. The primary strength in this Program is the clinical portion which allows these students to learn and train in the most modern educational setting available in the health sciences. Because of this, graduates of the Program are “work-ready” and also prepared for advanced education in a variety of basic and medical science disciplines. In 2000, the American Society of Clinical Pathologist published their “Quality Indicators and Benchmarks” for degree programs in this discipline. The Louisiana Tech Program has met and exceeded each one of these indicators of excellence for over 15 years. It is this success, and the hard work of the Program’s campus-based and clinical faculty that has kept this Program operational, while 60% of the degree programs in Medical Technology in the State and nation have closed. The Program Coordinator is a nationally-recognized authority in Medical Technology education (see CV) and the clinical faculty are among the highest trained of any Program of this type. Student and graduates of the Program have or continue to hold a variety of key positions at the State and national levels in the American Society of Clinical Laboratory Sciences, including President and Student Forum Chair.
Financial hardships in the hospitals that have supported our clinical affiliates have resulted in the closure of five of these affiliates in the past 10 years and a reduction in the number of clinical student positions in three others. The financial support provided by the University to each clinical site was insufficient to off-set these cuts.

There has also been a reduction in campus based faculty from 2 FTEs to 1 in the past 5 years. This has taxed the Program Coordinator and lead to resorting to using adjunct faculty to staff key courses.

Both issues have been continually addressed by the Coordinator.

XI. Future Actions to Improve the Program

Project any contemplated changes over the next two years to improve the program

The following actions have been proposed to maintain the Program and to continue it as one of national prominence:

(1) Louisiana Tech University majors in Medical Technology are enrolled for 4 consecutive quarters as full-time students while in the professional phase of their degree program. They receive 40 semester hours of lecture/laboratory instruction at the “400-level” during this period. 90% of the cost of this instruction, including instructor’s salaries, is borne by the medical centers in which our affiliated Schools of Medical Technology are located. According to a 2004 survey of Program Directors of our affiliated Schools, the expenses incurred to instruct 10 of our clinical students for the professional year are $105,759. Louisiana Tech University provides $1000 clinical student in support to our affiliates ($750 in budgeted funds and $250 from Clinical Laboratory Fee collected from each clinical student). One clinical site charges each clinical student an additional $2600 and another additional $500. Within the next 2 years, an increase in funding to the clinical programs to $3500/clinical student is essential to meet future need and maintain the current standards of excellence. These funds can come from a combination of an increase in the Clinical Laboratory Fee assessed to the student and from budgeted sources.

(2) It is also essential that the teaching commitment to and the provision of continuing education of the clinical faculty to each clinical program be restored. This is to meet the directive in the Board of Regent’s, “Report of the Statewide Committee on Baccalaureate Degree Programs in Medical Technology” and the contractual agreements the University have with each clinical site. This was provided by the Coordinator in Medical Technology in the past, but was discontinued when he had to teach those courses taught previously by faculty whose positions were un-filled or re-described with they left.

(3) Teaching and laboratory space has been planned for the Medical Technology Program in the Health Science and Biology Building. This includes 2 teaching labs, “smart” classroom with distance learning capabilities, and sufficient number of offices to house present and future faculty.

These are realistic expectations and can be achieved by the present or realistically-projected additional resources.
APPENDIX A-
COMPETENCY REQUIREMENTS AND COURSE OBJECTIVES FOR COURSES IN THE MAJOR
COURSE DESCRIPTION: The theory of operation, calibration and maintenance of major instruments used in scientific investigations will be taught by didactic presentation and "hands-on" experience.

EXPECTED COMPETENCIES

Upon completion of this course, participants shall:

1. Understand the use and care of each component of a standard operating procedure
2. Comprehend and apply the basic safety rules which apply to the performance of laboratory testing
3. Apply statistical analysis of data to validate the accuracy and precision of their analysis
4. Differentiate between the preparative and analytical roles of various instruments
5. Understand the incorporation of computers into the design and operation of instruments, and for the analysis and communication of data
6. Understand the scientific principles applied to the design and operation of all basic instruments used in the analytical laboratory
7. Measure specified analytes using representative laboratory instruments
8. Understand how the preparative, analytical, and data handling tasks performed by instruments can be interfaced into one automated instrument
9. Describe the design and function of the common automated laboratory analyzers
10. Apply the rules of cost accounting, safety, personnel acceptance, accuracy/precision, and flexibility to the selection of lab instruments

GRADING: Written Examinations = 85% of final grade
Laboratory Exercises = 15% of final grade

Written examinations shall include material covered in both the lecture and lab components.

Unannounced examinations may be given at the discretion of the instructor. Makeup examinations will be of the discussion type, will be given only to students with excused absences and will all be given at the instructor’s discretion. Students who miss an examination and if the instructor has received no excuse in writing, the student will receive “0” for that exam.

Grading Scale: 90 - 100% = A 60-69% = D
80 - 89% = B BELOW 69% = F

LABORATORY FEE: THE SCHOOL OF BIOLOGICAL SCIENCES HAS ASSESSED A $45 LAB SUPPLY CHARGE FOR THIS COURSE. THIS SHOULD BE PAID TO MS. MARY WATSON, SCHOOL SECRETARY IN CTH 215

SAFETY REQUIREMENTS: This course requires the handling of certain potentially dangerous biological products and chemicals. All students shall receive an in service on the safe handling of these hazards. It is the student’s responsibility to apply and conform to all of these rules when performing laboratory assignments. The instructor is not responsible for illness or injury due to negligence on the student’s part.

ATTENDANCE: Attendance is expected. Make up work shall be allowed if a student who is absent submits excuses acceptable to the instructor, in writing, for all class absences to the instructor within three (3) days after the student returns to class. This is in accordance with the University Bulletin.

GENERAL OBJECTIVES: The student shall:

Classes 1 & 3 - Characteristics of Instrumental Analyses - LE
A. Comprehend the significance of each component of a Standard Operating Procedure (SOP).
B. Describe the characteristics of specimens used in instrumental analyses as to:
   1. Source
   2. Methods of collection
   3. Handling, preservation, and storage
   4. Chain-of-custody procedures
C. Understand the importance of proper reagent selection and use, including the selection and use of standards and controls to accurate and precise instrumental analysis.
D. Identify the instruments used in instrumental analysis.
E. Distinguish between the preparative and detection functions of the instruments identified in D.

Class 2 - Laboratory Safety - LA
A. Review the essentials of chemical and laboratory safety.
B. List the requirements for use, containment, and disposal of biological, chemical, and radioactive materials.
C. Comprehend the OSHA Blood-borne Pathogen and Chemical Handling/Disposal Standards
D. Demonstrate the proper method of containing and decontaminating a lab surface after:
   1. A biological spill
   2. A chemical spill
   3. A radioactive spill
E. Correlate the methods of disinfection and sterilization with specific applications in the sciences.
Class 4 - Computers Applications and Quality Assurance in Instrumental Analysis - LE
A. Describe the tasks performed by computers in the analytical laboratory
B. Explain the methods of selection of proper instrumentation in the design of an experiment.
C. Describe the fundamental concepts of quality assurance as part of experimental design.
D. Describe the use of statistical analysis to assess quality.

Class 5 - Statistical Analysis of Laboratory Data - LA
A. Perform and interpret statistical analysis of analytical data provided by the instructor for the purpose of assessing quality.

Classes 6 & 9 - Fundamentals of Electricity - LE
A. Describe the basic characteristics of the electromagnetic spectrum.
B. Assess the interrelationships of frequency, wavelength, and energy in electromagnetic measurements.
C. Describe the applications of the measurement sound, light, electricity, and ionizing radiation in the design of analytical instruments.
D. Identify and describe the uses of the basic components of an electrical circuit.
E. Identify methods of converting one form of electromagnetic radiation to another.

Class 7 - EXAM 1 (Classes 1-5)

Class 8 - General Laboratory Apparatus - LA
A. Identify the glass and plastic ware commonly used in analysis performed in the environmental, biological and health sciences.
B. Correlate the composition of the items identified in A with specific uses.
C. Describe proper methods of cleaning and storage of the items listed in A.
D. Identify the types of manual and mechanical pipets.
E. Describe the components of a centrifuge.
F. Calculate the RCF of a centrifuge.
G. Demonstrate proper balancing and cleaning techniques for centrifuges.
H. Describe the components and methods of operation of mechanical balances.
I. Operate mechanical balances to the satisfaction of the instructor

Class 9 - Optical Instruments - Photometry - LE
A. Define wavelength and its relationship to photometric measurement.
B. Define Beer's Law and explain the relationships between the variables in this equation.
C. Describe the primary characteristics and uses of:
   1. Simple spectrophotometer
   2. UV spectrophotometer
   3. Flame photometer
   4. Atomic absorption spectrophotometer
   5. Fluorometer
   6. Nephelometer
   7. IR spectrophotometer
   8. Reflectance photometer
D. Describe how the components of the instruments listed in D differ from a photometer.

Class 10 - Optical Instruments - Photometry - LA
A. Identify and give the function of the basic components of a spectrophotometer
B. Disassemble and identify the essential components of a:
   1. Simple photometer
   2. UV spectrophotometer
   3. Flame photometer
C. Demonstrate the proper methods for performing:
   1. Wavelength calibration
   2. Linearity check
   3. Dark current evaluation
D. Demonstrate the operation of a spectrophotometer and the use of mechanical pipets by:
   1. Evaluating spectrophotometric data obtained in a pipetting experiment as to accuracy and reproducibility.
   2. Constructing a graph of absorbency vs. concentration using data obtained in the experiment 1
   3. Statistically, comparing the data obtained in the gravimetric calibration in experiment 1 with the data obtained in this experiment.

Class 11 - Optical Instruments - Photometry - LA
A. Identify and give the function of the basic components of a spectrophotometer
B. Disassemble and identify the essential components of a:
   1. Simple photometer
   2. UV spectrophotometer
   3. Flame photometer
C.. Demonstrate the proper methods for performing:
   1. Wavelength calibration
   2. Linearity check
   3. Dark current evaluation
D. Demonstrate the operation of a spectrophotometer and the use of mechanical pipets by:
   1. Evaluating spectrophotometric data obtained in a pipetting experiment as to accuracy and reproducibility.
   2. Constructing a graph of absorbency vs. concentration using data obtained in the experiment 1
   3. Statistically, comparing the data obtained in the gravimetric calibration in experiment 1 with the data obtained in this experiment.

Class 12 - EXAM 2 (Classes 6, 8-11)

Class 13 - Radiometry - LE
A. Characterize alpha, beta, gamma, and x-radiation, and nuclear magnetic resonance as to:
   1. methods of production
   2. uses in medical and biological testing
B. Explain the methods to standardize and collect data by:
   1. liquid and solid scintillation counting
   2. autoradiography
   3. conventional x-ray detectors
   4. CT scanners
   5. magnetic resonance imagers

Class 14 - Electrophoresis - LA
A. Describe the components required to perform:
   1. electrophoresis
   2. isoelectric focusing
B. Explain the effects of Stoke's Law and offer related factors on electrophoretic resolution.
C. Describe the methods for quantitation of electrophoretic fractions.
D. Describe the common applications of electrophoresis.
E. Compare the applications of electrophoresis to those of isoelectric focusing.
F. Explain the benefits and limitations of electrophoresis and isoelectric focusing.
G. Fractionate a mixture of proteins by gel electrophoresis.
H. Understand the theory of specific staining techniques used to identify biomolecules
I. Quantitate the fractions obtained in G by densitometry.
Class 15 - Chromatography - LE

A. Explain the theory of:
   1. Thin-layer/absorption chromatography
   2. Ion-exchange chromatography
   3. Gel-permeation chromatography
   4. Low pressure and high pressure partition liquid chromatography
   5. Affinity chromatography
   6. Gas-liquid chromatography

B. Describe the equipment required to perform the methods listed in A.

C. Describe the environmental, biological and clinical applications of the methods listed in B.

Class 16 - Potentiometry and Ion-Selective Electrodes - LE

A. Define:
   1. Polarography
   2. Amperometry
   3. Coulometry
   4. Conductometry
   5. ISE
   6. Potentiometry

B. Outline the analytical principle of each concept listed in A.

C. Describe how each concept in A is used in biological analyses.

D. Explain the benefits and liabilities of using electrodes in the measurement of analytes in fluids.

Class 17 - Practical Applications of Chromatography - LA

A. Separate Hemoglobin A-1C from other forms of hemoglobin using chromatography.

B. View and identify the components of a gas-liquid chromatograph.

Classes 18 and 21 - Immunoanalytical Techniques and Gene Probes - LE

A. Comprehend the theory of:
   1. Radioimmunoassay
   2. Non-isotopic immunoassay
   3. Immunodiffusion
   4. Immunoelectrophoresis
   5. Gene probe assays
   6. Immunoprecipitation

B. Describe the methods used to perform the techniques listed in A.

C. Describe the utility of the techniques listed in A.

D. Perform and interpret the results of a select immunoassay.

CLASS 19 - Exam 3 (Classes 13-17)

Class 20 & 23 - Optical Instruments - Microscopy - LA

A. After completing a written assignment:
   (1) Identify the basic components of light, bright and dark-field, fluorescent, phase contrast, and electron microscopes; (2) Assess these microscopes as to resolution and utility in the sciences.

B. Describe the basic methods of specimen preparation for examination with microscopes.

C. Demonstrate the proper use of the light microscope.

D. Demonstrate the proper methods of care and maintenance of the light microscope.

E. Review the operation of a:
   1. Phase contrast microscope
   2. Fluorescent microscope
   3. Electron microscope

Class 22 - Maintenance of Laboratory Equipment - LE

A. Understand the relationships between the proper maintenance of laboratory instruments and the quality of laboratory testing.

B. Describe the preventive maintenance tasks appropriate to all analytical laboratories.

C. Establish a preventive maintenance program for an instrument described in previous classes.

D. Troubleshoot a 3-5 instrument malfunctions using established guidelines for such activities.

CLASS 24 - Exam 4 (Classes 18, 20-23)

Class 25 - Selection Techniques for Instrument Purchase and Instrument Maintenance Programs - LE

A. Perform an instrument utilization study and operational cost analyses of instruments.

B. Correlate instrument selection with the physical plant in which the instrument is to be located such as:
   1. utility requirements
   2. safety requirements
   3. available personnel
   4. existing laboratory facilities

Class 26 - Care, Maintenance, and Proper Use of pH Meters and Assessment Techniques for Water Purity - LA

A. Identify all the parts of and assemble a pH meter.

B. Calibrate and temperature compensate a pH meter.

C. Correctly analyze unknown specimens provided by the instructor for pH.

D. Describe the methods for assessing water purity.

E. Correlate the specifications of purity for different types of water with uses of this reagent.

F. Understand the methods of analyzing iron and total hardness in water by Spectrophotometry and Visual Comparison.

G. Prepare the necessary reagents to assay iron and total hardness.

H. Assay 2 unknown solutions containing iron and total hardness by the methods listed in D.

I. Calculate the concentrations of the solutions analyzed spectrophotometrically using Beer's Law.

Classes 27, 28, and 29 - Automation - LE/LA

A. Differentiate between a manually-performed and an automated procedure.

B. Disassemble and identify the various components of an automated analyzer.

C. Understand the importance of computer-assisted technology in the design of automated instruments.
D. After having viewed a series of videos on laboratory automation: understand the analytical principles incorporated in the design, sample and reagent requirements, methods of sample identification and introduction into the system, method of data analysis, method of data output, and quality assurance capabilities of each instrument discussed.

Class 30 - LAST EXAM COVERING CLASSES 25-29

Class 31 - Makeup Examinations

TEXT: CLINICAL LABORATORY INSTRUMENTATION AND AUTOMATION, BY: WARD, ET AL

Each class will be supplemented with a handout

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BISC 250- INTRODUCTION TO CLINICAL LABORATORY SCIENCES  
SCHOOL OF BIOLOGICAL SCIENCES  
LOUISIANA TECH UNIVERSITY  
RUSTON, LOUISIANA

INSTRUCTOR: Kenneth E. Griswold, PhD  
OFFICE: CTH 116  
OFFICE HOURS: By Appointment, 10:00-12:00 Daily ( Fri. Clinical Students Only)  
PHONE/EMAIL: 257-4573/ egriswold@gans.latech.edu

CLASS REQUIREMENTS

This course is equally divided into a lecture portion and a laboratory portion. The lecture portion is to orient the student to the health related professions and to the delivery of modern health care. The laboratory portion is designed to allow students to demonstrate the fundamentals of computer literacy.

CLASS TIMES: Lecture portion= 8:00-9:15 T- GTM 1;  
LOCATIONS: Lab portions= 9:15-9:50 T; 8:00-9:50 - CTH 105

TEXT: None Required; Handout material shall be provided for each class; other reading materials are to be “downloaded” by the student as needed.

ATTENDANCE: Attendance is expected, as stated in the Class Attendance Policy on page 26 of the Louisiana Tech University Bulletin. A student who is absent shall submit an excuse for that absence. If an absence is unexcused, according to these Policies, the student will not be allowed to makeup any missed work, including Any missed Tests/assignments

GRADING: Daily quizzes should be expected each class period. YOUR QUIZ GRADE AVERAGE WILL COUNT 40% OF YOUR FINAL GRADE. Outside of class assignments will count 10% OF YOUR FINAL GRADE. Laboratory assignments/presentations will count 50% OF YOUR FINAL GRADE

GRADING SCALE:  
90 - 100% = A   60 - 69% = D  
80 - 89% = B   0 - 59% = F  
70 - 79% = C

ASSIGNMENTS: Each class will have reading assignments and/or projects that are due the following class period unless otherwise indicated by the instructors

CLASS RULES: Each student should:  
1. Be punctual ( tardiness is not permitted)  
2. Not chew gum, eat, or drink in the classroom or lab  
3. Not disturb the class in any manner  
4. Keep exams covered at all time and your eyes on your own paper  
5. Be courteous to all participants in the class  
6. Adhere to all additional rules that apply to the computer lab.

FAILURE TO ADHERE TO THESE RULES MAY RESULT IN DISMISSAL FROM THE CLASS AND THE REFERRAL OF THE INCIDENT TO THE BEHAVIORAL STANDARDS COMMITTEE
COURSE GOALS

This course is designed to: (1) orient the student to health-care and the health-related professions; and (2) evaluate the computer literacy and enhance the computer skills of each student. The terminal expectations of each student is that they demonstrate the following, with 100% accuracy and precision:
EXPECTED COMPETENCIES

Upon completion of this course the student shall:

A. Fully characterize the anatomical, physiological, and molecular attributes of blood and the blood-forming organs in a non-diseased person;

B. Describe the etiology, physical signs and symptoms, laboratory findings and treatment of the 20 most common diseases of blood and blood-forming organs;

C. Correctly collect blood by acceptable methods and perform the most commonly requested hematology laboratory procedures on these specimens;

D. Describe the analytical principles used in the design of the most commonly requested hematological procedures;

E. Interpret the results of representative hematology laboratory findings as to the diseases they reflect.

GRADING: There will be 4 written examinations which will include material presented in both the lecture and laboratory components of the course. The average of these examinations will count 90% of the final average. 10% of the final average is derived from the average grade made on enabling exercises. The grading scale used to compute the letter grade is:

- 90% - 100% = A
- 70% - 99% = D
- Below 60% = F
- 60% - 69% = C

IN ACCORDANCE WITH THE LA. TECH UNIVERSITY HONOR CODE, ALL STUDENTS MUST PLEDGE THE FOLLOWING: “BEING A STUDENT OF HIGHER STANDARDS, I PLEDGE TO EMBODY THE PRINCIPLES OF ACADEMIC INTEGRITY”. ANY STUDENT NEEDING TESTING OR CLASSROOM ACCOMMODATIONS BASED ON A DISABILITY ARE ENCOURAGED TO DISCUSS THOSE NEEDS WITH THE INSTRUCTOR AS SOON AS POSSIBLE.

SAFETY REQUIREMENTS: This course requires the handling of blood and blood products and certain potentially dangerous chemicals. All students shall receive an in service on the safe handling of these hazards. The instructor is not responsible for illness or injury due to negligence on the student’s part.

THERE IS A $45/STUDENT LAB SUPPLY CHARGE FOR THIS COURSE. THAT IS TO BE PAID BY CHECK OR MONEY ORDER TO MARY ALICE WATSON, SCHOOL SECRETARY, IN GTM 213.

ATTENDANCE: Attendance is expected. A student who is absent shall submit excuses for all class absences in accordance with the Louisiana Tech University Bulletin. Makeup exams, if absence is excused, are given at the instructor’s discretion. If an absence is unexcused, the student will not be allowed to makeup missed work, including missed tests.

ENABLING EXERCISES: Enabling exercises include class discussions, group activities, individual laboratory exercises, written reports, and integration of course material with previously learned material. Participation in enabling exercises are essential to the mastery of course material. Enabling exercises are due with the test that is given over the material covered in the labs in which the enabling exercises are conducted. Late submissions will not be accepted!!

OBJECTIVES key: LE= lecture class; LA= lab class

After completing each class assignment, the student shall,

CLASS 1 - Hematology and the Diagnostic Process - LE

I. Identify the components of the Sanquis, Vascular, and Hemopoietic Systems and describe the functions of these.

II. Integrate and interrelate functions of the Sanquis, Vascular and Hemopoietic Systems

III. Know the rationales for laboratory testing.
IV. Explain sensitivity and specificity of a diagnostic criterion.
V. Explain why a laboratory test result may vary from the expected result.
VI. List the effects of failure and overreaction of the hematologic systems.
VII. Answer 6-8 questions on the above with 100% accuracy.

CLASS 2 & 4 - Hematopoiesis and Catabolism - LE
I. Describe the process and site of hematopoiesis before and after birth
II. Name the precursors of each cell found in peripheral blood
III. Know the sources and target cells of the human hemopoietic growth factors
IV. Describe the membrane characteristics and metabolic activity of the RBC

CLASS 3 - Laboratory Safety and the Collection, Handling and Preservation of Blood for Hematological Testing - Part 1. - LA
I. Describe the safety hazards encountered in the hematology laboratory and the proper procedures to minimize them.
II. Demonstrate an understanding OSHA-sanctioned protective measures from blood-borne pathogens after having viewed a video on the subject and discussing the subject with the instructor.
III. Understand the psychological approaches to be taken with patients when performing a phlebotomy.
IV. Describe methods of site selection for a phlebotomy by: (1) venipuncture; and (2) capillary puncture
V. Describe the purpose of equipment used in: (a) venipuncture by syringe and vacutainer; (b) capillary puncture
VI. Outline the safety hazards relating to phlebotomy.
VII. List the type of anticoagulant used in phlebotomy and the purpose of each.
VIII. List the steps in obtaining a specimen by: capillary puncture; venipuncture by syringe; and vacutainer.
IX. Answer 6-8 questions on these with 100% accuracy.

CLASS 5 - Biochemistry of Hemoglobin: Synthesis and Metabolism - LE.
I. Understand the physio-chemical characteristics of hemoglobin.
II. Describe the steps of iron metabolism.
III. Understand the steps in and control of heme and globin synthesis.
IV. Describe the steps of iron metabolism.
V. Characterize the “normal” and “abnormal” hemoglobins as to structure and function.
VI. Review the analytical methods used to qualitatively analyze hemoglobin
VII. Answer 10-12 questions on the above with 100% accuracy.

CLASS 6 - Collection, Handling and Preservation of Blood for Hematological Testing - Part 2 - LA.
I. Describe how each of the following is critical to a correct phlebotomy:
   A. observation of patient status
   B. care of puncture wound
   C. mixing and labeling of specimens
   D. special preservation requirements for certain tests
   E. proper disposal of contaminated equipment
II. Using the techniques described in Class 3, the student shall demonstrate the proper method of capillary puncture, venipuncture with syringe and vacutainer to the satisfaction of the instructor.
III. Describe the proper methods of obtaining plasma and serum.
IV. Answer 5-8 questions on I-III with 100% accuracy.

CLASS 7 - EXAM 1 (CLASSES 1-6)

CLASSES 8, 10, 11 - Anemias and Polycythemias - LE
I. Understand the characteristics and significance of the following classes of anemias and identifying the most common examples of each class.
   A. hemoglobinopathy
   B. normocytic anemia
   C. macrocytic anemia
   D. microcytic anemia
   E. hemorrhagic anemia
   F. hemolytic anemia
   G. acquired anemia
   H. congenital anemia
II. Describe the diagnostic roles of: Folic Acid Assay, Schillings Test, Transferrin Assay, Serum Iron Assay, Serum Ferritin Assay, Reticulocyte Count, Osmotic Fragility Test, G-6-PD Test, Pyruvate Kinase Test, Sedimentation Rate, Hb Electrophoresis, and Solubility Tests
III. View slides of abnormal rbcs, be able to distinguish each on the basis of morphology and/or staining characteristics, and name a disease which causes these variants (a list of the rbc abnormalities will be provided by the instructor)
IV. Answer 12-14 ions on I-III. with 100% accuracy.

CLASS 9 - Manual and Automated Methods in the Hematology Laboratory -LA
I. Identify and describe the theory of operations of counting chambers, diluting pipets, and spectrophotometers.
II. Review the operation of the light microscope.
III. Describe the general characteristics of common reagents used in the hematology laboratory;
IV. Identify the special storage, and safety requirements required for common hematology reagents.

V. Discuss the methods for blood cell counts, total hemoglobin and hematocrit determinations by: describing the principles of each procedure; performing the mathematical calculations required in these tests.

VI. Identify and describe the theory of operation of automated differential white cell stainers and counters.

VII. Identify and describe the theory of operation of automated cell counters.

VIII. Identify and describe the theory of operation of automated coagulation equipment.

IX. Answer 8-10 questions on I-II with 100% accuracy.

CLASS 12- Performance of Total Hemoglobin Concentration, Hematocrit and Erythrocyte Counts - LA.

I. Explain definitions, formulas, and reference values of the blood indices: MCV, MCH, MCHC.

III. Describe the clinical utility of blood indices. Calculate cell counts.

IV. Perform the following on a specimen provided by you and another provided by the instructor:
   (1) total hemoglobin determinations by the Drabkin Method; (2) hematocrit determinations by the microhematocrit method; (3) erythrocyte counts by the Unopette method.

V. Describe the composition of all reagents used for these tests and how each reagent participates in the test.

VI. Calculate the red blood cell indices from the data obtained in IV.

VII. Answer 5-8 questions on the above with 100% accuracy.

CLASS 13- EXAM 2 (CLASSES 8-12)

CLASSES 14, 15 & 17 - Diseases of the Leukocytes - LE

VIII. Define the following terms:
   1. granulocytopenia
   2. neutropenia
   3. eosinopenia
   4. granulocytosis
   5. myelofibrosis
   6. preleukemia
   7. leukemia
   8. lymphocytosis
   9. eosinophilia
   10. neutrophilia
   11. basophilia
   12. leukopenia
   13. lymphoma
   14. leucytosis
   15. monocytosis
   16. myeloproliferation

II. Describe the correct method for these special procedures and the clinical application of each:
   A. Peroxidase Stain
   B. Leucocyte Alkaline Phosphatase Stain
   C. Periodic Acid-Schiff Stain
   D. Gene Probes in leukemia
   E. Lupus Erythematosis Preparation
   F. Flow Cytometry

III. Classify the following diseases according to cell(s) effected, etiology, incidence, clinical feature and laboratory findings:
   1. infectious mononucleosis
   2. agranulocytosis
   3. Leukemoid reaction
   4. acute and chronic myelocytic leukemia
   5. acute and chronic lymphocytic leukemia
   6. multiple myeloma
   7. lymphoma

IV. Answer 12-16 questions on the above with 100% accuracy.

CLASS 14- EXAM 3- (CLASSES 14-17)

CLASS 20 & 21 - Hemostasis - Part 1 - LE

I. Understand the hemostatic mechanism by:
   A. Defining the following terms:
      1. hemorrhage, 2. hemostasis, 3. coagulation, 4. platelet, 5. coagulation factor, 6. fibrinolyis, 7. purpura
   B. Learning the International Committee's nomenclature on blood clotting factors, the popular synonyms for each, and the physiochemical characteristics of each.
   C. Examining the modern theory of coagulation by summarizing the mechanism of:
      1. the initiator reaction, 2. thromboplastinogenesis, 3. thrombogenesis, 4. fibrin formation, 5. fibrinolysis

II. Evaluate the role of coagulation factors by:
   A. Defining the following terms:
      1. coagulation factor, 2. prothrombin, 3. fibrinogen, 4. fibrin, 5. plasmin
   B. Outlining the classical Morawitz Theory of Coagulation.
   C. Examining the modern theory of coagulation by summarizing the mechanism of:
      1. the initiator reaction, 2. thromboplastinogenesis, 3. thrombogenesis, 4. fibrin formation, 5. fibrinolysis

III. Answer 12-16 questions on I-II with 100% accuracy.
CLASS 23 & 24- Hemostasis - Part 3 - LE
I. Understand the role of vessel structure and function in hemostasis.
II. Summarizing how each of the following disorders can influence vascular hemostasis
   A. immunologic damage
   B. Collagen diseases
   C. aspirin and other drugs
   D. vitamin C deficiency
   E. vessel blockage by emboli or abnormal protein
   F. familial disorders
   G. allergic or anaphylactic purpura
III. Evaluate the role of platelets in hemostasis by:
   A. Giving the function of platelets in maintaining vascular integrity and their role in hemostasis.
   B. Distinguishing between the causes of intrinsic and extrinsic disorders of platelet function.
   C. Characterizing the types of thrombocytopenias according to clinical manifestation.
IV. Answer 3-5 questions on I-II with 100% accuracy.

CLASS 25- Hemostasis - Part 2 - LA
I. Outline the clinical significance of the following:
   A. Tests to monitor defects in Phase I.
      1. platelet count; 2. coagulation time; 3. bleeding time; 4. clot retraction; 5. tourniquet test
   B. Tests to monitor for defects in Phase II.
      1. coagulation time; 2. partial thromboplastin time; 3. prothrombin time
   C. Tests to monitor defects in Phase III
      1. prothrombin time; 2. clot retraction; 3. individual factor assay
   D. Tests to monitor defects in Phase IV.
      1. coagulation time; 2. Clot lysis; 3. individual factor assays; 4. clot retraction; 5. fibrinogen level
II. Perform a prothrombin time by the (A) automated method, (B) test tube method
III. Perform a platelet count by the UNOPETTE hemocytometer method
IV. Answer 12-16 questions on the above with 100% accuracy

CLASS 26- FINAL EXAM (CLASSES 23-28)
CLASS 27- MAKEUPS AND PROFESSIONAL REFLECTION
CLASS 28- LAB CLEANUP

Reading Assignment: Text -CLINICAL HEMATOLOGY- THEORY AND PROCEDURES
3rd Edition - Turgeon; Assignments will be supplemented by Handouts.

<table>
<thead>
<tr>
<th>Class #</th>
<th>Reading Assignment</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>HANDOUTS</td>
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<tr>
<td>3 and 6</td>
<td>1-6,14-33</td>
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<tr>
<td>2, 4, and 5</td>
<td>49-83, 159-166, 180-190</td>
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<td>7</td>
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<td>8, 10, and 11</td>
<td>70-73, 84-158, 246-249</td>
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<td>9</td>
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<td>75-76, 315-318, 321-322</td>
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<td>14, 15, and 17</td>
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<td>EXAM</td>
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<td>20 and 21</td>
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<td>27</td>
<td>MAKEUPS</td>
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BISC343 Medical Microbiology and Immunology (Fall 2003)

**Instructor:** Dr. Max Wu  
**Contact:** maxwu@latech.edu

**Office hours:** MW 2-5 PM, TR 10 AM -12 PM in CTH-120  
**Lecture hours:** MWF 11-12:15 in CTH-227  
**Lab hours:** R 1:15 – 4:15 PM in GTM-2


### Lecture Syllabus

<table>
<thead>
<tr>
<th>Date</th>
<th>Lecture Topics</th>
<th>Reading Assignments</th>
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<tbody>
<tr>
<td>09/08</td>
<td>Introduction; Classification; Morphology</td>
<td>1, 2, 3</td>
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<tr>
<td>09/10</td>
<td>Morphology; Structure; Synthesis</td>
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<tr>
<td>09/12</td>
<td>Morphology; Structure; Synthesis</td>
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<tr>
<td>09/15</td>
<td><strong>Quiz 1:</strong> Bacterial metabolism and Growth</td>
<td>4</td>
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<tr>
<td>09/17</td>
<td>Bacterial metabolism and Growth</td>
<td>4</td>
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<tr>
<td>09/19</td>
<td>Viral Classification; Structure; and Replication</td>
<td>6</td>
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<tr>
<td>09/22</td>
<td><strong>Quiz 2:</strong> Viral Classification; Structure; and Replication</td>
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<tr>
<td>09/24</td>
<td>Sterilization; Disinfection; and Antisepsis</td>
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<tr>
<td>09/26</td>
<td>Commensals and Microbial Flora in Humans</td>
<td>9</td>
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<tr>
<td>09/29</td>
<td><strong>Exam I</strong></td>
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<tr>
<td>10/01</td>
<td>Elements of Host Protective Responses</td>
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<td>10/03</td>
<td>Elements of Host Protective Responses</td>
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<tr>
<td>10/06</td>
<td><strong>Quiz 3:</strong> The Humoral Immune Response</td>
<td>12</td>
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<td>10/08</td>
<td>The Humoral Immune Response</td>
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<tr>
<td>10/10</td>
<td>Cellular Immune Response</td>
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<td>10/13</td>
<td>Cellular Immune Response</td>
<td>13</td>
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<tr>
<td>10/15</td>
<td><strong>Quiz 4:</strong> Immune Responses to Infectious Agents</td>
<td>14</td>
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<tr>
<td>10/17</td>
<td>Immune Responses to Infectious Agents</td>
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<tr>
<td>10/20</td>
<td>Serological and Molecular Diagnosis</td>
<td>17, 18</td>
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<td>10/22</td>
<td><strong>Exam II</strong></td>
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<tr>
<td>10/24 (last day to drop)</td>
<td>Mechanisms of Bacterial Pathogenesis</td>
<td>19</td>
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<tr>
<td>10/27</td>
<td>Antibacterial Agents</td>
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<td>10/29</td>
<td>Laboratory Diagnosis of Bacterial Diseases</td>
<td>21</td>
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<td>10/31</td>
<td><strong>Quiz 5:</strong> <em>Staphylococcus</em> and <em>Streptococcus</em></td>
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<td>11/03</td>
<td><em>Streptococcus</em> and <em>Enterococcus</em></td>
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<td>11/05</td>
<td><em>Bacillus</em>; <em>Listeria</em>; <em>Corynebacterium</em></td>
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<td>11/07</td>
<td>Enterobacteriaceae; <em>Pseudomonas</em></td>
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<tr>
<td>11/10</td>
<td><strong>Quiz 6:</strong> <em>Mycobacterium</em>; <em>Clostridium</em></td>
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Neisseria; Treponema; Chlamydiae 28, 41

Exam III

Lab Syllabus:

<table>
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<th>Date</th>
<th>Lecture Topics</th>
<th>Reading Assignments</th>
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</thead>
<tbody>
<tr>
<td>9/11</td>
<td>Safety review; use and care of microscope; Aseptic Technique; Streak plate; Gram stain</td>
<td>Ex. 1, 2, 4, 5, 14</td>
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<tr>
<td>9/18</td>
<td>Streak Plate; Gram, Acid-fast, and Capsule stain</td>
<td>Ex. 14, 15, 17</td>
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<td>9/25</td>
<td>Gram/Acid-fast tests; Biochemical activities; CHO metabolism; N₂ metabolism; IMViC; Streaking</td>
<td>p. 187-9, Ex. 20, 22</td>
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<td>10/02</td>
<td>Extracellular enzymes; O₂ utilization; Multiple-test media: Litmus Milk and TSI; Rapid ID kit-API20E and Enterotube; Streaking</td>
<td>Ex. 21, 24, 26, 27</td>
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<td>10/09</td>
<td>Immunology; Microbial agglutination; Hemagglutination; ImmunoAssay-ELISA; UV radiation; Bacteriostatic dyes; Antibiotic testing; Streaking</td>
<td>Ex. 48, 50, 51, 53</td>
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<tr>
<td>10/16</td>
<td>Streaking test; Indigenous flora: mouth, lip, skin</td>
<td>Ex. 58</td>
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<td>10/23</td>
<td>Pathogenic microbes of the skin and throat</td>
<td>Ex. 59</td>
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<tr>
<td>10/30</td>
<td>Observe/Record data; Review and Clean-Up</td>
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<td>11/06</td>
<td>Practical and Theoretical Exams</td>
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Note: You’re required to preview the introduction section in every assigned exercise prior to each lab.

Grading Policy: Lecture + Lab = 440 + 390 = 830 pts

<table>
<thead>
<tr>
<th>Lecture</th>
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<tr>
<td>Quizzes (15 each)</td>
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<td>Exams (100 each)</td>
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<td>Subjectives</td>
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<td>Total</td>
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<tr>
<td>Gram stain</td>
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<tr>
<td>Acid-fast stain</td>
<td>20 pts</td>
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<tr>
<td>Streaking</td>
<td>20 pts</td>
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<tr>
<td>Quizzes (5 each)</td>
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<tr>
<td>Lab Reports</td>
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<tr>
<td>Practical exam</td>
<td>50 pts</td>
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<tr>
<td>Theoretical exam</td>
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<tr>
<td>Subjectives</td>
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<tr>
<td>Total</td>
<td>390 pts</td>
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</tbody>
</table>

A = ≥ 90%; B = ≥ 80%; C = ≥ 70%; D = < 70%; F = < 60%

Make-Up Exams Policy: If you miss--
Exam I or II: the make-up date will be November 13 and the test will be comprehensive!
Exam III: the make-up date will be November 17 and the test will be comprehensive!

List of “not-to-do” to avoid penalty in the Subjectives (100 pts total):
--absence from lectures and labs
--lack of punctuality
--talking while I’m lecturing
--cell phone ringing while I’m lecturing
--wearing open-toe shoes to the lab
--failure to follow lab safety regulations and to maintain your assigned microscope

Lab fee: A $45.00 fee must be paid by 09/26 or a hold will be placed on your Winter 2004 registration and you will receive an “I” grade.

The University does not carry insurance to cover any bodily injury you incur during the lecture/lab.

Cheating and Plagiarism: University Honor Code should be observed at all time in this class. Possible actions, should such behaviors occur, include “zero point” and “immediate removal from the class”.

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BISC 344- CLINICAL CHEMISTRY AND TOXICOLOGY
INSTRUCTOR: K.E. Griswold, Ph.D.
OFFICE: CTH 116
OFFICE HOURS: 10:00-12:00 TH; 10:30-12:30 MW
(FRI.=CLIN. STUDENTS ONLY)
E-MAIL- egriswold@gans.latech.edu

OVERVIEW
This information is to direct your attention to the types of behaviors you are to exhibit upon completion of this course and to the expectations of your instructor. The primary purpose of this course is for the student to gain and apply knowledge in the field of clinical analysis

COMPETENCY STATEMENTS
AFTER COMPLETION OF THE COURSE, THE STUDENT SHALL:
Know the biochemical and metabolic characteristics of the clinically-significant analytes;
Use the analytical concepts learned in this and other classes to perform representative clinical chemistry assays;
Understand how variation in concentrations of the clinically-significant biochemicals can be used in the diagnosis and monitoring of disease.

GRADING: Cognitive knowledge of information presented in both lecture and laboratory assignments is assessed by written examination. Practical application of this knowledge is evaluated by the student’s successful performance of assigned laboratory exercises and the accuracy of the student’s reports of their findings in the laboratory. Final grades will be computed as follows:
WRITTEN EXAMS= 85%; LABORATORY REPORTS= 15%;
LABORATORY TECHNIQUE/SAFETY/CLEANLINESS/ATTENDANCE/PARTICIPATION= 5%

Grading will be done on a total point basis (points made vs. points possible). The grading scale used to compute the letter grade is:
90-100% = A  70- 79% = C  Below 60% = F
80- 89% = B  60- 69% = D

ATTENDANCE: Attendance is expected. Excused absences as defined in the LA Tech Bulletin will be honored. Makeup tests will be given only in the case of excused absences.

SAFETY REQUIREMENTS: This course requires the handling of certain potentially dangerous biological products and chemicals. All students shall receive an in-service on the safe handling of these hazards. It is the student’s responsibility to apply and conform to all of these rules when performing laboratory assignments. The instructor or University is not responsible for illness or injury due to negligence on the student’s part.

THERE IS A $45/ STUDENT LAB SUPPLY CHARGE FOR THIS COURSE. THAT IS TO BE PAID BY CHECK OR MONEY ORDER TO MARY ALICE WATSON, SCHOOL SECRETARY, IN GTM 213.

OBJECTIVES (subject to change)
These objectives will be met through the interaction of lecture and laboratory experiences supplemented by various reading, audiovisual, and interactive instructional media. LE = Lecture Class; LA = Lab class

CLASS I- Fundamental Characteristics of Analytical Methods-Part I - LE
A. Describe the relationships of clinical analysis to other sciences.
B. Describe how clinical laboratory test results are used to confirm a diagnosis.
C. Explain how each step in a clinical analysis is related to providing proper patient care.
D. Explain the purpose of each component of a laboratory request/report form
E. List the fundamental characteristics of a clinical analytical protocol
F. Correctly answer 5-8 questions on the above

CLASS II- Fundamental Characteristics of Analytical Methods -Part II -LE
A. Demonstrate the ability to perform the calculations necessary for the preparation of normal, molar, and percent solutions.
B. Demonstrate the ability to convert one type of dilution to another.
C. Utilize The data derived in A and B to prepare reagents to use in future laboratories in this course
D. Correctly answer 5-8 questions on the above.

CLASS III- Fundamental Characteristics of Analytical Methods- Part III- LA
A. Review the basic operation of laboratory equipment by demonstrating proficiency in the operation of mechanical pipets, spectrophotometers, electrophoretic equipment and basic laboratory glassware;
B. Describe the specimens used in clinical analysis as to: (1) source; (2) method of collection; (3) methods of specimen preservation and storage; (4) commonly encountered interfering substances
C. Describe the basic characteristics of analytical reagents, including standard solutions used in clinical analysis as to type and methods of preparation, storage and handling
D. Comprehend all aspects of minimizing fire, chemical, infectious, and other hazards in the clinical lab.
E. Interpret a Material Safety Data Sheet and explain how they can be used to improve laboratory safety
F. Verify to the instructor’s satisfaction their understanding of A and E.

CLASS IV and V- Fundamental Characteristics of Analytical Methods- Part IV- LE
A. Identify the essentials of quality laboratory performance
B. Understand the role of a quality control program in assessment of test results
C. Distinguish between accuracy and precision as assessments of quality
D. Describe the courses of action which should be taken when results are out of acceptable confidence limits
E. Describe the procedures by which analytical bias is statistically verified and measured.
F. Described how reference values for analytical procedures are derived and statistically validated.
G. Correctly answer 8-10 questions on the above

CLASS VI- Training Strategies for the Use of Self-Monitoring Glucose Analyzers and Determination of Analytical Bias in the Measurement of Glucose-Part 1- LA
A. Understand the importance of self-monitoring of blood glucose in the management of diabetic mellitus
B. Demonstrate the proper calibration and use of a self-monitoring glucose analyzer by:
   1. analyzing both control and patient blood specimens for glucose concentration
   2. validating the precision of the methods by analyzing the control results following Westgard’s Rules
C. Log the results of these test for use in calculating analytical bias in class # 10.
D. Correctly answer 5-8 questions on the above.

CLASS VII- EXAM 1 (CLASSES 1-5)

CLASS VIII- Characteristics and Analysis of Clinically-Significant Carbohydrates - LE
A. Identify carbohydrates as to their chemical and functional characteristics
B. Describe the digestion and basic metabolic fate of carbohydrates
C. Identify clinicopathological conditions related to carbohydrates including:
   1. Galactosemia
   2. Diabetes Mellitus
   4. Others
D. List the distinguishing characteristics of the hexokinase and glucose oxidase methods for the assay of carbohydrate
E. Describe Hemoglobin A1C and how it is measured
F. Correlate the measurement of Hemoglobin A1C with the prognosis for the progression of diabetes
G. Correctly answer 5-8 questions on the above.

CLASS IX- Training Strategies for the Use of Self-Monitoring Glucose Analyzers and Determination of Analytical Bias in the Measurement of Glucose-Part 2- LA
A. Understand the methods of analyzing glucose by Spectrophotometry
B. Assay the same unknown solutions of glucose used in Class 7 by the method listed in A.
C. Calculate the concentrations of the solutions analyzed spectrophotometrically using Beer's Law.
D. Explain the results obtained in B and C relative to accuracy and precision.
E. Describe how analytical bias between 2 analytical methods can be measured and statistically evaluated.
F. Calculate the analytical bias between the 2 glucose methods.
G. Determine the probable cause(s) of bias, if it exists.
H. Correctly answer 5-8 questions on the above.

CLASS X- Characteristics and Analysis of Clinically-Significant Lipids and Other Markers of Cardiovascular Disease- LE
A. Identify and list the basic physicochemical characteristics of the clinically-significant lipids.
B. Classify representative lipid profiles according to Fredrickson classification.
C. Correlate abnormal levels of the various lipid classes to the formation of atherosclerosis.
D. Describe the modes of treatment for atherosclerosis.
E. Describe how atherosclerosis can lead to secondary heart disease.
F. Describe how to assess risk, diagnose, and assess the prognosis of cardiac disease.
G. Describe the common methods for the analysis of cholesterol, triglycerides, LDL, HDL, troponin, and myoglobin.
H. Correctly answer 10-12 questions on the above.

CLASS XI- Structure and Function of the Kidney- LE
A. Correlate the macro and micro anatomy and physiology of the kidney with the process of urine formation.
B. Describe the common diseases of the kidney.
C. Correlate urinary output with normal urinary output, nocturia, anuria, oliguria, and polyuria.
D. Describe how Urea, Uric acid, and Creatinine are formed.
E. Describe the analytical methods for the measurement of the compounds listed in D.
F. Understand the clinical significance of the results of the analysis of the constituents listed in D.
G. Define creatinine clearance, and how to calculate it.
H. Correctly answer 5-8 questions on the above.

CLASS XII- Laboratory Assessment of Renal Function-LA
A. Identify all the equipment and reagents required to measure urea and creatinine in biological specimens.
B. Assay specimens provided by the instructor for urea and creatinine.
C. Interpret the results of the tests performed in B as to clinical significance.
D. Correctly answer 5-8 questions on the above.

CLASS XIII- EXAM 2-(CLASSES 6, 8-11)
CLASS XIV- Urine Chemistry & Clinically-Important Proteins - LE
A. Correlate the changes in the physical characteristics of urine with pathological conditions.
B. Correlate the changes in the following chemical tests of a urinalysis with pathological conditions: pH, glucose, ketones, protein, bilirubin, hemoglobin, leucocytes.
C. Describe the following formed elements found in urine: Casts; Microbial agents; Crystals; Cells; and Artifacts.
D. Correlate the observations of formed elements in urine with pathological conditions.
E. Name the special chemistry tests routinely performed on urine and describe the clinical utility of each.
F. Describe the common analytical methods used to perform the tests listed in F.
G. Describe the general chemical and physiological characteristics of amino acids and proteins.
H. Identify the clinically-significant proteins in biological fluids and classify them according to function.
I. Describe the major diseases which effect the concentration of the proteins described in H.
J. Describe the analytical methods used to measure the proteins described in H.
K. Correlate different protein electrophoretic patterns with specific clinicopathological conditions.
L. Complete a representative case history involving protein abnormalities.
M. Correctly answer 12-15 questions on the above.

CLASS XV-Urine Chemistry & The Measurement of Protein by Refractometry, Precipitation, and Colorimetry- LA
A. Standardize, control and assay specimens for protein by a precipitation/spectrophotometric method.
B. Determine the accuracy and precision of each method by determining the standard deviation and coefficient of variation of the control data accumulated by the class and comparing the result.
C. Comprehend the theory of Refractometry and hydrometry and how they relate to determining specific gravity.
D. Integrate the physical, chemical and microscopic examination of urine into a useful diagnostic aid by
performing the following semi-quantitative determinations on 2 urine specimens to the satisfaction of the instructor:
- pH
- Specific gravity
- Color
- Appearance
- Glucose
- Ketone
- Occult Blood
- Bilirubin
- Urine microscopic

E. Describe the analytical methods used to measure the analytes listed in B
F. Correctly answer 12-15 questions on the above

CLASS XVI- Body Fluids- LE
A. Describe the method of formation of cerebrospinal, pleural, amniotic, synovial, and ascites fluids.
B. Discuss the diseases which results in abnormalities in the quantitative or qualitative characteristics of each of the fluids listed in A.
C. List and describe the analytical methods used to perform quantitative and qualitative analyses on these fluids.
D. Correctly answer 5-8 questions on the above.

CLASS XVII & CLASS XVIII- LA/MS SOCIETIES OF CLINICAL LABORATORY SCIENCE MEETING-LE/LA

CLASS XIX- EXAM 3- (CLASSES 12, 14-16)
CLASS XX and XXII Characteristics and Analysis of Clinically-Significant Electrolytes - LE
A. Comprehend the physiological roles of sodium, potassium, chloride, bicarbonates, calcium, magnesium, iron, and hydrogen ion
B. Understand the theory of osmolality and how to measure it in biological fluids
C. Describe the analytical methods for determining blood pH, pCO2, pO2
D. Describe the disorders associated with abnormal pH, pCO2, and pO2
F. Describe the disorders associated with abnormal levels of the electrolyte listed in E
G. Correctly answer 10-15 questions relative to the above

CLASS XXI- Analysis of Clinically-Significant Electrolytes- LA
A. Describe the clinical utility of chloride, total iron and iron-binding analysis.
B. Perform chloride, iron and iron-binding analyses of 2 specimens provided by the instructor.
C. Perform all calculations necessary to derive accurate results of the tests listed in B
D. Interpret the results of the results obtained in C as to clinical significance.
E. Correctly answer 5-8 questions on the above

CLASS XXIII - Enzymology-LE
A. Describe the biosynthesis, structure, generalized function of enzymes.
B. Classify enzymes in accordance with the type of reaction (s) catalyzed, and in accordance with the nomenclature of the International Union of Biochemistry.
C. Discuss the in vivo and in vitro factors that influence the rate of enzymatic reactions.
D. Explain the concept of enzyme kinetics as it relates to enzymatic function in the body and in measurement of clinically-significant analytes.
E. Describe the lab techniques used to measure: (1) Acid and alkaline phosphatases; (2) Aspartate aminotransferase (3) Alanine aminotransferase; (4) Creatine kinase; (5) Lactic dehydrogenase; (6) Amylase; (7) Lipase
F. Understand the clinical significance of the enzymes listed in E.
G. Relate the isoenzymes and isoforms of LD, CK and other enzymes to site of synthesis
H. Correlate LD and CK isoenzyme and isoform values to the diagnosis of certain diseases.
I. Describe the non-enzymes, myoglobin and troponin, as to origin, structure, function, and clinical utility in the management of the myocardial infarction patient.
J. Correlate LD, CK isoenzyme and troponin assays to the diagnosis of myocardial infarctions.
K. Correctly answer 15-20 questions on the above

CLASS XXIV- Clinical Analysis of Isoenzymes-LA
A. Identify the analytical methods to identify and measure clinically-significant isoenzymes.
B. Describe the use of each of the pieces of equipment and reagents needed to perform LD isoenzyme separation and identification.
C. Define buffer and explain how buffers work to maintain a constant pH.
D. Perform an electrophoretic separation of LD isoenzymes on a specimen provided by the instructor.
E. Identify the clinical abnormality exemplified by the results of the test performed in D.
F. Correctly answer 5-8 questions on the above

CLASS XXV- EXAM 4- CLASSES 20-24)
CLASS XXVI and XXVII- Toxicology -LE/LA
A. Classify the commonly monitored drugs as to drug class
B. Distinguish between the therapeutic drug monitoring, emergency toxicology, and monitoring drugs of abuse
C. Define "peak" and "trough" concentrations of a drug.
D. Explain the use of the most common therapeutically-monitored drugs
E. Describe the analytical methods which are appropriate to toxicological testing
F. Explain how drugs of abuse testing programs are established and run.
G. Understand the concept of "chain-of-custody"

A. List the basic steps in a thin-layer chromatography
B. Describe the methods used to identify drugs separated by thin-layer chromatography
C. Identify unknown drugs in specimen provided, using thin-layer chromatography
D. Answer 5-8 questions on the above, with 100% accuracy

CLASS XXVIII- Gastrointestinal, Liver and Pancreatic Function Tests- LE
A. Describe the common diseases of the gastrointestinal tract
B. Describe the common test used to assess gastrointestinal function
C. Describe the causes and effects of the various diseases of the liver and pancreas
D. Characterize bilirubin as to production and catabolism
E. Differentiate between the types of jaundice
F. Describe the clinical analyzes used to diagnose and monitor diseases of the liver and pancreas
G. Correctly answer 6-8 questions on the above

CLASS XXIX- Clinically-Important Hormones - LE
A. Explain the physicochemical characteristics of a hormone
B. Identify the clinically important hormones as to site of synthesis, site of action, chemical classification
C. Correlate the variation in concentration of each of the clinically significant hormones with disease.
D. Review the analytical methods used to measure hormones
E. Laboratory clean up
F. Answer 10-15 questions on the above, with 100% accuracy

CLASS XXX- EXAM 5- (CLASSES 26-29)

READING ASSIGNMENTS

Reading assignments will be supplemented by handouts.

<table>
<thead>
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<th>Class #</th>
<th>Pages</th>
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BISC 445 IMMUNOHEMATOLOGY
COURSE SYLLABUS
SPRING 2002
Instructor: Mrs. Melanie Chapman, M.Ed., MT (ASCP)  
Phone: 327-4359  
Email: chapmam@stfran.com

Office Hours: by appointment

COURSE DESCRIPTION
The scope of this course includes common laboratory methods and interpretations for transfusion practices and immunohematology. The student will review the basic principles of cell preservation, genetics and immunology and apply this to blood groups and transfusion practice.

REQUIRED TEXT
Modern Blood Banking and Transfusion Practices, 4th edition by Harmening

CLASS POLICIES
This class will strictly adhere to all university policies regarding student attendance and academic conduct. Students needing testing accommodations or classroom accommodations based on a disability are encouraged to discuss the need with the instructor as soon as possible.

Each student will:

1. adhere to all laboratory policies and procedures to ensure the safety of all students.
2. wear appropriate laboratory attire.
3. work independently in laboratory experiments.
4. work cooperatively with other students in group lab experiments.
5. perform work of the highest possible quality.
6. ask appropriate questions of the instructor or lab assistant when assistance is needed.
7. clean work area and any equipment used in lab.
8. return materials used in lab to appropriate place.

Failure to adhere to any of these rules will result in lowering the laboratory grade by an amount determined by the instructor.

GRADES
Grades will be calculated based upon total points accumulated divided by the total number of possible points. Points are earned through daily quizzes, laboratory exercises and major examinations. A ten point quiz covering material from the previous class meeting, reading assignment and handouts should be expected each day of class. Four major exams will be given. Each exam will be comprehensive and will cover material from the lectures, video tapes, reading assignments, handouts and other classroom assignments. There will be no make-up quizzes or
Laboratory exercises, and make-up exams will be given only for excused absences. Approximately 30 points will be dropped from the total possible points so that the student will not be penalized for up to three absences.

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565

475
475
565 = 84%/B

The grading scale is based on the ten point system.

90-100 = A
80-89 = B
70-79 = C
60-69 = D

CLASS SCHEDULE

<table>
<thead>
<tr>
<th>Date</th>
<th>Subject</th>
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<tr>
<td>3-6</td>
<td>Introduction: Genetics</td>
<td>pp. 1-3; 20-35</td>
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### Objectives ABO System

After completing lecture and reading assignments, each student will with 75% accuracy:

1. State the expected antigens present on red blood cells and antibodies in plasma for blood types O, A, B, and AB.

2. List the approximate frequencies of the four major blood types in the general population.

3. Describe how the age of an individual affects his/her production of ABO antibodies.
4. State the immunoglobulin classes of ABO antibodies in the plasma.

5. Predict the ABO phenotypes and genotypes of offspring from various ABO matings.

6. Explain the formation of H, A, and B antigens on the red cells from precursor substance to immunodominant sugars.

7. Describe the formation of H, A, and B soluble substances.

8. Explain the principle of hemagglutination inhibition assay for the determination of secretor status.

9. Describe the qualitative and quantitative differences between the A₁ and A₂ phenotypes.

10. List ABO blood groups in order from most to least with respect to the amount of H antigen present on the red cells, and compare the reactivity of anti-H and Ulex europaeus with the ABO groups.

11. Identify the reactivity of three lectins used in the Blood Bank, and describe how they can be used to resolve discrepancies.

12. Describe the inheritance and serological findings associated with the Bombay phenotype.

13. List several causes of ABO typing discrepancies.

14. Interpret the results from ABO forward and reverse typing, and resolve any discrepancies.

**Antihuman Globulin Testing**

After completing lecture and reading assignments, each student will with 75% accuracy:

1. State the principle of the antiglobulin test.

2. Differentiate monospecific from polyspecific antihuman globulin (AHG) reagent.

3. Explain the antibody requirements for AHG reagents.

4. Briefly describe the preparation of monoclonal and polyclonal AHG reagents.

5. Discuss the use of polyspecific versus monospecific AHG in the indirect antiglobulin test (IAT).
1. Define hemolytic disease of the newborn (HDN).
2. Compare and contrast ABO HDN, Rh HDN, and HDN caused by other alloantibodies in terms of:
   a. pathology
   b. incidence
   c. blood types of mother and baby
   d. severity of disease
   e. laboratory data (anemia, DAT, bilirubin, reticulocytosis, blood smear)
   f. prevention and treatment
3. State three criteria that are necessary for HDN to develop.
4. Define Rh immune globulin and describe its function.
5. Identify the requirements that must be met before a woman can receive Rh immune globulin.
7. Given the fetal cell count in a Kleihauer-Betke test, calculate the number of 300-ug doses of RhIg that should be administered to prevent maternal alloimmunization.
8. Outline the protocol for testing of maternal and cord blood in cases of suspected hemolytic disease of the newborn.
9. Given maternal and infant ABO blood group phenotypes, state the possible ABO donor blood group(s) you would select for an exchange transfusion. Be specific as to donor blood groups for both the red blood cells and plasma.

HEMOLYTIC DISEASE OF THE NEWBORN

After completing lecture and reading assignments, each student will with 70% accuracy:

1. Define hemolytic disease of the newborn (HDN).
2. Compare and contrast the IAT and DAT. Include an explanation of principle, applications, and red cell sensitization.
3. List the reasons for the procedural steps in the DAT and IAT.
4. List the sources of error associated with the performance of the AHG test.

TESTING

After completing lecture and reading assignments, each student will with 70% accuracy:

1. Define adsorption, dosage, eluate, and neutralization.
2. Differentiate between the following antibodies: expected and unexpected, red cell immune and non-red cell immune, autoantibodies and alloantibodies, warm and cold.
3. Describe the purpose and limitations of the antibody screening tests.
4. List and discuss characteristics of antibody screening red blood cells.
5. List the benefits and risks for using monospecific anti-IgG over polyspecific antiglobulin reagents for routine antibody screening tests.
6. Outline the procedure used for antibody screening tests and describe the purpose of enhancement reagents and Coombs control red blood cells.
7. Properly interpret results of antibody detection and identification tests.
8. Describe how a patient's medical history is useful in antibody identification.
9. Explain the purpose of the autologous control in antibody screening and identification tests.
10. Correlate knowledge of the serologic characteristics of commonly encountered blood group antibodies with antibody identification studies.
11. Describe the rationale for properly ruling out antibody specificities in identification studies.
12. Explain the criteria for conclusive identification of an antibody.
13. Describe the use of selected cells and antigen typing in antibody identification.
14. Given initial panel results, properly select additional cells needed to complete antibody identification.
15. Calculate the approximate number of random donor units needed for screening to find a specific number of compatible units for a patient with unexpected antibodies.

**Objectives for Rh/Hr System**

After completing lecture and reading assignments, each student will with 75% accuracy:

1. Describe the discovery of the antibody now known as anti-D.
2. List the five major antigens of the Rh system.
3. Indicate two reasons why the Rh system is second only to the ABO system in relative clinical significance.
5. Use the Wiener and Fisher-Race terminology to describe Rh phenotypes.
6. Given the serologic results of Rh antigen typing (phenotyping), determine the possible Rh genotypes.
7. Describe the biochemical characteristics of the Rh antigens.
8. Describe the chemical and serologic characteristics of the Rh antibodies.
9. Select appropriate blood for transfusion to patients with Rh system antibodies.
10. Describe three mechanisms that might result in weak D expression on red blood cells.
11. List three instances in which the weak D status of an individual must be determined.
12. Differentiate four types of Rh typing reagents. Give two advantages for each.
13. Discuss causes of false-positive and false-negative Rh typing results.
14. Define the term *compound antigen* and list four such antigens in the Rh system.
15. Define the term *low-incidence antigen* and list five such antigens in the Rh system.
16. Define the term *high-incidence antigen* and list three such antigens in the Rh system.
17. Describe the Rhnull and the Rhmod phenotypes.
PURPOSE

The Clinical Laboratory Scientists (Medical Technologist) of today must devote much of their workday away from the bench as consultants to other technologists, physicians, nurses, other healthcare providers, and to clients (patients). They must solve management and educational issues to ensure that: (1) appropriate laboratory utilization optimizes full value patient outcomes; (2) their workplace comply with guidelines of relevant governmental and professional agencies; (3) proper resources (manpower, equipment, supplies) are available to optimize work performance; (4) that healthcare personnel and clients are informed on the use and validity of patient testing; (5) personnel foster interdisciplinary communication, collaboration, and cooperation to gain full value patient outcomes; (6) reimbursement policies avoid fraud and abuse; and (7) their workplace operates on a fiscal sound basis.

TODAY, CLINICAL LABORATORIANS, WHILE CONTINUING TO BE SCIENTISTS, MUST BE BOTH EDUCATORS AND MANAGERS. This course will emphasize basic educational and managerial techniques essential to your practice. Other topics to be discussed include career opportunities, interview techniques, credentialing, professionalism, critical thinking and ethics.

EXPECTED COMPETENCIES

Upon completion of this course, participants shall:

1. Apply basic educational principles to plan, conduct, and evaluate instructional activities
2. Understand the managerial and professional responsibilities of the clinical laboratorian
3. Develop standards for optimal laboratory performance and outcomes
4. Develop job descriptions and job performance standards for laboratory personnel
5. Correlate desired work outcome with the appropriate selection of equipment, LIS, and supplies
6. Understand and apply the principles of team management
7. Understand and apply those standards required to assure quality outcomes
8. Apply critical thinking skills to planning and the evaluation of outcomes
9. Identify professional standards of quality performance and develop strategies to assure they are met
10. Apply the affective and psychomotor elements of ethical practice
11. Correlate the dynamic nature of the profession with the necessity for continuing education.
12. Use credentialing and active participation in professional activities as a means to professional growth
13. Understand the source of and how to objective evaluate and use the literature appropriate to laboratory medicine.

ENABLING EXERCISES
Enabling exercises include class discussions, group activities, written reports, individual and group presentations, and the integration of previously learned material into student performance outcomes. Participation in enabling exercises are essential to mastery and use of the course material.

GRADING
There will be weekly written and oral assignments to be completed individually or in groups. These assignments will be graded as follows: Cognitive skills (thoroughness of preparation, accuracy of outcomes) = 50%; Psychomotor skills (communication skills used in presentations, application of the knowledge obtained to solve problems) = 25%; Affective skills (how well the individual or group followed instructions, participation as a team, attitude shown towards others in class, ethics in work) = 25%.

Grading Scale:
90-100% = A
80-89% = B
70-79% = C
60-69% = D
Below 69% = F

OBJECTIVES

PARTICIPANTS SHALL:

UNIT 1: Personal Characteristics of the Health care Professional- 9/9-9/16
A. Identify the desirable personal characteristics of a health care professional
B. Conduct a personality profile of themselves
   C. Evaluate the suitability of their personality to become a productive health care professional
   D. Identify the communication skills necessary for a productive health care professional
   E. Evaluate the suitability of their communication skills to become a productive health care professional

UNIT 2 - Professionalism and Ethics - 9/23-9/30
   A. Describe the elements of professional practice
   B. Describe how different health care professionals work together to affect an outcome
   C. Define the elements of ethical medical practice
   D. Know the “Patient’s Bill of Rights” and how to adhere to them.
   E. Know the standards of conduct associated with confidentiality of information
   F. Comprehend the purpose of licensure, registration, and certification as measures of ethical practice

UNIT 3 - Essentials of Laboratory Management - 10/2-10/9
   A. Describe the 5 major managerial functions
   B. Describe positive and negative attributes of the different styles of management
   C. Understand the regulatory roles of the Health Care Finance Administration, EPA, and other agencies over the operation of laboratories.
   D. Outline the elements of laboratory accreditation
   E. Define the essential elements of personnel management
   F. Correlate job descriptions with performance evaluations

UNIT 4 - “Your Clinical Education Program ------ What to Expect” - 10/14-10/16
   A. Name and give the location of each of the Medical Technology programs affiliated with La. Tech
   B. State the admission criteria for each site named in A
   C. Name the courses taken during the clinical phase of your academic program and describe the cognitive, psychomotor and affective skills developed in each
   D. Understand the safety and student conduct policies of each clinical program
   E. Discuss the application process to each clinical program
   F. Discuss the attributes of the clinical program with students currently enrolled in their clinical phase
   G. Complete the application forms for the program to which you applying

UNIT 5 - Health care Professionals as Educators - 10/21-11/18
   A. Recognize the roles of the healthcare provider as educator
   B. Discuss how the tenants of education apply to becoming an effective manager
   C. Outline the professional competencies required of the career-entry Medical Technologist
   D. Describe how to plan curricula and instructional objectives which develop the cognitive, affective and psychomotor competencies of students
   E. Discuss how resource materials can enhance learning and comprehension
   F. Discuss how to perform objective and subjective evaluations of student performance.
   G. Discuss the construction of certification examinations.
   H. Plan and present a lesson using the skills learned in D and E on effective recruitment strategies of designated “target” audiences

REQUIRED TEXT: Clinical Laboratory Science Education and Management, By: Wallace and Klosinski

READING ASSIGNMENTS
(EACH READING ASSIGNMENT SHALL BE SUPPLEMENTED WITH HANDOUT MATERIAL)

UNIT 1 pp. 238-247
UNIT 2 Handout
UNIT 3 pp. 167-278, 353-392
UNIT 4 pp. 135-164
UNIT 5 pp. 1-135, 295-297
NOTE: THE FOLLOWING RULES APPLY TO CLAB 460 THROUGH 489

GRADING: There will be written and practical examinations which will include material presented in both the lecture and laboratory components of these courses. Separate grades will be awarded for each portion.
The grading scale used to compute the letter grade is:

- 90% - 100% = A
- 80% - 89% = B
- 70% - 79% = C
- 60% - 69% = D
- Below 60% = F

IF A STUDENT WHO MAKES BELOW 69% MUST REPEAT THE COURSE TO PROGRESS IN THEIR CLINICAL PROGRAM

IN ACCORDANCE WITH THE LA. TECH UNIVERSITY HONOR CODE, ALL STUDENTS MUST PLEDGE THE FOLLOWING: “BEING A STUDENT OF HIGHER STANDARDS, I PLEDGE TO EMBODY THE PRINCIPLES OF ACADEMIC INTEGRITY”. ANY STUDENT NEEDING TESTING OR CLASSROOM ACCOMMODATIONS BASED ON A DISABILITY ARE ENCOURAGED TO DISCUSS THOSE NEEDS WITH THE INSTRUCTOR AS SOON AS POSSIBLE.

SAFETY REQUIREMENTS: This course requires the handling of blood and blood products and certain potentially dangerous chemicals. All students shall receive an in-service on the safe handling of these hazards. The instructor is not responsible for illness or injury due to negligence on the student’s part.

CLAB 460 & 461- CLINICAL HEMATOLOGY AND LAB

OBJECTIVES

The student shall:

1. Red cell structure and function
   1. Identify three areas of red cell metabolism crucial for normal erythrocyte survival and function.
   2. List the function of biochemical substances that compose the outer, central, and inner portion of the red cell membrane.
   3. Describe consequences of structural membrane defects that lead to rbc deformity.
   4. List criteria for normal hemoglobin synthesis.
   5. Describe the assembly of the protoporphyrin ring.
   6. List the number and type of globin chains found in humans.
   7. List the types of hemoglobin that compose normal hemoglobin.
   8. Describe the cellular manifestations of iron accumulation.
   9. Define shift to the left and shift to the right in relation to the hemoglobin/oxygen dissociation curve.
  10. List abnormal hemoglobins that are unable to transport oxygen.
  11. Describe the metabolic pathway that generates most of RBC ATP.
  12. Describe the steps in the extravascular breakdown of senescent RBC's.
13. Describe the steps in the intravascular breakdown of senescent RBC's.

II. Hematopoiesis

1. Name organs responsible for hematopoiesis in the fetus.
2. Trace cellular development from the stem cell to a single committed cell line.
3. Describe functions of colony stimulating factors.
4. Describe the functions of the various interleukins.
5. List the proper cell maturation sequence of erythropoiesis.
6. Recognize and describe the cells in the erythrocytic series.
7. List the maturation pool sequence for granulocytic production.
8. List the proper cell sequence for granulocytopenosis.
9. Distinguish between eosinophils and basophils.
10. List proper cell sequences for monocyte/macrophage phagocytic system.
11. List characteristics of lymphocytes.
12. Explain the process of platelet release.
13. Distinguish between osteoblasts and osteoclasts.

III. Bone Marrow

1. Name the bones that participate in active hematopoiesis in adults.
2. List those conditions that warrant bone marrow studies.
3. Name the most common skeletal sites for bone marrow aspiration.
4. Describe the role of the medical technologist during the bone marrow aspiration.
5. Describe the procedure for the preparation of the bone marrow aspirate for laboratory examination.
6. List and describe the use for the various stains used for bone marrow aspirates.
7. List and explain advantages and disadvantages of bone marrow biopsy.
8. Explain what is meant by the M:E ratio and how to calculate it.
9. List and describe those conditions where a bone marrow differential would have diagnostic value.
10. List and describe those conditions where evaluation of bone marrow iron stores would be useful.

IV. Anemias

1. List criteria used for the laboratory diagnosis of anemia.
2. List causes of anemia.
3. Describe the most common methods for the measurement of hemoglobin.
4. Explain how hemocrits are calculated on automated instruments.
5. Calculate and state the clinical relevance of RBC indices as related to the diagnosis of anemia.
6. Describe the appearance of the peripheral blood smear in anemia.
7. Explain the diagnostic value of the reticulocyte count as it relates to anemia.
8. List factors evaluated on bone marrow aspirate in relation to anemia.
9. Explain the diagnostic value of the hemoglobin electrophoresis in the diagnosis of anemia.
10. Explain the value of the antiglobulin test in the diagnosis of anemia.
11. List and describe laboratory methods for determining the sensitivity of RBC's to hemolysis.
12. List the commonly measured red cell enzymes and the clinical usefulness of the measurement as related to disease states.
13. Explain the use of measuring erythropoietin levels in the diagnosis of anemias.
14. Discuss the clinical value of performing a bone marrow culture.
15. Explain the limited clinical usefulness of the haptoglobin measurement in evaluation of hemolytic anemias.
16. List and explain the clinical usefulness of tests used in evaluation of iron deficient states.

V. Red Cell Morphology

1. Define the following:
anisocytosis  poikilocytosis  macrocyte  microcyte
hypochromia  polychromasia  codocyte (target cell)
spherocyte  ovalocyte  elliptocyte  stomatocyte
drepanocyte  acanthocyte  burr cell  helmet cell
schistocyte  teardrop cell  agglutination  rouleaux
Howell-Jolly body  basophilic stippling
sideroblastic granules  pappenheimer bodies
Heinz bodies  Cabot's rings

2. For the above list of terms, list the physiologic mechanism, peripheral blood findings, and disease states where they may be found.
3. List cell parameters for the classification of macrocytes and microcytes.
4. Identify clinical conditions that show oval macrocytes.
5. List disease states that produce a microcytic blood picture.
7. List conditions where one might find hypochromic RBC's.
8. List conditions that might produce polychromatophilic RBC's.
White Cell Morphology

9. Define the following:
   leukemoid reaction toxic granulation toxic vacuolization
   Dohle body PMN's May-Hegglin anomaly
   Chediak-Higashi Pelger-Huet anomaly Alder-Reilly anomaly
   Shift to the left

10. For the above, describe the morphologic changes seen,
    describe the physiologic mechanism causing the disorder, and
    list a possible disease state where one might find the
    morphological change.

VI. Hypochromic Anemias

1. State the primary function of iron in the body.
2. Trace iron transport from ingestion to tissue and hemoglobin
   incorporation.
3. List three stages of iron deficiency and describe findings
   associated with each stage.
4. List two major categories of iron deficiency.
5. List those findings that are most diagnostic for iron deficiency anemia.
6. List factors that affect iron absorption.
7. List and explain laboratory testing that can aid in distinguishing between IDA and
   anemia of chronic disease.

8. Define hemosiderosis.
9. Describe laboratory findings in patients with sideroblastic
   conditions.
10. List and describe findings for the major classifications of
    porphyrias.
11. Specify characteristic findings in lead poisoning.

VII. Megaloblastic Anemias

1. Define megaloblastic anemia.
2. List causes for megaloblastic dyspoiesis.
3. Describe clinical manifestations for B₁₂ and folate deficiencies.
4. Identify and correlate morphologic changes seen on peripheral smear in cases of
   megaloblastic anemias.
5. Describe and correlate the appearance of the bone marrow in
   cases of megaloblastic anemia.
6. Evaluate laboratory tests results in the differential diagnosis of macrocytosis.
7. Contrast the treatment of B₁₂ and folate deficiencies.
VIII. Aplastic Anemias

1. Define aplastic anemia.
2. List three classifications of causes of aplastic anemia.
3. List four causes of acquired aplastic anemia.
4. Name and describe the most common congenital disorder of aplastic anemia.
5. List laboratory results that are used as transplantation guidelines in cases of aplastic anemia.
6. Describe the typical appearance of bone marrow in aplastic anemia.
7. Describe laboratory results that are typical of aplastic anemia.
8. List treatments for aplastic anemia.
9. Define pure red cell aplasia and list characteristics associated with this condition.
10. Describe characteristics that define all types of congenital dyserythropoietic anemia.

IX. Hemolytic Anemias: Intracorpuscular Defects

1. Define intracorpuscular and extracorpuscular red cell defects as related to hemolytic processes.
2. List those tests and their expected values that reflect increased red cell destruction.
3. Calculate a corrected reticulocyte count and a reticulocyte production index and correlate results to those expected in hemolytic disorders.
4. List and explain the results of laboratory tests that aid in the classification of the cause of RBC hemolysis.
   Identify the RBC membrane abnormality associated with hereditary spherocytosis.
5. List and recognize those laboratory results associated with hereditary spherocytosis.
6. Describe the functional membrane abnormality associated with hereditary elliptocytosis.
7. Recall laboratory findings associated with hereditary elliptocytosis.
8. Identify the abnormality that causes the severe fragmentation and microspherocytosis characteristic of hereditary pyropoikilocytosis.

X. Hemolytic Anemias: Intracorpuscular Defects

1. Name the most common glycolytic enzyme deficiency associated with the pentose phosphate pathway, the Emden Myerhoff pathway.
2. Identify the particles associated with oxidative denaturation of hemoglobin.
3. Recall laboratory tests results that would indicate G-6-PD deficiency.
4. Identify disease states associated with decreased levels of G-6-PD.
5. Identify laboratory test results that would indicate a pyruvate kinase deficiency.
6. Discuss the deficiency that causes hemoglobin to be oxidized from the ferrous to the ferric state.

XI. Hemoglobinopathies

1. Characterize and differentiate hemoglobinopathies.
2. Define qualitative and quantitative hemoglobin defects.
3. Explain nomenclature used for hemoglobin defects.
4. Name the amino acid substitution found in sickle cell anemia.
5. List factors that contribute to the sickling process.
6. List and explain the three types of sickle cell crisis.
7. List and explain tests useful in the diagnosis of sickle cell disease.
9. List characteristics found in sickle cell trait.
10. Describe treatments and goals of those treatments for sickle cell anemia.
11. Name the amino acid substitution for hemoglobin C disease.
12. List and describe laboratory findings for hemoglobin C disease.
13. Identify and explain findings that aid in the diagnosis of hemoglobin SC disease.
14. List characteristics for Hgb D, Hgb E, and other variants and combinations such as Hgb O Arab and Hgb SD.
15. Identify causes of methemoglobinemia.
Describe useful techniques for studying hemoglobin variants with altered oxygen affinity.

17. Describe the composition of the normal physiologic hemoglobins.

XII. Hemolytic Anemias: Intracorporcular Defects

1. Name the hemoglobin defect of thalassemia.
2. List the type of globin chains and hemoglobin found in alpha and beta thalassemia.
3. Describe the clinical expression of different gene combinations of alpha and beta thalassemias.
4. Describe the delta-beta thalassemia and hemoglobin Lepore syndrome.
5. Describe and correlate to laboratory findings the condition Hereditary persistence of fetal hemoglobin.
6. Describe the association between thalassemias and their hemoglobin variants.
7. Describe alpha thalassemia associated with sickle cell anemia.
8. Describe characteristic laboratory findings associated with the diagnosis of thalassemia.
9. Explain the risks for patients with thalassemia major who are on regular blood transfusion programs.
10. Contrast laboratory findings in iron deficiency anemia and thalassemia (i.e. RBC indices).
11. Describe and recognize the appearance of the peripheral smear in thalassemia.
12. Explain the clinical usefulness of the Kliehauer-Betke stain in the diagnosis of thalassemia.

XIII. Paroxysmal Nocturnal Hemoglobinuria

1. Define PNH.
2. Describe the RBC abnormality associated with PNH.
3. Describe the three types of PNH red cells and include their relationship to complement.
4. List clinical features associated with PNH.
5. List laboratory findings associated with PNH.
6. Describe the procedure for the sugar water test.
7. Describe the procedure for the Ham's test.
8. List treatment therapies for PNH.
9. Diagram both the classic and alternate complement pathways.

XIV. Immune and Non Immune Hemolytic Anemias

1. List the mechanisms of immune hemolysis.
2. Define alloimmune hemolytic anemia.
3. Characterize and describe immediate hemolytic transfusion reaction.
4. Characterize delayed hemolytic transfusion reaction.
5. List the causes of hemolytic disease of the newborn.
6. Describe laboratory findings for HDN.
7. List various treatments for HDN.
8. Define autoimmune hemolytic anemia.
9. List characteristics of warm autoimmune hemolytic anemia.
10. List features of cold agglutinin syndrome.
11. Describe the principle and procedure for the Donath/Landsteiner test for PCH.
12. List mechanisms for drug induced hemolytic anemia.
13. List and describe classifications for non immune hemolytic anemia.
14. Describe the techniques for laboratory diagnosis of malarial infections.
15. Name other organisms associated with hemolytic anemia.

XV. Anemia Associated With Other Disorders

1. Identify laboratory findings associated with anemia of inflammation.
2. List causes for anemia of inflammation.
3. Describe the immune processes responsible for inducing the anemia of inflammation.
4. Describe treatments for anemia of inflammation.
5. Describe anemia associated with endocrine disorders (thyroid, Hypogonadism, pituitary dysfunction, adrenal insufficiency)
6. Describe anemia associated with renal disease.
7. List laboratory findings associated with renal disease.
8. Describe anemia associated with liver disease.
9. List laboratory findings associated with anemia of liver disease.
10. Describe findings associated with anemia of alcoholism.

XVI. Cell Biology and Disorders of Neutrophils

1. Name the three major types of leukocytes found in the peripheral blood.
2. Describe the production and circulating kinetics of hematopoietic cells.
3. List normal values for the various cell types found in the peripheral blood.
4. Characterize the changes in the neutrophil count, morphology and movement that occur in response to infections.
5. Describe the changes that occur in a neutrophil movement as a result of inflammatory reactions.
6. List the steps in phagocytosis.
7. Distinguish between quantitative and qualitative disorders of neutrophils.
8. List and define the two main classes of neutropenia.
9. List and define four types of acquired neutropenia.
10. List conditions classified as congenital neutropenia.
11. Describe conditions associated with chemotaxis disorders.
12. Name conditions associated with defects in cytoplasmic granules.
13. Name conditions associated with biochemical defects.
14. Describe neutrophil dysfunction associated with congenital deficiencies of neutrophil glycoproteins.
15. Describe disease characteristics associated with hyperimmune globulin E syndrome (Job's Syndrome).
16. Name two conditions in which abnormal morphology and normal functions are found in neutrophils.
XVII. Infectious Mononucleosis and Reactive Lymphocytosis

1. Identify the distinguishing characteristics of reactive lymphocytes.
Correlate conditions associated with the appearance of reactive lymphocytes in the peripheral blood.
3. State a cause for heterophile negative mononucleosis like syndrome.
4. Describe clinical manifestations of EBV associated infectious mononucleosis.
5. Describe laboratory tests that are used to diagnose infectious mononucleosis.

XVIII. Introduction to Leukemia and Acute Leukemias.

1. Define leukemia.
2. Describe the classification of leukemias.
3. Describe the risk factors for leukemia.
5. Distinguish among types M1 through M6 of acute myeloid leukemia.
6. Distinguish among types L1 through L3 of acute lymphoblastic leukemia.

XIV. Myelodysplastic Syndromes

1. Name a leukemic trait shared by the myelodysplastic syndromes.
2. List diagnostic criteria for the myelodysplastic syndromes.
3. Identify features of refractory anemia and refractory anemia with ringed sideroblasts.
4. Identify the chromosome abnormality associated with myelodysplastic syndromes.

XX. Chronic Leukemias

1. List general features of chronic lymphocytic leukemia.
2. Name and describe laboratory methods used to study lymphocytes in lymphoproliferative disorders.
3. List diagnostic criteria of chronic lymphocytic leukemia.
5. Explain differential diagnostic criteria that are used to characterize lymphocytic leukemias, lymphomas, and lymphoproliferative disorders.

List general features of chronic myelogenous leukemia.
Name laboratory features characteristic of chronic myelogenous leukemia.
9. Explain differential diagnostic criteria that are used to characterize chronic myelogenous leukemia.

XXI. Myeloproliferative Disorders

1. List characteristics found in the myeloproliferative disorders.
2. Identify the predominant abnormal erythrocyte morphology associated with idiopathic myelofibrosis.
3. Contrast myelofibrosis and chronic myelogenous leukemia using clinical and laboratory features.
4. List those laboratory findings associated with polycythemia vera.
5. Select those features that distinguish secondary polycythemia and relative erythrocytosis from polycythemia vera.
6. List and explain therapy for control of polycythemia vera.
7. Name conditions that may cause an absolute erythrocytosis.
8. List criteria for the diagnosis of essential thrombocythemia.

XXII. Plasma Cell Disorders

1. List laboratory tests for whole blood evaluation of immunoglobulin disorders and correlate results found in those tests to disease states.
2. List laboratory tests and describe laboratory findings in the serum evaluation of immunoglobulin disorders.
3. List and describe laboratory test findings for urine evaluation of immunoglobulin disorders.
4. List diagnostic criteria for multiple myeloma.
5. List diagnostic criteria for Waldenstrom's Macroglobulinemia.
6. Describe heavy chain disease and list features and laboratory results which would aid in their diagnosis.
7. Correlate densitometer tracings of protein electrophoresis to their respective immunoglobulin abnormalities.

XXIII. The Lymphomas

1. Name, describe and recognize the cell characteristically found in Hodgkin's disease.
2. List distinguishing features for lymphocyte predominance, mixed cellularity, lymphocyte depletion, and nodular sclerosing Hodgkin's disease.
3. List distinguishing features for the four stages of Hodgkin's disease.
4. Describe classification criteria for non Hodgkin's lymphomas.
5. List and describe results that may be needed to differentiate diagnosis for lymphomas.
XXIV. Lipid Storage Diseases and Histiocytoses

1. Describe the defect in lipid storage diseases.
2. Name the enzyme deficiency in Gaucher's disease.
3. List characteristics found in Gaucher's disease.
4. Recognize and describe the appearance of Gaucher's cells.
5. Name the enzyme deficiency of Niemann-Pick disease.
6. Recognize and describe the Niemann-Pick cell.
7. Name the enzyme deficiency of Tay-Sach's disease.
8. List characteristics and clinical features of Tay-Sach's disease.
11. Recognize and describe the characteristic cell found in Sea-Blue Histiocytosis.
12. List other histiocytic disorders.

XXV. Introduction to Hemostasis.

1. List the functions of the vascular system.
2. Describe the major function of the endothelium.
3. Name the three structural zones of platelets.
4. Describe the functions of the structural zones of platelets.
5. Explain the role of platelets in the hemostatic process.
6. List the steps in platelet plug formation.
7. Describe essential elements for the process of platelet adhesion.
8. Describe the process of platelet aggregation.
9. Name the product responsible for stabilization of the hemostatic plug.
10. List characteristics for the contact coagulation proteins.
11. Name the product responsible for the stabilization of the hemostatic plug.
12. List characteristics for the contact coagulation proteins.
13. List characteristics for the prothrombin proteins.
14. List characteristics for the fibrinogen group.
15. Name those factors unique to the extrinsic system.
16. Explain the activity of the extrinsic system.
17. Name the factors unique to the intrinsic system.
18. List the sequence of events in the intrinsic pathway that lead to the common pathway.
19. Name those factors found in the common pathway.
20. List the functions of thrombin.
21. Name those substances that activate plasminogen to plasmin.
22. List the functions of plasmin.
23. Explain the role of the kinin system in coagulation.
24. List the protease inhibitors and describe the function of each.
25. List the function of C3a, C3b, C5a, C1 inhibitor as they relate to coagulation.
26. Describe the use of the prothrombin time test in monitoring hemostasis.
27. Describe the use of the activated partial thromboplastin time test in monitoring hemostasis.
28. Correlate coagulation results with disorders of the intrinsic and extrinsic systems and further differentiate by factor deficiency by using results from substitution studies using aged serum and absorbed plasma.
29. Correlate PT and APTT results with those factors that may be deficient and suggest further testing that may resolve the coagulation discrepancy.

XXVI. Vascular and Platelet Disorders

1. List signs, symptoms, and laboratory values characteristic of von Willebrand's disease.
2. Characterize Bernard-Soulier syndrome and correlate laboratory data that supports the diagnosis of this disorder.
3. Characterize Glanzmann's thrombasthenia and correlate laboratory data that supports the diagnosis of this disorder.
5. List differential findings for other congenital disorders of platelet function. (May-Hegglin, TAR baby syndrome, Wiscott-Aldrich, Chediak-Higashi)
6. For the following disorders that may result in acquired qualitative platelet disorders, list those characteristics that support their respective diagnosis.

<table>
<thead>
<tr>
<th>Renal disease - uremia</th>
<th>Paraproteinemias</th>
</tr>
</thead>
<tbody>
<tr>
<td>Myeloproliferative disorders</td>
<td>Cardiac bypass</td>
</tr>
<tr>
<td>Liver disease</td>
<td>DIC</td>
</tr>
<tr>
<td>Drug therapy</td>
<td>platelet antibodies</td>
</tr>
</tbody>
</table>

7. Define the term thrombocytopenia.
8. List conditions that are classified as non immunologic causes for thrombocytopenia.
9. List conditions responsible for immunologic thrombocytopenia.
10. Describe disorders associated with thrombocytosis.
11. List conditions that show inherited vascular defects.
12. List conditions that show acquired vascular defects.
13. Describe platelet aggregation curves showing normal response to ADP, collagen, epinephrine, arachidonic acid, and ristocetin.
XXVII. Defects of Plasma Clotting Factors
1. List defects that may impair the coagulation system.
2. Name the factor deficiency associated with hemophilia A.
3. List laboratory tests for the differential diagnosis of
   Hemophilia A and von Willebrand's disease and contrast the
   results for the two disorders.
4. Name the factor deficiency found in Hemophilia B.
5. List laboratory findings associated with deficiencies of each
   coagulation factor.
6. Describe circulating anticoagulants and their effect on coagulation testing.
7. Describe circulating anticoagulant inhibitors and their effect on hemostasis.
8. Define and explain laboratory screening tests for the evaluation of coagulation
   abnormalities.

XXVIII. Interaction of the Fibrinolytic, Coagulation, and Kinin Systems
1. List plasminogen activators and negative feedback clotting mechanisms.
2. Describe plasmin's action in forming the intermediate degradation product, D-dimer.
3. Name the primary inhibitor of the fibrinolytic system and describe how it performs
   this action.
4. List mechanisms and clinical conditions associated with DIC and correlate laboratory data with its diagnosis.
5. Define the three generalized clinical states of DIC with regard to the typical laboratory abnormalities associated
   with each.
6. Identify therapies for treatment of DIC and describe how each therapy produces its effect.
7. Compare and contrast DIC and Primary fibrinolysis using laboratory data.

XXIX. Thrombosis and Anticoagulant Therapy
1. Name the natural anticoagulants/inhibitors present in plasma.
2. Explain the action of thrombotic factors.
3. Identify components of plasminogen activation.
4. Explain the advantage of using functional assays instead of immunologic assays for evaluating thrombosis.
5. Evaluate and explain antithrombin III levels during heparin therapy.
6. Associate thrombosis and pregnancy.
7. Recognize laboratory data associated with DIC.
8. Explain the action of oral anticoagulants.
9. List tests used to monitor oral anticoagulant therapy.
10. Explain the anticoagulant mechanism of heparin.
11. List laboratory tests used to monitor heparin therapy.
12. List agents used in thrombolytic therapy.
13. List laboratory tests used to monitor thrombolytic therapy that are not affected by heparin and explain why these tests
    are not affected by heparin.
XXX. Routine Hematology Methods

1. Calculate a manual WBC count.
2. Calculate a manual RBC count.
4. Calculate a percent, absolute, and corrected reticulocyte count.
5. Calculate a reticulocyte production index.
7. Calculate MCV.
8. Calculate MCH.
9. Calculate MCHC.
10. Classify RBC's based on the MCV and MCH.
11. List factors that affect ESR.
12. Identify hemoglobins separated at alkaline and acid pH on hemoglobin electrophoresis.
14. Describe the differential solubility test for hemoglobin S.
15. Describe the acid elution test for hemoglobin F.
16. List tests that identify Heinz bodies.
17. Identify conditions that show increased and decreased osmotic fragility.
18. Describe basic principles for the Ham's test and sugar water test.
19. Calculate platelet estimates from a peripheral blood smear.
20. Calculate a corrected WBC count for nucleated RBC's.
21. Explain the principle of automated cell counting.
22. Identify cell parameters measured directly by the Coulter.
23. Identify parameters calculated by the Coulter.
24. Explain the principle for the measurement of hemoglobin by the cyanmethemoglobin method.

XXXI. Automated Differential Analysis

1. Describe the methodolgy used by the Coulter for automated differentials.
2. Explain the main use of a leukocyte histogram.
3. Decide circumstances in which one would accept automated differentials or when to perform manual differentials.
4. Determine corrective action when a result is flagged or when results of the CBC due not correlate.
5. Interpret a WBC histogram.
XXXII. Special Stains

1. For the following special stains, identify the purpose, principle, specimen and interpretation of each.
2. For each special stain, identify the cells or cell lines that may be identified.

- Leukocyte Alkaline Phosphatase
- Peroxidase
- Sudan Black B
- Specific Esterase (Naphtol AS-D Chloroacetate)
- Non-Specific Esterase (Alpha-Napthol Butyrate)
- Combined Esterase
- ACP, TRAP
- PAS
- TdT
- E Rosetting
- Cytoplasmic Immunoglobulins
- Surface Immunoglobulins

3. Explain the principle of flow cytometry.
4. List clinical applications of flow cytometry.

XXXIII. Coagulation Testing

1. Explain the diagnostic use of the bleeding time.
2. Explain the principle of platelet adhesion and it's importance to coagulation.
3. List basic requirements for platelet aggregation as an in vitro means of evaluating platelet function.
4. Explain the use of whole blood clotting times, APTT, PT, TT, reptilase time, Stypven time, prothrombin consumption.
5. Describe the principle for one stage quantitative factor assays.
6. List conditions having low and high fibrinogen levels.
7. Interpret a Factor VIII screening test.
8. Relate clinical conditions to Factor VIII related antigen.
9. List methods of measurement for anti-thrombin III.
10. Identify methods for diagnosis of protein C deficiency.
11. Define pathologic anticoagulants.
12. Recognize APTT results that may indicate circulating anti-coagulants.
13. List criteria for detecting lupus inhibitors.
14. List confirmatory tests for lupus anticoagulants.
15. Describe the various uses of latex tests in the diagnosis of DIC.
16. List tests for measuring plasmin's action on a fibrin clot.
17. List a test that evaluates fibrinolytic activity by measuring plasminogen activator concentration.
CLAB 462 & 463 IMMUNOLOGY-SEROLOGY

I. CELLS AND TISSUES

After completing lecture and reading assignments, each student will, with 75% accuracy:

1. List the cells associated with the immune system.
2. Discuss the function of each cell in the immune system.
3. Compare and contrast between primary and secondary lymphoid organs.
4. Discuss the role of the thymus in T cell maturation.
5. Describe maturation of a B cell from the pre-B cell to a plasma cell.
7. Identify and discuss the function of the following key antigens on T cells: CD2, CD3, CD4, CD8, sIg and TdT.

II. MECHANISMS OF RESPONSE

1. Define the following terms: cytokine, opsonin, chemotaxis.
2. Describe the steps involved in B-cell and T-cell antigen recognition.
3. Discuss the central role of the T helper cell in both cell-mediated and humoral immunity.
4. Explain the activation of TH, Tc and B cells.
5. Describe the mechanisms involved in the elimination of antigen by Tc, natural killer cells, antibodies and macrophages.
7. State the function of Ts cells.

III. AUTOIMMUNE/ IMMUNODEFICIENCY DISEASES

1. Define autoimmunity.
2. Discuss the general mechanism of autoimmunity.
3. Explain the theories that cause autoantibody production.
4. Describe the patterns seen when antinuclear antibody is detected by indirect immunofluorescence.
5. List the marker antibodies and explain the significance of each.
6. State the immunofluorescent pattern associated with the major nuclear antigens.
7. Define rheumatoid factor.

8. For each of the following diseases, state the general abnormality and major serologic changes:
   a. Systemic lupus erythematosus
   b. Rheumatoid arthritis
   c. Sjogren's syndrome
   d. Progressive systemic sclerosis
   e. Polymyositis-dermatomyositis
   f. Autoimmune hemolytic anemia
   g. Progressive Systemic Sclerosis (Scleroderma)
   h. Polymyositis-Dermatomyositis

9. Discuss the differences between nonorgan-specific and organ-specific autoimmune diseases.

10. List the laboratory test procedures used to diagnose thyroid autoimmune diseases.

11. Describe the differences between Graves' disease and Hashimoto's thyroiditis.

12. List the laboratory test procedures used to diagnose liver autoimmune diseases.


14. Identify autoimmune antibodies and immunologic changes associated with myasthenia gravis and Goodpasture's syndrome.

15. Classify selected immune deficiencies as humoral, cellular, or combined.

16. Discuss the information generated from various laboratory tests and how they are used to evaluate immunocompetence.

17. Suggest the most likely type of immune deficiency when provided with laboratory and clinical data.

18. Characterize the laboratory findings of hypergammaglobulinemia as monoclonal or polyclonal based on serum protein electrophoresis, immunoelectrophoresis, immunofixation electrophoresis, and quantitation of immunoglobulin classes.

19. Compare and contrast polyclonal and monoclonal gammopathies with respect to cellular processes, the concentration of immunoglobulin, and the appearance on immunofixation electrophoresis (or immunoelectrophoresis).

20. Classify each of the following diseases or conditions as a monoclonal gammopathy or a polyclonal gammopathy and describe the expected changes on serum protein electrophoresis, immunoelectrophoresis, immunofixation electrophoresis, and quantitation of immunoglobulins: Chronic infection, Multiple myeloma, Waldenstrom's macroglobulinemia, Heavy-chain disease.

IV. MHC/NATURE OF ANTIGENS/Mechanisms of Response

1. Describe the difference between antigens and immunogens.

2. List several factors that contribute to immunogenicity and discuss how each of the factors contributes to immunogenicity.

3. Define the following terms: hapten, adjuvant, antigenic determinant, epitope, MHC, gene, allele, gene product, polymorphism, haplotype, genotype, and relative risk.

4. Compare and contrast the MHC Class I, II and III products with respect to structure, cellular or humoral distribution, and function.
5. Given the HLA phenotypes of parents and offspring, determine the genotype and haplotype of each.
6. Given the HLA phenotypes of an alleged father, mother, and offspring, determine if the alleged father is excluded as the biologic father, if possible.
7. Describe how relative risk can be related to a disease.
8. Define the following terms: cytokine, opsonin, chemotaxis.
9. Describe the steps involved in B-cell and T-cell antigen recognition.
10. Discuss the central role of the T helper cell in both cell-mediated and humoral immunity.
11. Explain the activation of Th, Tc and B cells.
12. Describe the mechanisms involved in the elimination of antigen by Tc, natural killer cells, antibodies and macrophages.
14. State the function of Ts cells.

V. ACUTE PHASE RESPONSE- HYPERSENSITIVITY

1. Discuss the role of acute phase proteins in the immune response.
2. Discuss the clinical significance of abnormal levels of acute phase proteins.
3. Define hypersensitivity, atopy and allergen.
4. Discuss the key immunologic reactant involved in immediate hypersensitivity.
5. Describe the changes that take place in IgE-coated mast cells and basophils when binding with specific antigen occurs.
6. Describe anaphylaxis.
7. Discuss the advantages and disadvantages of skin testing for immediate hypersensitivity.
8. Compare and contrast the RAST and RIST test methods.
9. Discuss how cellular damage occurs in type II hypersensitivity.
10. Given an example, categorize conditions/diseases into the appropriate type of hypersensitivity.
11. Distinguish between type II and type III hypersensitivity reactions on the basis of the nature of the antigen involved and mechanisms of cellular injury.
12. Explain how type IV sensitivity differs from the other three types of hypersensitivity reactions.
VI. ANTIBODY STRUCTURE AND FUNCTION

1. Describe the structure of a typical immunoglobulin.

2. Define the following terms: Fc component, Fab component, J chain, secretory component, heavy chain, light chain, constant region, variable region, isotype, allotype, idiotype, monoclonal antibody, elution, specificity, affinity, avidity and heterophile antibody.

3. Characterize the five immunoglobulin classes, according to function and structure.

4. Discuss the differences between the subclasses of IgG.

5. Differentiate between light and heavy chains of immunoglobulins.

6. Explain how papain and pepsin cleave the immunoglobulin molecule.

7. State how immunoglobulins are detected and measured in the laboratory.

8. Discuss how monoclonal antibodies are produced and how they are used in the clinical laboratory.

9. Explain why antigen-antibody interactions are reversible.

10. Describe the forces that work to keep antigen bound to antibody.

11. List four methods of antibody elution.

12. Explain the clinical utility in detecting heterophile antibody.

VII. DILUTIONS AND TITERS; PRECIPITATION AND AGGLUTINATION REACTIONS

1. Define and apply the following terms: solute, diluent, dilution, serial dilution, titer.

2. Calculate simple and compound (serial) dilution problems.

3. Define a precipitation reaction.

4. Explain how the zone of equivalence is related to the lattice hypothesis.

5. Differentiate between single and double diffusion.

6. Compare and contrast the various types of precipitation reactions. Include examples of the various types.
7. Explain the advantages and disadvantages of each type of precipitation reaction.

8. Evaluate sources of error for each type of precipitation reaction.

9. Determine the relationship between two antigens by observing the pattern of precipitation resulting from Ouchterlony immunodiffusion.

10. Interpret results from observing various precipitation reactions.

11. Compare and contrast agglutination and precipitation reactions.

12. Describe the phases of agglutination.

13. Describe and give examples of each of the following:
   a. direct agglutination
   b. passive agglutination
   c. reverse passive agglutination
   d. agglutination inhibition

14. Discuss why enhancement media may be needed in agglutination reactions.

15. Explain how anti-human serum is prepared.

16. Compare and contrast direct and indirect antiglobulin techniques.

VIII. MISCELLANEOUS SEROLOGY

1. Discuss significant titers of IgG and IgM in determining recent and past infections.

2. Discuss the significance of a fourfold rise in antibody titer.

3. Explain the role of *Streptococcus pyogenes* and its components in the development of rheumatic fever (RF), rheumatic heart disease (RHD), and acute glomerulonephritis (AGN).

4. Describe the importance of immunologic procedures in the diagnosis of RF, RHD, and AGN.

5. Discuss the relationship of an increased anti-streptolysin O (ASO) titer with a previous streptococcal infection.

6. Explain the relationship between a positive ASO and a negative anti-hyaluronidase test (AHT).

7. Describe the basic methods used for diagnosis of previous streptococcal infections.

8. Interpret test results, and explain reasons for false positive results.

9. State the treponemes that infect humans, the syndromes and infections they cause, and the epidemiological differences.

10. Describe the four stages of syphilis and congenital syphilis.

11. Identify appropriate therapy for syphilis and congenital syphilis.

12. Describe three types of direct detection tests for syphilis and in what stage of syphilis they are useful for diagnosis.
13. Describe the serological diagnosis of syphilis, indicating the differences between nontreponemal and treponemal tests, and name the stages of syphilis for which serological tests are most useful.

14. Describe the symptoms and complications of acute rubella virus infection.

15. List the major abnormalities associated with congenital rubella infection.

16. Discuss the appearance of IgG and IgM antibodies in the course of acute disease and congenital infection.

17. Discuss the principles of the following tests used in rubella antibody testing: Hemagglutination inhibition, Passive hemagglutination, Solid-phase immunoassays.

18. List appropriate tests for diagnosing congenital infection and determining recent rubella infection and immune status.

19. Describe the Epstein-Barr virus.

20. Discuss the diseases caused by Epstein-Barr virus.

21. Discuss the tests used to detect heterophile antibody.

22. Discuss specific tests used to detect antibodies to the Epstein-Barr virus.

23. Given laboratory results, suggest the most likely disease and whether the infection was recent, remote, or reactivated.

24. List the four major rickettsia groups.

25. Name the organisms that are the causative agents of the following: epidemic typhus, endemic typhus, scrub typhus, and Q fever.

26. Describe the cold agglutinin test for mycoplasma.

27. Describe methods for febrile agglutinins.

**IX. IMMUNOFLOUORESCENCE**

1. Define fluorescence, direct immunofluorescence, indirect immunofluorescence and substrate in the context of diagnostic immunology.

2. Compare and contrast direct immunofluorescence and indirect immunofluorescence with respect to substrate, steps in the procedure, and conjugate.

3. For the following sources of error associated with indirect immunofluorescence, discuss what each is and how to monitor it: increased nonspecific staining, increased background staining, decreased specific fluorescence, and increased autofluorescence.

4. Describe two applications of indirect immunofluorescence to include the substrate used, analyte detected, and expected patterns.

**X. COMPLEMENT**

1. Describe the nature of the complement components.

2. Differentiate between the classical and the alternative pathways, including proteins and activators involved in each.

3. Discuss formation of the three principal units of the classical pathway; recognition, activation, and membrane attack units.
4. List the complement control proteins and describe how they exhibit their function.

5. Relate biologic manifestations of complement activation to generation of specific complement products.

6. Recall the disease states that result from abnormalities in complement components or control proteins of the complement sequence.

7. Analyze laboratory findings and indicate disease implications in relation to complement abnormalities.

8. Discuss the tests that evaluate the function of the complement systems.

9. Discuss the procedures for detecting complement component levels.

10. Describe the complement fixation test.

XI. LABELED ASSAYS/NEPHELOMETRY/MMUNOFLUORESCENCE

1. Compare and contrast binding reagents.

2. In the context of immunoassays, define ligand, tracer, homogeneous, heterogeneous, competitive, noncompetitive, ELISA, RIST, and RAST.

3. For each method of separation, explain its mechanism of separation and how it contributes to error in an assay.

4. Given parameters of an assay, classify the assay as heterogeneous or homogeneous, and competitive or noncompetitive, and state the analyte, label, signal measured, and conjugate.

5. State the principle of enzyme linked immunosorbent assay, radioimmunoassay, enzyme multiplied immunoassay, and fluorescence polarization immunoassay.

6. State the clinical utility of measuring total IgE, allergen-specific IgE, and human chorionic gonadotropin.

7. Explain why luteinizing hormone can be an interference when measuring human chorionic gonadotropin.

8. Discuss the advantages and disadvantages of each type of immunoassay.

9. Choose an appropriate immunoassay for a particular analyte.

10. State the basic principles of turbidimetry and nephelometry.

11. Identify the major components of instruments for turbidimetry and nephelometry.

12. Describe the performance characteristics and limitations of nephelometry.

13. Give examples of common applications of turbidimetry and nephelometry.


15. Compare and contrast direct immunofluorescence and indirect immunofluorescence with respect to substrate, steps in the procedure, and conjugate.

16. For the following sources of error associated with indirect immunofluorescence,
discuss what each is and how to monitor it: increased nonspecific staining, increased background staining, decreased specific fluorescence, and increased autofluorescence.

17. Describe two applications of indirect immunofluorescence to include the substrate used, analyte detected, and expected patterns.

XII. INTRODUCTION TO NATURAL IMMUNITY

1. Define the following terms: antigen, antibody, hapten, immunoglobulin, immunity, immunology, vaccination, attenuated vaccine, phagocytosis.

2. Differentiate between innate and adaptive immunity.

3. Categorize examples of immunity as:
   a) innate or adaptive
   b) cellular or humoral
   c) active, passive or adoptive

4. Outline the key processes involved in natural immunity.

5. Discuss the historical contributions made by Jenner, Pasteur, Koch, Metchnikoff, Bordet, and Landsteiner in the field of immunology.

6. List the cells associated with the immune system.

7. Discuss the function of each cell in the immune system.

8. Compare and contrast between primary and secondary lymphoid organs.

9. Discuss the role of the thymus in T cell maturation.

10. Describe maturation of a B cell from the pre-B cell to a plasma cell.

11. Explain what constitutes a cluster of differentiation.

12. Identify and discuss the function of the following key antigens on T cells: CD2, CD3, CD4, CD8, sIg and TdT.

SEROLOGY/IMMUNOLOGY LAB
After completing the Serology/immunology laboratory rotation, the student will, with 75% accuracy:

2.1. Discuss how quality control (QC) is monitored for the different procedures and instruments in the immunology and serology laboratory; how QC is used to evaluate performance records, and what corrective actions would need to be taken if QC values are not within established limits.
2.2 Perform QC procedures according to the SFMC Serology laboratory.
2.3 Perform daily maintenance routines.
2.4 Define solute, diluent, dilution, compound dilution, and serial dilution.
2.5 Calculate simple and serial dilutions when given the amount of solute (or serum) and the amount of diluent.
2.6 List the panic (critical) values for the SFMC Serology laboratory, and outline the protocol for reporting these results.
2.7 Outline the procedure and describe the principle of the Amniostat-FLM test.
2.8 Correlate results of the Amniostat-FLM test to fetal lung maturity.
2.9 Outline the procedure for cold agglutinins.
2.10 Correlate the presence of cold agglutinins to a disease state.
2.11 Perform the Crypto-LA test, including specimen preparation and quality control.
2.12 Discuss the principle of the Crypto-LA test.
2.13 Explain why specimens for the Crypto-LA test are heated prior to testing.
2.14 Interpret results for the Crypto-LA test.
2.15 Outline the procedure for the NOW Legionella Urinary Antigen test.
2.16 Compare the urine antigen test for Legionella with other methods for the detection of Legionella in terms of sensitivity and specificity.
2.17 List the specimens that may be used for the Directigen Meningitis test, and discuss which are preferred.
2.18 Outline the procedure for the Directigen Meningitis test.
2.19 Describe the clinical situations that warrant the Directigen Meningitis test, and explain why this procedure should not be performed on >95% of CSF specimens.
2.20 Perform the procedure for the Color-Card Mono Agglutination test, and interpret the results.
2.21 Name and describe the reference method for detecting infectious mononucleosis.
2.22 Define “heterophile antibody”.
2.23 Correlate a positive color card mono agglutination test to various diseases.
2.24 List causes of false-positive and false-negative results for the color card mono agglutination test.
2.25 Describe the serological diagnosis of syphilis, indicating the differences between nontreponemal and treponemal tests, and name the stages of syphilis for which serological tests are most useful.
2.26 Perform the procedure for the RPR test and interpret results.
2.27 Discuss the principle of the RPR test.
2.28 List the contents of the RPR antigen.
2.29 List causes of biological false positives for the RPR and VDRL tests.
2.30 Discuss the protocol for reporting and confirming positive RPR and VDRL results.
2.31 Discuss limitations of the RPR procedure.
2.32 Compare specimen types and specimen preparation for the RPR and VDRL tests.
2.33 Perform the procedures and interpret results for the VDRL, quantitative VDRL, and spinal fluid VDRL tests.
2.34 Describe specimen collection and preparation procedures for RSV testing.
2.35 Perform the procedure and interpret results for the RSV test.
2.36 Discuss the principle of the RSV test.
2.37 Perform the procedure and interpret the results for a rapid group A strep test.
2.38. Discuss the principle of the group A strep test currently in use in the SFMC laboratory.
2.39. Discuss the recommended protocol for patients who are suspected of having group A *Streptococcus* pharyngitis and who test negative for a rapid streptococcal test.
2.40. Discuss the principle and the clinical utility of the Varicella Zoster test.
2.41. Perform the procedure and interpret the results for the Varicella Zoster test.
2.42. Discuss the principle and the clinical utility of the Rubella test.
2.43. Perform the procedure and interpret the results for the Rubella test.
2.44. Discuss the principle of the fungal serology test, and interpret patterns of “identity”, “partial identity” and “non-identity”.
2.45. Perform the procedure and interpret the results for the ANA profile.
2.46. Correlate positive results of the ANA profile to disease states.
2.47. Discuss limitations of the gel test procedures for fungal serology and the ANA profile.
2.48. Perform the procedure for and interpret the results of the antinuclear antibody (ANA) test.
2.49. List the reagents used for the ANA test and the action and composition of each.
2.50. Correlate various patterns of fluorescence to possible diseases.
2.51. Describe proper specimen collection and handling for the Chlamydia direct test.
2.52. Define “elementary body”.
2.53. Perform the procedure and interpret the results for the Chlamydia direct test.
2.54. Discuss the principle of the anti-DNA test.
2.55. Perform the procedure for and interpret the results of the anti-DNA test.
2.56. Correlate positive results for the anti-DNA test to specific disease states.
2.57. Discuss the principle of the FTA-ABS test.
2.58. Perform the procedure for and interpret the results of the FTA-ABS test.
2.59. Perform the procedure for and interpret the results of the HSV1/HSV2 direct test.
2.60. Describe proper specimen collection and handling for the HSV1/HSV2 direct test.
2.61. Outline the procedure for DFA Legionella testing.
2.62. Discuss the principle of the DFA Legionella test.
2.63. Outline the procedure for the IFA Legionella test.
2.64. List appropriate specimens for the IFA Legionella test.
2.65. Discuss the principle of the IFA Legionella test.

**CLAB 464 & 465- CLINICAL MICROBIOLOGY AND LAB**

**OBJECTIVES**

After completion of lecture and reading assignments the student will, with 75% accuracy, be able to:
I. INTRODUCTION

1. List the steps involved in the diagnosis of an infectious disease.
2. List three areas of reporting in microbiology and discuss the clinical utility of each.
3. Identify criteria for proper specimen collection, transport, storage and inoculation.
4. Judge the best course of action concerning specimens that are unsatisfactory or suboptimal.
5. Discuss various purposes of direct examinations.
6. List several types of direct examinations and correlate each with organisms detected.
7. State the principle of various stains used in microbiology.
8. Describe the procedure for the Gram stain, including reagents, expected results at each step and causes of unexpected results.
9. State the purpose (clinical utility) of the following stains: Ziel-Neelsen, Kinyoun, Methylene blue, acidine orange, auramine-rhodamine, calcofluor white, Gray, Leifson, Hiss, Anthony, India Ink, Muir, Dorner.
10. Correlate the stains listed above with various microorganisms and/or structures.
11. List several factors that affect the cultivation and growth of microorganisms on culture media.
12. Discuss the various methods of sterilization.
13. Define the following types of media: supportive, enrichment, selective, differential.
14. For the following list of media, list the type; organisms cultured and inhibited; enrichment, differential and selective substances; and indicators:
   - BAP
   - Chocolate
   - Mueller-Hinton
   - Stuart transport
   - EMB
   - MacConkey
   - CNA
   - PEA
   - HE
   - XLD
   - SS
   - BS
   - GN Broth
   - Campy J
   - CIN
   - TCBS
   - Schaedler
   - Thioglycollate
   - Mannitol Salt
   - BCYE
   - Brucella blood
   - Loeffler’s
   - McBride’s
   - BG
   - Sabouraud
   - Cornmeal
   - LJ
   - TM
   - MTM
   - NYC
15. Define the following terms: aerobic, anaerobic, microaerophilic, facultatively anaerobic, capnophilic, humidophilic, psychrophilic, thermophilic.
16. Describe different techniques to provide capnophilic and anaerobic growing conditions.
17. Correlate optimal temperatures for transport, storage and incubation to various organisms.
18. Interpret the results of cultures using relative quantity data, direct smears, collection sites,
colonial morphology, cellular morphology, and structural morphology, correlating the results to various disease states or normal flora status.

19. List the principle of reaction, reagents used and expected results for various organisms for rapid (spot) biochemical tests, conventional biochemical tests, and susceptibility (inhibitor) tests.

II. GRAM-POSITIVE COCCI (MICROCOCCACEAE)

1. Describe gram stain characteristics of the medically significant gram positive cocci.
2. Describe colony growth characteristics of staphylococcus.
3. Identify those biochemical and serological tests that can distinguish *Staphylococcus aureus* from other gram positive cocci.
4. Discuss disease states caused by *Staphylococcus aureus*, *S. epidermidis*, and *S. saprophyticus*.
5. Define the term "beta lactamase" and discuss its significance as it relates to treatments of infection.
6. Identify biochemical and inhibitor tests that distinguish coagulase-negative staphylococci (CNS), *Micrococcus* and *Stomatococcus*.
7. List expected results, false reactions, and sources of error for various biochemical, serological and inhibitor tests used to identify the Micrococcaceae.
8. Describe the gram stain morphology of the different species of *Streptococci*.
9. Describe colony growth characteristics of streptococci.
10. Differentiate by biochemical test staph. and strep.
11. List and describe different enzymes that cause increased virulence of *Streptococci*.
12. Explain two systems of classifying *streptococci*.
13. Define alpha, beta, and gamma hemolysis, and correlate the pattern of hemolysis with different species of streptococci.
14. For each of the following organisms, choose appropriate testing to aid in identification, validate that testing by describing what constitutes a positive and negative result and classify by hemolytic reaction and Lancefield grouping:
   - *Strep. pneumoniae*   *Strep. pyogenes*  
   - *Strep. agalactia*   *Strep. viridans*  
   - Enterococci
15. Define the terms AMRSA and AVRE and discuss the clinical significance of each.
16. Discuss standard protocol for susceptibility testing of the clinically significant Micrococcaceae.
17. Predict susceptibility and resistance to various drugs for the clinically significant Micrococcaceae.
18. Discuss disease states caused by the organisms listed in #14.

III. ENTEROBACTERIACEAE
1. List the genera and species of the Enterobacteriaceae that colonize humans or are associated with human infections.
2. List those characteristics that are common to all members of Enterobacteriaceae.
3. State the gram stain morphology and colony characteristics of the important Enterobacteriaceae.
4. List organisms that are found to be common causes of gastroenteritis.
5. List culture media that is routinely used for stools.
6. Correlate stool media growth characteristics to the various members of Enterobacteriaceae that cause gastroenteritis.
7. Select the laboratory methods appropriate for handling and culturing Enterobacteriaceae.
8. Define IMViC.
9. For the following biochemical tests, list the primary media contents and/or reagents added; explain the principle of reaction; select appropriate test(s) to differentiate the Enterobacteriaceae; list sources of error:
   - Motility
   - O-F glucose
   - O-F lactose
   - TSI (KIA)
   - Indole
   - Methyl Red
   - VP
   - Citrate
   - Decarboxylases
   - LIA (lysine)
   - PAD
   - Urease
   - Nitrate
   - ONPG
10. Explain the purpose of serogrouping Salmonella, Shigella and E.coli 0157:H7; Describe the serogrouping procedure and name potential sources of error.
11. Describe the normal habitat and discuss the diseases caused by the more commonly isolated Enterobacteriaceae.
12. Discuss antimicrobial susceptibility testing and therapy for the more commonly isolated Enterobacteriaceae.
13. Identify the more commonly isolated Enterobacteriaceae by various biochemical tests.
14. Select appropriate control organisms for various biochemical tests.

IV. GRAM NEGATIVE NON-FERMENTITIVE RODS

1. Summarize the characteristics of nonfermentative gram-negative bacilli (NFB).
2. Explain the principle of the oxidative-fermentative (OF) test and evaluate the test when given a description of the test results or a description of the technique used to perform the test. Evaluate sources of error.
3. Name the three tests that may be used to categorize NFB into eight different groups.
4. Summarize the characteristics of the genus Pseudomonas.
5. Compare the pigments produced by the pseudomonads.
6. Differentiate the more commonly isolated NFB using Gram-stain, colony characteristics and biochemical tests.
7. Discuss the diseases caused by the NFB.
8. Compare the characteristics of Acinetobacter spp. with the Enterobacteriaceae and compare Moraxella spp. with Moraxellacatarrhalis and Neisseria spp.
9. Integrate material presented in previous lectures as it pertains to NFB.
V. The Gram Positive Bacilli

1. Discuss the diseases caused by the gram-positive rods. (See Handout 12a for list).

2. Differentiate among the various gram-positive rods using Gram stain and other relevant staining characteristics, colonial morphology, hemolysis patterns and biochemical tests.

3. Select the specimens and the laboratory methods appropriate for culturing these organisms.

4. Explain the principle of each test used in identification of gram-positive rods.

5. Evaluate gram-positive rod identification tests when given a description of the results or a description of the technique used to perform the test.

6. Summarize the methods for distinguishing atypical Bacillus species from nonfermentative gram-negative rods.

7. Integrate the material presented in previous chapters as it relates to gram-positive bacilli.

8. Describe the clinical utility of the Elek and Weld tests.

VI. AEROBIC GRAM NEGATIVE COCCI

1. Describe gram stain morphology, colony morphology, and characteristics of growth for Neisseria gonorrhoeae, N. meningitidis, and Moraxella catarrhalis.

2. List sites of infection and colonization for Neisseria gonorrhoeae, N. meningitidis, and Moraxella catarrhalis.

3. Choose media that would be used to grow N. gonorrhoeae; list ingredients found in the media, and describe special growth conditions needed for the species.

4. Given the results of sugar fermentation (glucose, maltose, lactose), correlate to different species of Neisseria.

5. For the oxidase and tributyrin tests, state the reagent, principle, positive and negative reactions, gram negative cocci detected, and sources of error.

6. Discuss rapid and confirmatory tests for Neisseria and the situations for which they should be employed.

7. Discuss the clinical utility of the direct exam for pathogenic Neisseria.

8. Describe disease states that may be caused by N. meningitidis and Moraxella catarrhalis.

9. Correlate various identification test results with N. cinerea and differentiate using those tests between N. cinerea, N. meningitidis, and N. gonorrhoea.

10. List drugs of choice for treatment and prophylaxis for the pathogenic gram negative cocci.

11. Explain why susceptibility testing is rarely performed for the pathogenic gram negative cocci.
VII. GRAM POSITIVE COCCOBACILLI

1. State the Gram stain reaction and cellular and colonial morphology for the following organisms:
   - *Haemophilus* spp.
   - *Brucella* spp.
   - *Haemophilus ducreyi*
   - *Francisella tularensis*
   - *Pasteurella multocida*
   - *Bordetella* spp. (*B. pertussis, B. parapertussis, B. bronchiseptica*)
   - *Actinobacillus actinomycetemcomitans*

2. Discuss the diseases caused by each of the preceding organisms.

3. Outline the methods for collecting, transporting, and processing specimens for the preceding organisms.

4. Select the media and incubation conditions appropriate for culturing the preceding organisms. List components of the media.

5. Choose the laboratory tests appropriate for identifying *Haemophilus* isolates to the genus and species level, and explain the principle of each test.

6. Evaluate *Haemophilus* organism identification tests when given a description of the test results or a description of the technique used to perform the test.

7. Choose laboratory methods to identify the following organisms and correlate results to the organism.
   - *Haemophilus influenzae*  
   - *H. influenzae* biogroup *aegyptius*
   - *H. parainfluenzae*
   - *H. haemolyticus*
   - *H. parahaemolyticus*
   - *H. aphrophilus*
   - *H. paraaphrophilus*
   - *H. ducreyi*

8. Define HACEK and summarize the characteristics common to this group.

VIII. ANEROBES

1. Summarize the environmental conditions required by anaerobic bacteria.

2. Describe the normal habitat of anaerobic bacteria.

3. Recognize the following organisms as anaerobic bacteria and state the Gram-stain reaction of each:
   - *Actinomyces*
   - *Bilophila wadsworthia*
   - *Peptococcus niger*
   - *Lactobacillus*
4. Summarize the types of diseases associated with anaerobic organisms.

5. Outline the methods for appropriately collecting, transporting, and processing specimens for anaerobic cultures.

6. Summarize the key features of the various anaerobic culture media.

7. Discuss the methods of cultivating cultures anaerobically.

8. Outline the procedures for examining and working up cultures for anaerobic bacteria.

9. Evaluate anaerobic identification tests when given a description of test results or the technique used to perform the procedure.

10. Discuss the diseases associated with *Clostridium*, *Actinomyces*, *Mobiluncus* and *Propionibacterium* spp.

11. Compare the different methods for detecting *Clostridium difficile*.

12. Summarize the typical laboratory’s role in the diagnosis of botulism.

13. Outline the methods for distinguishing *Bacillus* spp., *Clostridium* spp., and *Lactobacillus* spp.

14. Differentiate between anaerobic bacteria using Gram-stain, colonial, and biochemical characteristics and any other significant attributes.

15. Integrate the material presented in previous chapters as it pertains to anaerobic bacteria.

**IX. MYCOBACTERIA**

1. Discuss the diseases caused by mycobacteria and recognize the names of the “nonpathogenic” mycobacteria.

2. Name the species that belong to the various mycobacterial groups and complexes.

3. Review the safety practices appropriate for handling mycobacterial specimens and cultures.

4. Determine if a specimen is appropriate for a mycobacterial culture when given a description of the specimen and the manner in which it was handled.

5. Explain the principles of the concentration, decontamination and digestion procedures.

6. Select the appropriate method for processing a given specimen.
7. Assess an acid-fast stained smear for the correct preparation when given a description of the smear results or the procedure used.
8. Compare egg-based, agar-based, selective, and nonselective media with respect to their composition and use in mycobacteriology laboratories.
9. Summarize the incubation conditions and examination procedures used to culture mycobacteria.
10. State the principle of the BACTEC systems, MB/BacT system, Septi-Chek method, ESP Myco system, and lysis-centrifugation method.
11. Evaluate mycobacterial identification tests when given a description of the results or a description of the technique used to perform the test.
12. List three methods other than culture for identifying mycobacteria and name the organisms that can be identified by each.
13. Outline the key characteristics of the more important mycobacteria.
14. Summarize the antimicrobial susceptibility tests that are appropriate for mycobacteria.
15. Integrate the material presented previously as it pertains to mycobacteria.

X. MYCOLOGY

1. Describe the general characteristics of fungi.
2. List and describe the growth requirements of fungi.
3. Define the terms associated with fungal structures.
4. Describe asexual reproduction and sexual reproduction of fungi.
5. Describe the appropriate specimen collection procedures, staining methods, and culture techniques used in the mycology laboratory.
6. Characterize the following different types of mycoses, defining the tissues they affect:
   a. superficial   b. cutaneous,  c. subcutaneous  d. systemic
   e. opportunistic saprobi
7. List the common opportunistic saprobes associated with infections in immunocompromised hosts.
8. From photographs of fungal colonies and microscopic preparations, recognize the following:
   e. Bipolaris  f. Curvularia   g. Aspergillus h. Fusarium
   i. Penicillium j. Paecilomyces k. Scopulariopsis l. Malassezia furfur
   m. Exophiala werneckii n. Trichosporon beigelii
   o. Microsporum audouinii p. Microsporum canis
   q. Microsporum gypseum r. Epidermophyton floccosum
   s. Trichophyton t. Cladosporium carrionii
   u. Exophiala jeaneslmei v. Fonsecaea   w. Wangiella
   x. Sporothrix schenckii y. Blastomyces dermatitidis
   z. Paracoccidioides brasiliensis aa. Histoplasma capsulatum
   bb. Coccidiodes immitis
9. Discuss safety precautions to use when working with systemic pathogens.
10. Briefly describe blastomycosis, paracoccidioidomycosis, histoplasmosis, and coccidioidomycosis, including any special epidemiologic (geographic) associations, mode of transmission, causitive agents, and main types of clinical infection.

11. Identify from colonial morphology, corn meal-Tween 80 morphology, and appropriate biochemical tests:
   a. *Candida albicans*  
   b. *C. tropicalis*  
   c. *C. parapsilosis*  
   d. *C. krusei*  
   e. other *Candida* species  
   f. *Geotrichum* spp.
   g. *Cryptococcus* spp, including *C. neoformans*

12. Outline the procedure, including interpretation and appropriateness of the test for:
   a. Corn meal-Tween 80 morphology  
   b. Germ tube test  
   c. carbohydrate assimilations  
   d. carbohydrate fermentations  
   e. urease test  
   f. rapid nitrate test  
   g. India ink preparation  
   h. caffeic acid or niger seed agar

**XI. VIROLOGY**

1. Describe the characteristics of viruses, and differentiate these organisms from bacteria.

2. Describe how viruses multiply.

3. Describe the proper procedures for collection and transport of viral specimens.

4. Name the appropriate specimen for maximum recovery of the suspected viral agent.

5. Describe the different methods used in the diagnosis of viral infections.

6. Define cytopathic effect (CPE) and describe how it is used to presumptively identify viral agents.

7. For each of the following viral agents, discuss how the virus is transmitted or acquired, the infection the virus produces, and the preferred method of laboratory diagnosis:
   a. adenovirus  
   b. bunyavirus (California encephalitis, La Crosse arbovirus, Hantavirus)  
   c. coronavirus  
   d. flavivirus (arbovirus, Hepatitis C)  
   e. Hepadnavirus (HBV)  
   f. Herpesvirus (HSV1, HSV2, Varicella-zoster, cytomegalovirus, EBV)  
   g. Orthomyxovirus (influenza)  
   h. Papovavirus (HPV)  
   i. Paramyxovirus (measles, mumps, parainfluenza, RSV)  
   j. Picornavirus  
   k. Retrovirus (HIV, HTLV)  
   l. Rhabdovirus (rabies)
XII. MISCELLANEOUS PATHOGENS

1. Summarize the characteristics of the following organisms:

- *Gardnerella vaginalis*
- *Mycoplasma* spp.
- *Ureaplasma urealyticum*
- *Rickettsia* spp.
- *Ehrlichia* spp.
- *Coxiella burnetii*
- *Bartonella* spp.
- *Calymmatobacterium granulomatis*
- *Tropheryma whippelii*
- *Chlamydia trachomatis*
- *Legionella* spp.
- *Streptobacillus moniliformis*

2. Discuss the diseases associated with the organisms listed in objective 1.

3. Discuss the laboratory tests used to diagnose infections caused by the organisms listed in objective 1.

4. Compare the laboratory tests used to diagnose infections caused by *C. trachomatis*.

5. Summarize the features of culture media for the organisms listed in objective 1.

6. Review the safety precautions appropriate for handling specimens and cultures that may contain *Rickettsia* and *Coxiella*.

7. Evaluate bacterial identification tests when given a description of the test results or the technique used to perform the test.

8. Integrate the material presented in previous chapters.

XIII. ANTIMICROBIAL THERAPY, QC, AUTOMATION, EMERGING TECHNOLOGIES

1. Define the following terms: antibiotic, antimicrobial agent, antibacterial agent, chemotherapeutic agent, bactericidal, bacteriostatic, spectrum of activity, mechanism of action, pharmacokinetics, and cross-resistance.

2. Compare additive, synergistic, antagonistic, and indifferent drug interactions.

3. Differentiate between gram-positive and gram-negative cell walls and intrinsic and acquired resistance.

4. List the bacterial sites that may be targets for antimicrobial agents.

5. Discuss the role of plasmids in antimicrobial resistance.

6. Classify a given antimicrobial agent (e.g. β-lactam and natural penicillin).

7. For each antimicrobial agent discussed, summarize its key aspects.

8. Discuss mycobacterial chemotherapy.

9. Briefly summarize the factors that must be considered when:
   a. determining whether an antimicrobial susceptibility test (AST) is appropriate for a given isolate.
   b. selecting the antimicrobial agents to test and report.
After completing the Serology laboratory rotation, the student will, with 75% accuracy:

2.1. Discuss how quality control (QC) is monitored for the different procedures and instruments in the immunology and serology laboratory; how QC is used to evaluate performance records, and what corrective actions would need to be taken if QC values are not within established limits.

2.3 Perform QC procedures according to the SFMC Serology laboratory.

2.4 Perform daily maintenance routines.

2.4 Define solute, diluent, dilution, compound dilution, and serial dilution.

2.5 Calculate simple and serial dilutions when given the amount of solute (or serum) and the amount of diluent.

2.7 List the panic (critical) values for the SFMC Serology laboratory, and outline the protocol for reporting these results.

2.7 Outline the procedure and describe the principle of the Amniostat-FLM test.

2.8 Correlate results of the Amniostat-FLM test to fetal lung maturity.

2.9 Outline the procedure for cold agglutinins.

2.10 Correlate the presence of cold agglutinins to a disease state.

2.11 Perform the Crypto-LA test, including specimen preparation and quality control.

2.12 Discuss the principle of the Crypto-LA test.

2.13 Explain why specimens for the Crypto-LA test are heated prior to testing.

2.14 Interpret results for the Crypto-LA test.

2.15 Outline the procedure for the NOW Legionella Urinary Antigen test.

2.17 Compare the urine antigen test for Legionella with other methods for the detection of Legionella in terms of sensitivity and specificity.

2.17 List the specimens that may be used for the Directigen Meningitis test, and discuss which are preferred.

2.18 Outline the procedure for the Directigen Meningitis test.

2.19 Describe the clinical situations that warrant the Directigen Meningitis test, and explain why this procedure should not be performed on >95% of CSF specimens.

2.21 Perform the procedure for the Color-Card Mono Agglutination test, and interpret the results.

2.21 Name and describe the reference method for detecting infectious mononucleosis.

2.22 Define “heterophile antibody”.

2.23 Correlate a positive color card mono agglutination test to various diseases.

2.24 List causes of false-positive and false-negative results for the color card mono agglutination test.

2.25 Describe the serological diagnosis of syphilis, indicating the differences between nontreponemal and treponemal tests, and name the stages of syphilis for which serological tests are most useful.

2.26 Perform the procedure for the RPR test and interpret results.

2.27 Discuss the principle of the RPR test.

2.30 List the contents of the RPR antigen.

2.31 List causes of biological false positives for the RPR and VDRL tests.

2.30 Discuss the protocol for reporting and confirming positive RPR and VDRL results.

2.31 Discuss limitations of the RPR procedure.
2.32. Compare specimen types and specimen preparation for the RPR and VDRL tests.
2.33. Perform the procedures and interpret results for the VDRL, quantitative VDRL, and spinal fluid VDRL tests.
2.34. Describe specimen collection and preparation procedures for RSV testing.
2.35. Perform the procedure and interpret results for the RSV test.
2.36. Discuss the principle of the RSV test.
2.37. Perform the procedure and interpret the results for a rapid group A strep test.
2.38. Discuss the principle of the group A strep test currently in use in the SFMC laboratory.
2.40. Discuss the recommended protocol for patients who are suspected of having group A Streptococcus pharyngitis and who test negative for a rapid streptococcal test.
2.40. Discuss the principle and the clinical utility of the Varicella Zoster test.
2.41. Perform the procedure and interpret the results for the Varicella Zoster test.
2.42. Discuss the principle and the clinical utility of the Rubella test.
2.43. Perform the procedure and interpret the results for the Rubella test.
2.44. Discuss the principle of the fungal serology test, and interpret patterns of “identity”, “partial identity” and “non-identity”.
2.45. Perform the procedure and interpret the results for the ANA profile.
2.66. Correlate positive results of the ANA profile to disease states.
2.67. Discuss limitations of the gel test procedures for fungal serology and the ANA profile.
2.68. Perform the procedure for and interpret the results of the antinuclear antibody (ANA) test.
2.69. List the reagents used for the ANA test and the action and composition of each.
2.70. Correlate various patterns of fluorescence to possible diseases.
2.71. Describe proper specimen collection and handling for the Chlamydia direct test.
2.72. Define “elementary body”.
2.73. Perform the procedure and interpret the results for the Chlamydia direct test.
2.74. Discuss the principle of the anti-DNA test.
2.75. Perform the procedure for and interpret the results of the anti-DNA test.
2.76. Correlate positive results for the anti-DNA test to specific disease states.
2.77. Discuss the principle of the FTA-ABS test.
2.78. Perform the procedure for and interpret the results of the FTA-ABS test.
2.79. Perform the procedure for and interpret the results of the HSV1/HSV2 direct test.
2.80. Describe proper specimen collection and handling for the HSV1/HSV2 direct test.
2.81. Outline the procedure for DFA Legionella testing.
2.82. Discuss the principle of the DFA Legionella test.
2.83. Outline the procedure for the IFA Legionella test.
2.84. List appropriate specimens for the IFA Legionella test.
2.85. Discuss the principle of the IFA Legionella test.

10. Outline the procedures for performing and interpreting the following tests: dilution (broth and agar), disk diffusion, E-test, β-lactamase, serum inhibitory and bactericidal titers, and minimum bactericidal concentration tests.
11. Evaluate ASTs for sources of error when given a description of the procedure used to perform the test or of the test results.
12. Correlate minimum inhibitory concentration, disk diffusion, and β-lactamase tests.
15. Discuss the use of antibiograms in AST.
16. Describe the current clinical applications of direct antigen detection methods, nucleic acid probes, and PCR in microbiology.
17. Describe the significance of rapid reporting.
18. Describe microscopic and rapid biochemical tests used for rapid detection.
19. Describe how established manual methods have been designed for the rapid identification of isolates.
20. Compare the automated methods for rapid identification of bacteria and yeasts.
21. Discuss the general guidelines for establishing a QC program, describing the way to monitor equipment maintenance and performance, culture media and reagent performance, AST testing, personnel competency, use of stock cultures, and the development and updating of procedure manuals.

**XIV> BACTERIOLOGY LAB**

A. **GOAL:** To produce knowledgeable and competent technologists in the microbiology laboratory by providing clinical experience and professional guidance.

B. **Objectives:** Upon completion of this laboratory rotation, the student will, with 80% accuracy:

B-1. Identify the basic functions of the bacteriology laboratory.
   1.1. List five essential safety practices practiced in the microbiology lab and the locations of all safety equipment.
   1.2. List the major functions of the microbiology department.
   1.3. Describe the contents of the bacteriology procedure manuals.
   1.4. Use safety protocol and techniques at all times.
   1.5. Write a Microbiology laboratory procedure using NCCLS format.

B-2. List the basic concepts and principles of the departmental protocol concerning specimen collection, preservation, and plating.
   2.2. Name the major potential error in specimen collection.
   2.3. Describe the collection techniques used for specimens in the microbiology laboratory.
   2.4. Describe the major specimen preservation techniques utilized in the microbiology laboratory.
   2.5. List the various culture types plated in the microbiology lab, list the media utilized
for each type of specimen and match specimen sources to the correct culture category.

2.6. Dispose of contaminated materials using the protocol of the microbiology lab.

2.7. Describe techniques and methods used to disinfect and sterilize in the microbiology lab including chemical procedures and autoclave procedures.

B-3. Perform QC, calibration and maintenance on all equipment found in the microbiology lab.

3.1. Record the various daily temperature checks on required equipment.

3.2. Record checks on the CO₂ incubators found in the microbiology lab.

3.3. Perform any required maintenance on equipment found in the microbiology lab.

3.4. Assist in the checks for dating of reagents and media, perform QC checks on the media as needed and assist in the replenishment of any supplies or reagents as needed.

B-4. Describe the basic concepts and principles concerning the performance of the testing done in the microbiology laboratory.

4.1. Given the genus for a microorganism, list the gram stain reaction and an example of species in the genus for the following organisms:

   - **Staphylococcus**
   - **Streptococcus**
   - **Gemella**
   - **Citrobacter**
   - **Escherichia**
   - **Morganella**
   - **Salmonella**
   - **Yersinia**
   - **Alcaligenes**
   - **Eikenella**
   - **Aeromonas**
   - **Listeria**
   - **Lactobacillus**
   - **Haemophilus**
   - **Francisella**
   - **Clostridium**
   - **Mobiluncus**

   - **Micrococcus**
   - **Enterococcus**
   - **Neisseria**
   - **Edwardsiella**
   - **Hafnia**
   - **Proteus**
   - **Serratia**
   - **Burkholderia**
   - **Acinetobacter**
   - **Vibrio**
   - **Plesiomona**
   - **Erysipelothrix**
   - **Nocardia**
   - **Pasteurella**
   - **Bordetella**
   - **Bacteroides**
   - **Propionibacterium**

   - **Stomatococcus**
   - **Leuconstoc**
   - **Moraxella**
   - **Enterobacter**
   - **Klebsiella**
   - **Providencia**
   - **Shigella**
   - **Pseudomonas**
   - **Stenotrophomonas**
   - **Campylobacter**
   - **Bacillus**
   - **Corynebacterium**
   - **Actinomyces**
   - **Brucella**
   - **Peptostreptococcus**
   - **Prevotella**
   - **Veillonella**

4.2. Given the abbreviation, list the generic name for each of the following antimicrobial agents.
4.3. Given the following media, list its key components, purpose, and expected differential appearance of organism groups:

- Alkaline peptone water
- Amies transport medium
- Anaerobe transport medium
- BS agar
- BAP
- BHI
- Brilliant green agar
- Brucella broth
- Burkholderia cepacia
- Pseudomonas cepacia
- CVA
- Cary-Blair transport medium
- CHOC
- CNA
- GN broth
- HTM agar
- HE agar
- LJ
- MAC
- MACS (SMAC)
- Middlebrook
- Mueller-Hinton broth and agar
- SS agar
- Selenite broth
- Thioglycollate broth
- TCBS
- Stuart’s transport media
- Transgrow (MTM)

4.4. Streak agar plates for bacterial growth and good isolation.

4.5. Obtain pure cultures from well isolated colonies.

4.6. Choose appropriate media for specimens from various sources.

4.7. Describe proper time and temperature requirements for all the culture types found in the microbiology lab.

4.8. Identify typical colony types for the most commonly identified genera (e.g. *Staphylococcus*, *Streptococcus*, *Enterobacteriaceae*, *Haemophilus*, *Enterococcus*, yeast, etc.) grown on the most frequently used media. (BAP, CHOC, CNA, MAC.)

4.9. Differentiate between indigenous and pathogenic flora as it appears on the primary culture media.

4.10. Select, perform and interpret the biochemical and serological testing needed to identify organisms encountered in the microbiology lab.

4.11. Perform MIC and disk diffusion susceptibility testing and interpret results according to the type of organism isolated.

4.12. Describe the different patterns of hemolysis encountered on BAP and correlate to the organisms that demonstrate each pattern.

4.13. Use the API identification system to identify members of the Enterobacteriaceae family.

4.14. For each of the biochemical tests in the API identification system, state the chemicals, the basic principle, and the expected reactions for a negative and positive test.

4.15. Describe the colony characteristics observed on primary plating media for yeast.

4.16. List three techniques for the identification of yeast and describe each method.

4.17. Given an unknown, choose appropriate testing and identify the most likely genus and species.
4.18. Perform and interpret skin tests for tuberculosis and correlate positive results to various disease states.
4.19. List all panic results for the microbiology lab and describe the protocol to be followed when these results are obtained.
4.20. Perform and describe the various staining techniques used in the microbiology lab for bacteria, fungi, yeast, and acid fast bacteria.
4.21. Perform and describe techniques for wet preps done in the microbiology lab and indicate clinical usefulness.
4.22. Describe the proper use for anaerobic jars and list those organisms that are dependent on or will benefit from anaerobic incubation.
4.23. Accurately perform a gram stain and interpret the results.
4.24. List reaction characteristics for the Enterobacteriaciae using KIA and TSIA and describe the differences between the two media.
4.25. Interpret KIA and TSIA reactions and correlate to groups of bacteria based on fermentation of glucose, lactose, and sucrose, gas production, and H2S production.
4.26. Identify stool pathogens which may be isolated in the microbiology lab using Microbiology Procedure Manual.
4.27. Describe the biochemical test for bile solubility, its reaction characteristics, ingredients of the reagents, organisms that are positive for bile solubility.
4.28. Perform and describe the procedure for organism ID and sensitivity using the Vitek instrument.
4.29. For the following tests, state the basic principle, reagents used, interpretation of positive and negative results, purpose (i.e. which organisms are differentiated) and appropriate control organisms: catalase, coagulase (latex agglutination test), oxidase, urease, indole, butyrate esterase hydrolysis, bile esculin hydrolysis, 6.5% NaCl.
4.30. Identify the components of X and V factors.
4.32. Define the term beta-lactamase, discuss its clinical significance, list organisms that may produce it and correlate to expected susceptibility results.

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**CLAB 466 & 467**

**IMMUNOHEMATOLOGY**

**Lecture #1 Genetics:**

After completing lecture and reading assignment, each student will, with 75% accuracy:

1. Define the following terms: (L-1)
   - gene
   - allele
   - homozygous
   - heterozygous
   - genotype
   - phenotype
   - dominance
   - recessiveness
   - codominance
   - incomplete dominance
   - diploid
   - haploid
   - mitosis
   - meiosis
2. Correctly use the terms in Objective 1 in discussions of inheritance in general and specific applications to blood group inheritance. (L-2)

3. Describe the major concepts of mendelian genetics, including laws of independent segregation and of independent assortment. (L-1,2)

4. Briefly describe mitosis and meiosis. (L-1)

5. Construct and interpret a pedigree chart using symbols described in this chapter. (L-2,3)

6. Describe four patterns of inheritance. For each pattern, draw an example of of a pedigree of that type of inheritance. (L-2,3)

7. Briefly describe linkage and give examples from blood group genetics. (L-2)

8. Briefly describe what is meant by the term position effects and give one example from blood group genetics that illustrates this phenomenon. (L-2)

9. Briefly describe the term polymorphic and describe the impact of blood group polymorphisms on human blood group systems. (L-2)

10. Given the necessary data, calculate the number of units of blood that must be screened for a given transfusion. (L-2)

11. Distinguish between X-linked and autosomal inheritances. (L-2)

12. Describe the processes of replication, transcription and translation. (L-1)

13. Briefly describe molecular techniques for analyzing DNA, RNA and protein and discuss how they are used as analytical tools. (L-2)

Vocabulary Terms

gene: composed of deoxyribonucleic acid (DNA); the basic unit of inheritance located on the chromosome. Each gene is found on a specific position of the chromosome referred to as the locus.

allele: any alternate form of a gene that can occupy a given chromosomal location (locus). Each individual inherits one allele from the mother and one from the father, making up a homologous pair for each trait.
**phenotype:** observed expression of genes (e.g. blood type A)

**genotype:** genetic make-up of an individual (e.g. A0 or AA)

**haploid:** the condition of having one set of chromosomes (maternal or paternal). The sex cells (gametes) of higher organisms are haploid.

**diploid:** the condition of having two sets of chromosomes (maternal and paternal). The somatic cells of higher organisms are diploid.

**homozygous:** pertaining to the condition that exists when the two alleles for a given trait are the same.

**heterozygous:** pertaining to the condition that exists when two alleles for a given trait are different.

**dominance:** expression of inherited trait when the allele is present in either the homozygous or heterozygous form.

**recessiveness:** expression of inherited trait only when the allele is present in the homozygous form.

**codominance:** inherited traits that are expressed whether the allele is present in the homozygous or heterozygous form (both genes are expressed).

**incomplete dominance:** the condition in which the products (traits) are expressed but the effect of one allele is stronger than that of the other.

**meiosis:** cell division and replication that result in the formation of haploid gametes (eggs and sperm), which carry either the maternal or paternal genetic information.

**mitosis:** cell division and replication that result in the formation of two diploid daughter cells with exactly the same genetic information as the parent cell.

**pedigree chart:** a diagrammatic method of illustrating the inheritance of genes within a given family.

**proband/propositus:** the individual being studied in a pedigree, such as the individual with a certain disease or other inherited trait of interest.

**autosomal inheritance:** alleles that are carried on any autosome (except the X or Y sex).
chromosome)

linkage: the tendency of genes that are located in close proximity on a chromosome to be associated in inheritance

polymorphic: describes a population that contains two or more phenotypes

blood group antigen: membrane chemical structures capable of inducing the production of antibody in foreign hosts. Red cell antigens differ among members of the species (alloantigens); therefore, individuals can produce antibodies directed against antigens on transfused red cells. This is the basis for much of the science of immunohematology.

Objectives for Lecture #2: Immunology Review

1. Define the term antigen and describe the common characteristics of antigen molecules that contribute to immunogenicity.

2. Discuss the mechanism of the humoral immune response.

3. Compare and contrast the characteristics of the primary antibody response with the secondary (anamnestic) response, including time from antigen challenge to antibody production, antibody titer, antibody class, and antibody affinity and avidity.

4. Describe the basic immunoglobulin structure.

5. Describe the structural and functional characteristics of the five immunoglobulin classes and any implications these may have in immunohematology.

6. Discuss the clinical significance of blood group antibodies.

7. Discuss the importance of the complement system to blood banking.

8. Discuss in detail the two stages of the agglutination reaction and factors that can affect each other.

9. Define the following terms and use them correctly in discussion of the immune system as it relates to immunohematology:

   - Primary response
   - Specificity
   - Prozone
   - Antigen
   - Epitope
   - B lymphocyte
   - Variable region
   - Affinity
   - Constant region
   - Postzone
   - Antibody
   - Antigenic determinants
   - Autologous
   - Anamnestic response
   - Elution
   - Hypervariable region
   - Hemolysis
   - Antigenic determinants
   - Humoral immunity
   - Immunoglobulin
   - Equivalence
Objectives for Lecture #3 Antihuman Globulin Testing

After completing lecture and reading assignments, each student will with 75% accuracy:

1. State the principle of the antiglobulin test.
2. Differentiate monospecific from polyspecific antihuman globulin (AHG) reagent.
3. Explain the antibody requirements for AHG reagents.
4. Briefly describe the preparation of monoclonal and polyclonal AHG reagents.
5. Discuss the use of polyspecific versus monospecific AHG in the indirect antiglobulin test (IAT).
6. Compare and contrast the IAT and DAT. Include an explanation of principle, applications, and red cell sensitization.
7. List the reasons for the procedural steps in the DAT and IAT.
8. List the sources of error associated with the performance of the AHG test.

Objectives for Lecture #4 ABO System

After completing lecture and reading assignments, each student will with 75% accuracy:

15. State the expected antigens present on red blood cells and antibodies in plasma for blood types O, A, B, and AB.
16. List the approximate frequencies of the four major blood types in the general population.
17. Describe how the age of an individual affects his/her production of ABO antibodies.
18. State the immunoglobulin classes of ABO antibodies in the plasma.
19. Predict the ABO phenotypes and genotypes of offspring from various ABO matings.
20. Explain the formation of H, A, and B antigens on the red cells from precursor substance to immunodominant sugars.
22. Explain the principle of hemagglutination inhibition assay for the determination of secretor status.

23. Describe the qualitative and quantitative differences between the A₁ and A₂ phenotypes.

24. List ABO blood groups in order from most to least with respect to the amount of H antigen present on the red cells, and compare the reactivity of anti-H and Ulex europaeus with the ABO groups.

25. Identify the reactivity of three lectins used in the Blood Bank, and describe how they can be used to resolve discrepancies.

26. Describe the inheritance and serological findings associated with the Bombay phenotype.

27. List several causes of ABO typing discrepancies.

28. Interpret the results from ABO forward and reverse typing, and resolve any discrepancies.

Objectives for Lecture #5 The Lewis System

After completing lecture and reading assignments, each student will with 75% accuracy:

1. Describe the formation and secretion of Lewis antigens and their absorption onto the red cells.

2. Discuss the inheritance of the Lewis genes and their interactions with the other blood group genes.

3. Given the ABO, H, secretor and Lewis genotype, determine which ABO, H, and Lewis antigens will be present on the red blood cells and in the secretions.

4. List the Lewis phenotypes and their frequencies in the white and black populations.

5. Describe how Lewis antigens are developed after birth.

6. Describe how pregnancy may affect Lewis phenotypes.
7. List the characteristics of the Lewis antigens and antibodies.

8. Discuss the clinical significance of the Lewis antibodies.

Objectives for Lecture #6 Rh/Hr System

After completing lecture and reading assignments, each student will with 75% accuracy:

18. Describe the discovery of the antibody now known as anti-D.

19. List the five major antigens of the Rh system.

20. Indicate two reasons why the Rh system is second only to the ABO system in relative clinical significance.


22. Use the Wiener and Fisher-Race terminology to describe Rh phenotypes.

23. Given the serologic results of Rh antigen typing (phenotyping), determine the possible Rh genotypes.

24. Differentiate Rh from LW.

25. Describe the biochemical characteristics of the Rh antigens.

26. Describe the chemical and serologic characteristics of the Rh antibodies.

27. Select appropriate blood for transfusion to patients with Rh system antibodies.

28. Describe three mechanisms that might result in weak D expression on red blood cells.

29. List three instances in which the weak D status of an individual must be determined.

30. Differentiate four types of Rh typing reagents. Give two advantages for each.

31. Discuss causes of false-positive and false-negative Rh typing results.

32. Define the term compound antigen and list four such antigens in the Rh system.

33. Define the term low-incidence antigen and list five such antigens in the Rh system.

34. Define the term high-incidence antigen and list three such antigens in the Rh system.

35. Describe the Rh\textsubscript{null} and the Rh\textsubscript{mod} phenotypes.
Objectives for Lectures #7 and 8 Other Blood Group Systems

After completing lecture and reading assignments, each student will with 75% accuracy:

1. List the antigen frequencies for the common antigens K, M, S, s, Fya, Fyb, Jka, Jkb, and P1.
2. Define Kpa, Js, and Lu as low-frequency antigens and Kpb, Js, Lu, and I as high-frequency antigens.
3. Associate the antigen phenotypes S-s-U-, Js(a+), and Fya(a-b-) with blacks.
4. Describe the reciprocal relationship of I antigen to i antigen.
5. Identify I, P1, and Lutheran antigens as being poorly expressed on cord cells.
6. Explain the association of MN with glycoporphin A and Ss with glycoporphin B.
7. Define M, N, I and P1 antibodies as “naturally occurring”, cold-reacting agglutinins that are usually clinically insignificant.
8. Define K, k, S, s, Fya, Fyb, Jka, and Jkb antibodies as “immune”, antiglobulin-reactive antibodies that are clinically significant.
9. Differentiate the antibodies that commonly show dosage (M/N, S/s, K/k, Jka/Jkb) from those that show dosage less frequently (Fya/Fyb and Lu/Lu).
10. Differentiate antigens that are denatured by routine blood bank enzymes (M, N, S, s, Fya, Fyb) from antigens whose reactivity with antibody is enhanced (Ii, P1, Jka, Jkb).
11. Correlate the common 37°C AHG-reactive antibodies K, k, S, s, Fya, Fyb, Jka, and Jkb with transfusion reactions and hemolytic disease of the newborn.
12. Describe the Kidd antibodies as a common cause of delayed hemolytic transfusion reactions.
13. Describe the association of autoanti-I with Mycoplasma pneumoniae infections and autoanti-i with infectious mononucleosis.
14. Describe the common characteristics of the McLeod phenotype, including very weak Kell antigen expression, acanthocytosis, and Duchenne muscular dystrophy.
15. Describe the association of the Fya(a-b-) phenotype with Plasmodium vivax resistance.
16. Define the term high-titer, low-avidity (HTLA) antibody, and list six examples.
17. Describe the serological characteristics and clinical significance of HTLA antibodies.
18. List the antigens and phenotypes of the P blood group system
19. Describe the serological characteristics and clinical significance of the following P system antibodies: anti-P1, anti-P, anti-Pk, and anti-p.

Objectives for Lecture #9 Autoimmune Hemolytic Anemia

After completing lecture and reading assignments, each student will with 75% accuracy:

1. List four categories of autoimmune hemolytic anemia.
2. Briefly describe what information should be gathered prior to the initiation of a serological investigation of a positive DAT.
3. Compare the types of immune hemolytic anemias with respect to reactive temperatures, red cell destruction, and the type of protein (antibody or complement) coating the red cells.
Identify the common benign cold autoantibodies and list their common characteristics.

Discuss problems encountered in laboratory testing of specimens containing cold autoantibodies, and outline testing procedures that can differentiate between specificities.

Discuss pathologic cold autoantibodies, including laboratory testing and clinical treatment.

Differentiate between warm autoimmune hemolytic anemia (WAIHA) and drug-induced immune hemolytic anemia.

Discuss strategies for solving the serologic problems associated with warm autoimmune hemolytic anemia, including the resolution of ABO and Rh typing discrepancies and the detection and identification of alloantibodies.

Interpret serologic results in cases of warm autoimmune hemolytic anemia and select appropriate blood for transfusion if indicated.

Compare the four classic mechanisms for drug-induced hemolysis, and give examples of medications causing each type.

Objectives for Lecture #10 Hemolytic Disease of the Newborn

After completing lecture and reading assignments, each student will with 75% accuracy:

Compare and contrast ABO HDN, Rh HDN, and HDN caused by other alloantibodies in terms of:

a. pathology
b. incidence
g. blood types of mother and baby
h. severity of disease
i. laboratory data (anemia, DAT, bilirubin, reticulocytosis, blood smear)
j. prevention and treatment
k. diagnosis
l. treatment
m. morbidity and mortality

State three criteria that are necessary for HDN to develop.

Define Rh immune globulin and describe its function.

Identify the requirements that must be met before a woman can receive Rh immune globulin.

Describe methods for screening and quantitation of fetal-maternal bleeds.

Given the fetal cell count in a Kleihauer-Betke test, calculate the number of 300-ug doses of RhIg that should be administered to prevent maternal alloimmunization.

Discuss factors that can cause false-positives in the Kleihauer-Betke stain.

Outline the protocol for testing of maternal and cord blood in cases of suspected hemolytic disease of the newborn.

Given maternal and infant ABO blood group phenotypes, state the possible ABO donor blood group(s) you would select for an exchange transfusion. Be specific as to donor blood groups for both the red blood cells and plasma.

State the blood components and the maximum age of the donor unit preferred for intrauterine or exchange transfusions.
OBJECTIVES FOR LECTURE 11-Compatibility Testing

After completing lecture and reading assignments, each student will with 75% accuracy:

1. Define compatibility testing and list four procedures that constitute routine compatibility testing.
2. Describe the AABB standards for the following:
   a. Required information for the blood sample label
   b. Information required on blood/component, compatibility tag, and request form
   c. Testing of recipient blood
   d. Repeat testing of donor blood
   e. Retention of blood samples
   f. Emergency release of blood
   g. Transfusion of infants less than 4 months of age
   h. Inspection and issue of blood
   i. Reissue of blood
3. Discuss the rationale for the selection of plasma or serum for blood banking procedures.
4. List four blood groups that may cause in vitro hemolysis.
5. Select appropriate blood for emergency release in the following circumstances:
   a. Type unknown
   b. ABO discrepancy
   c. Rh typing problem
6. Select appropriate donor units based on ABO and Rh type, availability, presence or absence of alloantibody in the patient, unit’s age, and unit’s appearance.
7. Define the following terms:
   a. Unexpected antibody
   b. Clinically significant antibody
   c. Major crossmatch
   d. Minor crossmatch
8. Briefly discuss the use of the following techniques in compatibility testing:
   a. Saline
   b. Albumin
   c. LISS
   d. Enzyme
   e. PEG
   f. Gel
9. Discuss the limitations of compatibility testing procedures.
10. Name two criteria that must be met before the crossmatch procedure can be abbreviated.
11. List the steps necessary to reidentify the patient before transfusion.

Objectives for Lecture #12 Special Testing

After completing lecture and reading assignments, each student will with 75% accuracy:

1. Describe the principle and list applications for the gel test and solid-phase techniques.
2. List advantages of using a panel of enzyme-pretreated red blood cells in conjunction with an untreated panel and explain why enzyme-pretreated panels cannot be used alone.
3. Describe the effect that chemicals such as enzymes, DTT, ZZAP, CDP, and AET have on certain blood group antigens.
4. Describe the principles and applications for the following techniques: elution adsorption, neutralization, and antibody titers.
5. Briefly describe the principles of three types of elution techniques.
6. Recognize panel results that indicate the presence of multiple alloantibodies and antibodies to high-frequency and low-frequency antigens and list steps to resolve these antibody problems.
7. Compare and contrast the serological characteristics of warm and cold autoantibodies.
8. List and describe four techniques used to avoid detection of cold autoantibodies in antibody detection tests.
9. Outline the serologic investigation of warm autoantibodies, including the use of eluitions, adsorptions, and ZZAP.

**Objectives for Lecture #13 Antibody Identification**

After completing lecture and reading assignments, each student will with 75% accuracy:

16. Define adsorption, dosage, eluate, and neutralization.
17. Differentiate between the following antibodies: expected and unexpected, red cell immune and non-red cell immune, autoantibodies and alloantibodies, warm and cold.
18. Describe the purpose and limitations of the antibody screening tests.
19. List and discuss characteristics of antibody screening red blood cells.
20. List the benefits and risks for using monospecific anti-IgG over polyspecific antiglobulin reagents for routine antibody screening tests.
21. Outline the procedure used for antibody screening tests and describe the purpose of enhancement reagents and Coombs control red blood cells.
22. Properly interpret results of antibody detection and identification tests.
23. Describe how a patient's medical history is useful in antibody identification.
24. Explain the purpose of the autologous control in antibody screening and identification tests.
25. Correlate knowledge of the serologic characteristics of commonly encountered blood group antibodies with antibody identification studies.
26. Describe the rationale for properly ruling out antibody specificities in identification studies.
27. Explain the criteria for conclusive identification of an antibody.
28. Describe the use of selected cells and antigen typing in antibody identification.
29. Given initial panel results, properly select additional cells needed to complete antibody identification.
30. Calculate the approximate number of random donor units needed for screening to find a specific number of compatible units for a patient with unexpected antibodies.

**Objectives for Lecture #14 Donor Selection and Component Preparation**

After completing lecture and reading assignments, each student will with 75% accuracy:

1. Identify the demographic information required from every prospective blood donor to ensure adequate identification.
2. Give the minimum acceptable levels for the following tests, for both allogeneic and autologous donors:
   a. Weight
   b. Temperature
   c. Pulse
   d. Blood pressure
   e. Hemoglobin
   f. Hematocrit

3. Select an acceptable allogeneic blood donor when given the results of the physical examination and medical history.

4. State the medical history information that would be cause for permanent, indefinite deferral.

5. Identify information that would be cause for temporary deferral, and state the length of time for the deferral.

6. List the special medical history and physical examination information required of apheresis donor.

7. Explain the four major types of autologous blood donation procedures.

8. State the procedure for performing a whole blood donor phlebotomy, including arm preparation, blood collection, and postphlebotomy care instructions for the donor.

9. Recognize a donor reaction; identify the difference between mild, moderate, and severe reactions; and state the recommended treatments for each.

10. List the 10 tests that are required to be performed on all allogeneic blood donor units.

11. List the information that is required to be on the blood unit label.

12. Identify the primary ingredient, storage conditions, shelf life, quality control requirements, and indications for use for each of the following blood components:
   a. Red blood cells
   b. Leukocyte-reduced red blood cells
   c. Washed red blood cells
   d. Frozen, deglycerolized red blood cells
   e. Platelet concentrates (random, single donor)
   f. Single-donor plasma (fresh frozen, frozen within 24 hours, liquid, frozen)
   g. Cryoprecipitate concentrate
   h. Granulocyte concentrate
i. Factor VIII concentrates  
 j. Factor IX concentrates  
 k. Rh immunoglobulin  
 l. Plasma derivatives (immune serum globulin, plasma protein fraction, normal serum albumin, volume expanders)

**Objectives for Lecture #15 Transfusion Complications**

After completing lecture and reading assignments, each student will with 75% accuracy:

1. Define *transfusion reaction*.

2. Discuss risks of transfusions.

3. Compare and contrast immediate hemolytic transfusion reactions (IHTR) with delayed hemolytic transfusion reactions (DHTR).

4. List the types of immediate and delayed transfusion reactions.

5. Differentiate clinical signs and symptoms of each described transfusion reaction.

6. List laboratory findings associated with IHTR and DHTR.

7. For each type of transfusion reaction, discuss definition, pathophysiology, signs, symptoms, therapy, prevention, and clinical work-up.

8. List antibodies most associated with immediate and delayed hemolytic transfusion reactions.

9. Identify procedures to follow at a patient’s bedside in the event of a suspected transfusion reaction.

10. Discuss the importance of the patient’s history in relationship to medications, transfusion history, and pregnancies.

11. List logical steps and procedures to follow in a laboratory investigation of transfusion reactions.

12. Discuss reporting of transfusion reaction work-ups.

13. List accreditation agencies involved in determining policies regarding transfusion reactions.

14. State regulatory record requirements and procedure to follow in reporting a fatal transfusion reaction.

**Objectives for Lecture #16 Transfusion Therapy**

After completing lecture and reading assignments, each student will with 75% accuracy:
1. Describe the blood components currently available for therapeutic use.

2. Discuss the composition of each blood component and product, including the approximate volume of each product.

3. Select the appropriate blood product for patients with specific disorders.

4. State the expected incremental increase of a patient’s:
   a. Hematocrit following transfusion of each unit of packed red cells.
   b. Platelet count following transfusion of each unit of platelets.

5. List the required procedures to prepare each blood component for transfusion.

6. Compare and contrast the two types of filters used for blood transfusion.

7. List the groups of recipients at highest risk of infection from transfusion of Cytomegalovirus-positive red blood cells or platelets.

8. Discuss the role of irradiation in the prevention of posttransfusion graft-versus-host disease.

9. State the purpose of the maximum surgical blood order schedule.

10. State the main advantage of autologous transfusion.

11. Review the most important factors to consider when emergency transfusion is indicated.

12. Define massive transfusion.

13. Differentiate the various transfusion requirements of oncology and transplantation patients.


15. State the respective blood components of choice for treatment of von Willebrand’s disease and hemophilia A.

16. Specify the steps involved in the proper administration of blood.

**Objectives for Quality System Lecture**

After completing lecture and reading assignments, each student will with 75% accuracy:

1. Compare and contrast quality assurance, quality control, quality system and compliance as they apply to the blood bank.
2. Define the following components of a quality system and indicate how each one applies: SOP, staff, equipment, and document control.

3. Evaluate the process of implementing a new procedure or policy in the blood bank.

4. Explain the process of validating an instrument in the blood bank, such as a new serofuge or cell washer.

5. Outline the steps necessary when a procedure is changed or a new procedure is added to the Standard Operating Procedures (SOP) manual.

6. List the governing bodies that provide guidelines and/or accreditation for the blood bank.

7. Describe methods used to evaluate employee competency.

8. Explain the importance of documentation as it refers to the blood bank.

9. Evaluate the application of Current Good Manufacturing Practices (cGMP) regulation requirements to the blood bank.

10. List 10 quality system essentials and the blood bank operations to which they are applied.

11. Use a flowchart to describe a process or procedure.

12. Describe the role of auditing in a quality system.

**Laboratory Rotation**

**Blood Bank**

I. Goals:
   The goal of this laboratory is to produce knowledgeable and competent technologists in Blood Bank by providing clinical experience and professional guidance.

II. OBJECTIVES:
   Upon completion of this laboratory rotation, the student will:

   BB-1. Safety, functions, QC, QA

   1. List five essential safety practices.
   2. Practice techniques according to the blood borne pathogens standard.
   3. List several functions of the blood bank laboratory.
   4. Perform and accurately record daily temperature checks with no “write-overs” or “white-outs”.
5. Perform and record daily inventory checks with no “write-overs” or “white-outs”.

BB-2. Principles and concepts of specimen collection

1. Name the major error that occurs in specimen collection.
2. List major specimens used for the testing that takes place in the blood bank.
3. List any specimen additives used in the blood bank and proper use for each additive and the principle of its action.
4. Evaluate sources of error concerning blood collection and select courses of action for each error.
5. Describe our protocol for retaining and testing recipient and donor samples.

BB-3. Vocabulary

I. Define each of the following terms.

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<thead>
<tr>
<th>Term</th>
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<td>Absorbed Anti A</td>
<td>Absorption</td>
<td>ACD</td>
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<td>Adsorption</td>
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<td>Alloantibody</td>
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<td>Anamnestic response</td>
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<td>BGSS</td>
<td>Bombay blood type</td>
<td>Bovine</td>
</tr>
<tr>
<td>Bromelin</td>
<td>Complement components</td>
<td>Chimera</td>
</tr>
<tr>
<td>Chemically modified Anti-D</td>
<td>Chromosome</td>
<td>Cis</td>
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<tr>
<td>position</td>
<td>CPD</td>
<td>Cis</td>
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<tr>
<td>CPD</td>
<td>CPD-Al</td>
<td>Codominant</td>
</tr>
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</table>
The anti-human globulin test

1. Perform and describe the procedure for the antihuman globulin test.
2. Distinguish positive and negative AHG tests.
3. Describe the basic principle of the direct AHG (DAT) test.
4. List causes of positive results for the direct AHG.
5. List situations where AHG testing would be useful.
6. Select courses of action to follow up positive AHG tests, and correlate the results of those tests to disease states.
7. Perform and describe the procedure for the indirect AHG test.
8. Interpret the results of a completed indirect AHG (IAT) test.
9. Describe those situations where an IAT test would be useful.
10. Describe the basic principle of the indirect AHG (IAT) test.
11. When using the IAT test in antibody screening, select proper follow up tests for positive results.
12. List factors that may interfere with AHG testing, both direct and indirect, and distinguish these factors into those that cause false positives and false negatives.
13. State the purpose of adding Check Cells to all negative AHG (direct and indirect) tests.

BB-5 ABO system

1. Perform and describe the procedure for ABO grouping.
2. Given the reaction patterns for ABO groupings, interpret correctly the type of the ABO type.
3. List those reagents used in the ABO groupings.
4. Given ABO groupings that show discrepancies, choose testing that will aid in resolving the discrepancy and correctly interpret the subsequent ABO grouping.
5. Given the ABO groupings of parents, list all possible offspring that may be produced.
6. List in order, from strongest to weakest, the reactivity of the ABO groups with Anti-H lectin.
7. Describe distinguishing characteristics and reaction patterns of the ABO system antibodies.
8. Given the secretor genotype of an individual, determine the secretor status of the individual.
BB-6. Rh System

1. Perform, describe, and correctly interpret Rh blood typing according to SFMC SOP.

2. Given the reactions of Rh antigen typings, correctly identify the phenotype and place into Fisher-Race nomenclature.

3. Given the Rh phenotype of a recipient and donor in either standard or Fisher-Race nomenclature, predict which Rh antibodies may be produced.

4. List the major antigens in the Rh system.

5. List the situations which require a negative control when testing for the D antigen.

6. Perform, describe, and correctly interpret the procedure for weak D status.

7. Describe those situations for which weak D status should be tested.

8. List the Rh antigens in order of strongest to weakest in terms of immunogenicity.

9. List causes for false positive and false negative reactions using Rh typing reagents and select a course of corrective action for each.

10. Describe distinguishing properties and reaction characteristics of the Rh system antibodies.

BB-7. Other blood groups (including MNSs, U, P, I, Kell, Duffy, Kidd, Lutheran, Lewis)

1. Perform and describe typing procedures for blood group systems other than ABO and Rh, and correctly interpret results.

2. Describe distinguishing properties and reaction characteristics of antibodies in systems other than ABO and Rh.

3. Correlate the relationship between the Lewis substances and secretor status of the individual.

4. Correlate various disease states with any relationship they might have with any of the blood group systems.

5. List the characteristics of various antigens of other blood groups.

BB-8. Donor selection and component preparation

1. List acceptable donor ranges for the following:
   a. weight
   b. temperature
c. pulse
d. blood pressure
e. hematocrit, hemoglobin
f. age
2. List donor deferment status for the following:
   a. positive test for hepatitis
   b. tattoos
   c. malaria, antimalarial drugs, or travel history to malarial endemic areas
d. blood transfusion
e. vaccinations or immunizations
f. pregnancy
g. HGH recipient
h. Positive HIV test
3. Given data generated by a donor questionnaire and interview, accept or reject donors by using knowledge of donor selection criteria.
4. Describe testing that must be performed on donor units.
5. Select appropriate actions to be taken when testing of a donor unit is positive.
6. List testing performed on donor units by the transfusing facility and the collecting facility.
7. Defend the policy of retyping donor units in the blood bank.
8. For the following components, list shelf-life, storage temperature, QC requirements, volume, indications for use, content, dosage effect, transfusion criteria or testing required.
   RBCs             Leukocyte poor RBCs
   Washed RBCs      Frozen/Thawed deglycerolized RBCs
   Random donor platelets        Platelet single donor pheresis
   Single donor FFP             Single donor plasma
   (liquid/frozen)
cryoprecipitate         Granulocytes
Factor VIII              Factor IX
Immune serum globulin normal serum albumin
RhIG                    Fibrinogen
9. Given various disease states and laboratory results, select appropriate blood component therapy to best treat the situation or disease state.
1. Perform and describe the procedure for an antibody screen and correctly interpret the results of the screen.
2. Describe the reagents used in the antibody screening procedure.
3. Explain the importance of prenatal antibody screening as it relates to HDN.
4. Describe characteristics of reactions of agglutination from 4+, 3+, 2+, 1+, W, mf.
5. Describe and perform the procedure for antibody identification and correctly interpret the results of the panel identification.
6. Given the results of an antibody panel, interpret correctly or suggest additional testing that may aid in the antibody identification.
7. Given the results of an antibody identification panel, select possible compatible units and confirm their antigen negativity by performing appropriate testing.
8. Discuss other possibilities besides antigen typing for finding compatible units for patients with multiple or rare antibodies.
9. Select additional appropriate testing for patients with antibodies against high frequency antigens and low frequency antigens, respectively.
10. Perform and describe methods for the removal of cold reacting antibodies and suggest situations where these methods might best be employed.
11. Perform and describe procedures for the removal of warm reacting autoantibodies and suggest situations where these techniques might best be employed.
13. Correlate rouleaux to various disease states.
14. Describe those situations where a titer of an antibody may be useful and describe a procedure for the titer.

BB-10. Compatibility testing

1. Define the greatest threat to safe transfusion therapy.
2. Describe the proper procedure for collecting a sample for compatibility testing.
3. List the steps involved in compatibility testing.
4. Identify the most critical pretransfusion serological test.
5. Choose appropriate follow up testing for any unexpected result in the compatibility test.
6. Perform the compatibility test according to established procedure for our blood bank.
7. After performance of the compatibility test, select appropriate donor units for transfusion.
8. List possible causes of incompatibility in the major crossmatch and choose ways of resolving these incompatibilities.
10. Describe those situations where transfusion of non-group specific blood may be done.
11. Describe testing that has to be done before transfusion of plasma products.
12. Describe our protocol and policy concerning massive transfusion.

BB-11. Problem solving

1. Given results of ABO groupings that show discrepancies, perform or suggest testing which will aid in resolving the discrepancy.
2. Given results that show Rh typing discrepancies, perform or suggest testing that will aid in resolving the discrepancy.
3. Given the results of a positive antibody screen, perform or suggest followup testing to ID the antibody and provide appropriate blood for transfusion.
General Laboratory Principles and Procedures

After completing reading assignments and lecture the student will, with 75% accuracy, be able to:

1.1. Identify the function of the clinical chemistry laboratory. (L-1)
1.2. Define the term reagent grade chemical. (L-1)
1.3. Explain why the terms deionized water and distilled water have been replaced by the term “reagent grade water”. (L-2)
1.4. Describe the procedure for the preparation of reagent grade water. (L-2)
1.5. Identify the varying chemical grades used in reagent preparation and indicate their correct use. (L-1, L-2)
1.6. Define the following terms: primary standard, SRM, secondary standard. (L-1)
1.7. List the various types of pipets available and identify a specific use for each type. (L-1)
1.8. Describe two ways to calibrate a pipet. (L-2)
1.9. Define a desiccant and discuss its use in the clinical laboratory. (L-1)
1.10. Discuss the properties and uses of various types of glassware in the clinical laboratory. (L-1)
1.11. Describe the storage and cleaning procedures for glassware and plasticware. (L-1)
1.12. Explain the basic principle of centrifugation. (L-1)
1.13. List the types, components and uses of various centrifuges. (L-1)
1.14. Discuss the proper operation, utilization and maintenance of a centrifuge. (L-2)
1.15. Given the appropriate data, calculate the RCF. (L-2)
1.16. Identify the basic principle concerning weights and balances. (L-1)
1.17. List and discuss the types of balances used. (L-1)
1.18. Identify sources of error you may encounter when weighing materials on an analytical balance. (L-1)
1.19. Define the terms solution, solute, saturated, unsaturated, supersaturated, miscible, immiscible and partially miscible. (L-1)
1.20. Describe methods for concentrating solutions. (L-1)
1.21. Convert results from one unit format to another using the SI system. (L-2)
1.22. Identify and describe the types of samples used in clinical chemistry. (L-1)
1.23. Outline the general steps for processing blood samples. (L-1)
1.24. Identify the preanalytical, precollection, collection and postcollection variables that can adversely affect laboratory results. (L-1)
1.25. Define the acronyms OSHA, NCCLS, CDC AND CAP.
1.26 Identify the required components of a laboratory safety program. (L-1)
1.27 Identify the symbols used for safety in the clinical chemistry laboratory. (L-1)
1.28 Select a course of action concerning the safe handling of a chemical. (L-3)
1.29 Identify hazards related to handling chemicals, biologic specimens and radiologic materials. (L-1)
1.30 Describe steps used as precautionary measures when working with electrical equipment, cryogenic materials, and compressed gases, and avoiding mechanical hazards associated with laboratory equipment. (L-2)
1.31 Select the correct means for disposal of waste generated in the clinical laboratory. (L-2)

Instrumentation

After completing lecture and reading assignments, the student will, with 75% accuracy:

1. For each of the following analytical methods, explain the general principle, identify and correct sources of error, discuss clinical applications, and compare to other analytical methods in terms of clinical utility and advantages/disadvantages:
   a. spectrophotometry
   b. fluorometry
   c. atomic absorption spectrophotometry
   d. potentiometry
   e. amperometry
   f. coulometry
   g. thin-layer chromatography
   h. gas-liquid chromatography
   i. Ion exchange chromatography
   j. HPLC
   k. mass spectrophotometry
   l. freezing point osmometry
   m. vapor pressure osmometer

2. Describe the operation and component parts of the following instruments:
   a. spectrophotometer
   b. atomic absorption spectrometer
   c. fluorometer
   d. gas chromatograph
   e. osmometer
   f. ion-selective electrode
   g. pH electrode

2. Outline the quality assurance and preventative maintenance procedures involved in the following instruments:
   a. spectrophotometer
   b. atomic absorption spectrometer
   c. fluorometer
d. gas chromatograph

3. Define the following terms:
   a. automation
   b. continuous flow
   c. discrete analysis
   d. random access

4. Describe the major steps in automated analysis.

5. List an example of a discrete analyzer and a centrifugal analyzer.

6. Distinguish between an open versus a closed reagent system.

7. Compare the different approaches to automated analysis used by instrument manufacturers.

8. Discuss the three phases of the laboratory testing process.

9. Define Beer’s law, and state the necessary conditions that must be met in order for Beer’s law to be followed.

10. Use Beer’s law to calculate the concentration of an unknown substance given the absorbance of that substance, the absorbance of a known standard and the concentration of that known standard.

11. List conditions that cause deviations from Beer’s law and describe how such situations are resolved in the clinical laboratory.

Heme Derivatives and Porphyrins

After completing lecture and reading assignments, the student will, with 75% accuracy, be able to:

1. Outline the stages in bilirubin metabolism from formation to excretion and predict the effects of defects at each stage on plasma bilirubin fractions. (L-1,3)
2. Suggest a consistent diagnosis (i.e., disorder in bilirubin metabolism) given a set of laboratory results, including bilirubin (total and direct), urine biirubin, urine urobilinogen, and fecal pigments. (L-2)
3. Describe the forms of bilirubin found in plasma and discuss the measurement of each by various bilirubin analysis methodologies. (L-1)
4. Describe the commonly used methods of analysis and the expected results for total bilirubin and direct bilirubin. (L-1)
5. Given the appropriate data, calculate the indirect bilirubin. (L-2)
6. Identify the sources of error in specimen collection and handling of samples for bilirubin determinations. (L-1)
7. Define porphyria and differentiate between acute and non-acute porphyria. (L-1)
8. List porphyrin analytes and RBC enzymes that will be elevated in each of the acute and non-acute porphyrías. (L-1)
9. Describe the principles of methodology for the determination of porphobilinogen in urine. (L-1)
10. Describe the principles of methodology for the determination of porphyrins in blood, urine and feces. (L-1)
11. Identify methods for the separation and identification of specific porphyrins. (L-1)

**Carbohydrates**

After completing lecture and reading assignment, each student will, with 75% accuracy:

1. Identify the basic chemical composition of carbohydrates. (L-1)
2. Define the terms monosaccharide, disaccharide and polysaccharide, listing examples of each. (L-1)
3. Discuss the metabolism of carbohydrates in terms of glycogenesis, glycogenolysis, gluconeogenesis and glycolysis. (L-1)
4. Describe the effects of the following hormones upon blood glucose concentration: insulin, somatostatin, ACTH, growth hormone, cortisol, epinephrine, glucagon, thyroxine, human placental lactogen and somatomedins. (L-1)
5. Discuss the effects of the following collection and handling techniques upon glucose concentrations:
   a. blood in a tube, uncentrifuged
   b. plasma removed after slight centrifugation
   c. completely separated serum at room temperature
   d. completely separated serum at 4°C
   e. whole blood with sodium flouride (L-1)
6. State the reference ranges for serum and whole blood glucose levels. Compare expected results for arterial, venous and capillary samples. (L-1)
7. Identify the basic principles of methodology and list interfering substances for each of the following glucose determination methods: hexokinase, glucose oxidase and glucose dehydrogenase. (L-1)
8. Discuss the clinical signs and symptoms, etymology and laboratory findings for the following diseases: type 1 diabetes mellitus, type 2 diabetes mellitus, gestational diabetes mellitus and hypoglycemia. (L-1)
9. Discuss the major acute and chronic complications associated with diabetes mellitus. (L-1)
10. Describe how the following laboratory tests are used in the evaluation of hypo- or hyperglycemia: blood glucose, glycated hemoglobin (hemoglobin A1c) and ketones. (L-1,2)
11. Discuss the role of self-monitoring devices for diabetics in the measurement of blood glucose. (L-1,2)
12. State the criteria recommended by the American Diabetes Association for the diagnosis of diabetes mellitus. (L-1)
13. Compare methods for glycated hemoglobin analysis in regard to product measured and frequency of use in clinical laboratories. (L-2)
14. Discuss laboratory tests used to evaluate the presence of ketoacidosis and microalbuminuria in regard to methods and clinical significance. (L-1)

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15. Identify three conditions that should be met in patient preparation for an oral glucose tolerance test. (L-1)
16. Describe the procedure for a 2 hour GTT. (L-1)
17. Discuss how the following factors affect glucose tolerance: posture, nausea, anxiety, coffee, cigarettes, activity, corticosteroids, age and weight. (L-1)
18. Interpret glucose tolerance curves, correlating them to absence of disease or specific diseases. (L-2)
19. State two reasons why an intravenous glucose tolerance is done instead of an oral one. (L-1)
20. Discuss the clinical significance of lactate in the blood. (L-1)
21. Describe the specimen requirements and principles of methodology for the determination of lactate. (L-1)

**Cardiac Markers**

After completing lecture and reading assignments, the student will, with 75% accuracy:

1. List the criteria for diagnosis of acute myocardial infarction. (L-1)
2. Identify characteristics of the ideal marker of cardiac injury. (L-2)
3. List four different markers for diagnosis of cardiac injury and sketch their release patterns. (L-2)
4. Discuss why creatine kinase isoenzyme MB (CK-MB) activity assays were replaced with CK-MB mass assays. (L-2)
5. Explain why both CK-MB and troponin levels are needed to evaluate cardiac injury. (L-2)
6. Discuss the clinical utility of BNP and hs-CRP. (L-2)

**Electrolytes and Acid-Base Metabolism**

After completing lecture and reading assignments, the student will, with 75% accuracy:

1. Discuss the clinical applications of performing plasma and urine osmolality determinations. (L-2)
2. Given the appropriate data, calculate the estimated plasma osmolality.
3. Outline the homeostatic regulation of sodium, potassium, chloride and water in the body. (L-1)
4. List the clinical conditions associated with increased or decreased plasma concentrations of sodium, potassium, chloride and carbon dioxide. (L-1)
5. Identify methods for the determination of sodium, potassium, chloride and carbon dioxide. (L-1)
6. Evaluate sources of error for methods for the determination of sodium, potassium, chloride and carbon dioxide. (L-2,3)
7. Discuss the causes and consequences of hypo- and hyperkalemia. (L-2)
8. Describe the function and regulation of potassium ions and the effect of alkalosis, acidosis, and other factors on plasma potassium concentrations. (L-1,2)
9. Define “chloride shift” and explain why this phenomenon occurs. (L-1)
10. List the medical conditions associated with alterations in serum chloride concentration. (L-1)
11. Discuss the importance of the bicarbonate ion-carbon dioxide plasma buffer system. (L-2)
12. Describe the interrelationships of our metabolic and respiratory acid-base systems. (L-2)
13. Describe the physiological meaning(s) for alterations in pH, partial pressure of carbon dioxide (pCO₂), bicarbonate (HCO₃⁻), and partial pressure of oxygen (pO₂). (L-2)
14. List the reference ranges for pH, partial pressure of carbon dioxide (pCO₂), bicarbonate (HCO₃⁻), and partial pressure of oxygen (pO₂). (L-1)
15. Describe the function of hemoglobin as both an oxygen carrier and a hydrogen ion buffer. (L-1)
16. Evaluate pO₂ in determining the adequacy of arterial oxygenation by the lungs. (L-2)
17. Interpret pH, pCO₂ and HCO₃⁻ results in evaluating respiratory and metabolic acid-base status. (L-2)
18. Describe proper specimen collection and handling techniques for arterial blood gases and evaluate sources of error. (L-1,2)

**Endocrinology**

After completing lecture and reading assignments, the student will, with 75% accuracy:

1. State the functions of the endocrine system. (L-1)
2. Explain how positive and negative feedback mechanisms control hormone concentration in the peripheral circulation.(L-2)
3. Given a list of hormones, categorize them as steroid, protein, or amine. (L-1)
4. List the major hormones from the hypothalamus, anterior pituitary, posterior pituitary, thyroid, parathyroids, adrenal medulla, adrenal cortex, pancreas, ovaries, testes, placenta and gastrointestinal tract. (L-1)
5. Differentiate between free and bound hormone and indicate which form is more physiologically important. (L-1)
6. Distinguish between primary, secondary and tertiary disease states. (L-1)
7. Summarize the expected laboratory findings and correlate results associated with the following disease states: acromegaly, GH deficiency, SIADH6, diabetes insipidus, Cushing’s syndrome, Addison’s disease, CAH, Conn’s syndrome, pheochromocytoma, hyperparathyroidism, hypoparathyroidism, hyperaldosteronism, hypoaldosteronism, infertility, hirsuitism, amenorrhea, hypogonadism, Sheehan’s syndrome, Zollinger-Ellison syndrome. (L-1,2)
8. Contrast primary ad secondary hormone disorders. (L-2)
9. Discuss the importance of multiple measurements of some hormone levels and stimulation/suppression tests for other hormone levels. (L-1)
10. Describe special procedures or precautions in sample collection and handling for hormone levels, and evaluate sources of error. (L-1,3)
11. Outline the biosynthesis, secretion, transport, action and regulation of thyroid hormones. (L-1)
12. Explain the principle of various thyroid function tests. (L-1)
13. Correlate laboratory findings to various thyroid disorders. (L-2)
14. Identify the appropriate laboratory thyroid function testing protocol to use to evaluate or monitor patients with suspected thyroid disease. (L-1)

**Enzymes**

After completing lecture and reading assignments, the student will, with 75% accuracy, be able to:

6.1 Define enzyme in terms of protein and catalyst. (L-1)
6.2 Discuss the derivation of enzyme nomenclature. (L-1)
6.3 Discuss the effect of the following enzyme reactions: enzyme concentration, substrate concentration, pH, temperature and inhibitors. (L-1)
6.4 Compare and contrast the kinetic method and fixed-time method for the measurement of enzymes. (L-2)
6.5 Identify units used for measuring enzyme activity. (L-1)
6.6 Define isoenzyme and discuss clinical applications for their measurement. (L-1)
6.7 Identify five methods for isoenzyme analysis. (L-1)
6.8 List reference ranges and discuss the clinical significance of the following enzymes: AST, ALT, CK, LD, ALP, GGT, amylase, lipase, trypsin, chymotrypsin, cholinesterase, acid phosphatase and 5’NT. (L-1,2)
6.9 Describe methods for the determination of AST and ALT. (L-1)
6.10 Describe methods for the determination of LD activity and for measuring LD isoenzymes. (L-1)
6.11 Describe methods for the determination of alkaline phosphatase, acid phosphatase, gamma glutamyltransferase, amylase, lipase and cholinesterase. (L-1)
6.12 Correlate the findings of CK and LD isoenzymes to the following conditions or sample alterations: myocardial infarction, hemolysis, pulmonary embolism and liver disease. (L-2)
6.13 Identify methods for the determination of amylase isoenzymes and discuss the clinical significance of them. (L-1)
6.14 Describe methods for the determination of trypsin in duodenal fluid and stool. (L-1)
6.15. Describe methods for the determination of chymotrypsin in serum, duodenal or pancreatic aspirates and stool. (L-1)
6.16. Evaluate sources of error in enzyme assays and select courses of action accordingly. (L-3)

Lipids

After completing lecture and reading assignments, each student will, with 75% accuracy:

1. Define lipid and lipoprotein in terms of chemical structure and solubility characteristics. (L-1)
2. Describe the general chemical structure, biological function(s), and clinical significance of the following lipids: chylomicrons, fatty acids, triglycerides, phospholipids, and cholesterol. (L-1)
3. For the major lipoprotein classes: (a) relate physical characteristics and functions to the composition of the lipoprotein particle, and (b) identify the characteristics used to distinguish each class. (L-1)
4. Discuss the exogenous and endogenous pathways of lipoprotein metabolism. (L-1)
5. Discuss the pathogenesis of atherosclerosis and coronary heart disease. (L-1)
6. Describe the major primary lipid disorders and the associated changes in plasma lipids/lipoproteins. (L-1)
7. Identify factors or clinical conditions that may be secondary causes of hyperlipidemias. (L-1)
8. Establish protocols to minimize effects of preanalytical variation on lipid/lipoprotein testing. (L-2)
9. Describe routine test methods for measuring total cholesterol, triglycerides, high-density lipoprotein (HDL) cholesterol, low-density lipoprotein (LDL) cholesterol, and apolipoproteins. (L-2)
10. Evaluate sources of error and select appropriate courses of action in the methods listed above, including specimen collection and handling. (L-2,3)
11. Given the appropriate data, calculate LDL cholesterol using the Friedwald formula. (L-2)
12. Discuss the clinical utility of the following tests: plasma appearance, cholesterol, triglyceride, HDL, LDL, apolipoproteins. (L-1)
13. Assess risk for coronary heart disease based upon concentrations of the major serum lipids, lipoproteins and lipoprotein constituents. (L-2)

Nitrogen Metabolites

After completing lecture and reading assignments, each student will, with 75% accuracy:

1. Define NPN. (L-1)
2. Discuss the clinical utility of plasma urea measurement. (L-1)
3. List two methods for the determination of urea and describe the methodology for each. (L-1)
4. Discuss the clinical utility of plasma creatinine and creatinine clearance measurements. (L-1)
5. Describe the methodology of the Jaffe reaction. (L-1)
6. Given the appropriate data, calculate a creatinine clearance. (L-2)
7. Discuss the clinical significance of increased and decreased plasma uric acid levels. (L-1)
8. Describe the principles of methodology for the determination of uric acid. (L-1)
9. List several conditions, inherited or acquired, that cause increased levels of ammonia in the blood. (L-1)
10. Identify methods for the determination of ammonia. (L-1)
11. Evaluate sources of error in specimen collection and handling and preanalytical variables for specimens for the determination of ammonia, BUN, creatinine and uric acid (L-2)
12. Explain the usefulness of the BUN:creatinine ratio. (L-1)

Proteins and Amino Acids

After completing lecture and reading assignments, the student will, with 75% accuracy, be able to:

5.1. Describe the basic chemistry of amino acids and proteins. (L-1)
5.2. Identify the uses and clinical applications of the following types of amino acid analyses: screening tests, quantitative tests and exact identification. (L-1)
5.3. Describe the following screening test procedures: TLC, colorimetric screening tests for urine and Guthrie microbiological test. (L-1)
5.4. List and describe three quantitative separation procedures for amino acids. (L-1)
5.5 Discuss clinical signs and symptoms, laboratory diagnosis, treatment and prognosis for each of the following disorders: phenylketonuria, alkaptonuria, homocystinuria, cystinuria and maple syrup disease. (L-2)
5.6. List three methods for the determination of total protein in serum and identify the principle of methodology for each. (L-1)
5.7. State which of the methods is the reference method. (L-1)
5.8. Discuss the clinical uses of the three preceding methods. (L-1)
5.9. Identify sources of error for the biuret method and refractometry in the determination of serum total protein. (L-1)
5.10. State the reference ranges for total protein in ambulatory and bed-ridden adults. (L-1)
5.11. Identify the most abundant protein in human plasma. (L-1)
5.12. Describe the functions, clinical significance of increased and decreased levels and methods of analysis for the following proteins: albumin, alpha-1-antitrypsin, alpha-1-glycoprotein, alpha-1-fetoprotein, haptoglobin, ceruloplasmin, transferrin, C-reactive protein and alpha-2-macroglobulin. (L-2)
5.13. Identify the basic principle concerning turbidimetry and nephelometry. (L-1)
5.14. Discuss two sources of error concerning light scattering measurements. (L-1)
5.15. Diagram the basic components of a nephelometer. (L-2)
5.16. Identify sources of error concerning nephelometric and turbidometric measurements. (L-2)

5.17. List several clinical applications concerning nephelometric procedures. (L-1)

5.18. Identify basic principles concerning electrophoresis. (L-1)

5.19. List the factors involved in the rate of migration for electrophoresis procedures. (L-1)

5.20. Describe the procedures for serum protein electrophoresis. (L-1)

5.21. Identify the purpose of buffers in electrophoresis procedures. (L-1)

5.22. Identify the most common stains used in SPE. (L-1)

5.23. Compare the procedure of direct densitometry to elution of dye procedures. (L-2)

5.24. Identify similarities and differences between traditional electrophoresis, isoelectric focusing electrophoresis, polyacrylamide gel electrophoresis, capillary electrophoresis, and two-dimensional electrophoresis. (L-1)

5.25. Discuss four factors that may impede resolution in electrophoresis. (L-2)

5.26. Compare the properties of the following separation media: cellulose acetate, agarose, polyacrylamide. (L-2)

5.27. Name the species separated and identified by Southern blotting, Northern blotting, and Western blotting. Describe the general design of each technique. (L-1)

5.28. Evaluate sources of error and select a course of action concerning electrophoresis. (L-3)

5.29. Correlate the following disease states or specimen alterations to specific protein electrophoresis patterns: plasma, hemolyzed specimen, monoclonal gammopathy, inflammatory response, hypogammaglobulinemia, inflammatory response, hypergammaglobulinemia, nephrotic syndrome and chronic hepatic disease. (L-2)

5.30. Compare the migration rates of the five major serum protein fractions. (L-2)

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**Statistics and Quality Management**

After completing reading assignments and lecture, the student will, with 75% accuracy:

1. Define the following terms:
   a. quality assurance
   b. quality control
   c. observation
   d. quantitative observation
   e. variable
   f. population
   g. sample
   h. mean, mode, median
   i. Range
   j. statistics
   k. reference interval
   l. control, standard, primary standard, secondary standard
   m. reference method
   n. calibration
   o. accuracy, precision
   p. random error, systematic error
2. Calculate the following:
   a. sensitivity
   b. specificity
   c. predictive value
   d. mean
   e. median
   f. range
   g. standard deviation
   h. coefficient of variation

3. Explain how the preceding parameters (2) apply to laboratory practice.

4. Describe the pre-analytic and post-analytic phases of quality assurance.

5. Select control materials that are appropriate for tests of interest.

6. Construct Levey-Jennings control charts with appropriate control limits; plot example control data; interpret the control results.

7. Interpret control results with Westgard rules to determine if patient test results can be reported and, if not, what type of analytical errors are occurring in out-of-control runs.

8. Identify the regulatory and accreditation requirements for QC for tests of interest.

9. Compare and contrast quality control, quality assurance and quality improvement.

10. Evaluate laboratory QC data and identify appropriate corrective action when data falls out of control range.

11. Identify QC shifts and trends.

12. Discuss the role of the medical technologist in maintaining laboratory quality.

13. Discuss the processes involved in method selection and evaluation.

14. Discuss proficiency testing programs.

15. Discuss the role of medical technologists in point-of-care testing.

**Therapeutic Drug Monitoring**

After completing lecture and reading assignments, the student will, with 75% accuracy:
1. Define therapeutic drug monitoring (TDM) and pharmacokinetics. (L-1)
2. State the reasons for performing TDM. (L-1)
3. Discuss the key principles for interpretation of plasma drug concentrations. (L-2)
4. Explain the factors affecting drug absorption, metabolism and excretion. (L-1)
5. Discuss the concept of half-life, steady-state concentration and therapeutic concentrations of drugs. (L-1)
6. Compare peak and trough measurements. (L-2)
7. State proper timing of sample collection for various TDM measurements. (L-1)
8. Analyze and interpret drug concentrations of case studies, correlating disease states to decreased clearance of specific drugs. (L-2,3)
9. List drugs in the following classes which are therapeutically monitored: anticonvulsant, cardioactive, bronchodilator, antibiotic, psychotropic, antineoplastic and immunosuppressant. (L-1)
10. Compare the specific requirements (including time of collection after dosing, time to steady state, therapeutic concentration, and elimination rate) for monitoring each of the following drugs: phenobarbital, phenytoin, valproic acid, primidone, carbamazepine, ethosuximide, digoxin, lidocaine, quinidine, procainamide, disopyramide, propranolol, theophylline, caffeine, gentamicin, tobramycin, amikacin, lithium, tricyclic antidepressants, cyclosporine, and tacrolimus and sirolimus. (L-1)
11. Discuss methods for the determination of the drugs listed above. (L-1,2)
12. Name five drugs for which active metabolites should be monitored and discuss the appropriate strategy for monitoring each. (L-1)

**Toxicology**

After completing lecture and reading assignments each student will, with 75% accuracy:

1. Compare and contrast clinical and forensic drug testing purpose and protocols. (L-2)
2. State the sample(s) of choice for clinical and forensic drug testing protocols. (L-1)
3. Discuss the components of federally mandated (SAMHSA) workplace drug testing. (L-1)
4. List the five drugs tested under the federal (SAMHSA) guidelines. (L-1)
5. Distinguish between screening and confirmatory tests for detecting and identifying drugs of abuse. (L-1)
6. List drugs for which antidotes are available and choose the appropriate antidote for each drug. (L-1,2)
7. Discuss commonly identified drugs and metabolites for the following drug classes: alcohols, analgesics, antidepressants, hallucinogens, hypnotics, stimulants, tranquilizers, metals and pesticides. (L-1,2)
8. Describe clinical symptoms associated with toxic concentrations of the drug classes listed above. (L-1)
9. Discuss the applications of the following laboratory methods and techniques used in toxicology: spot tests, osmolal gap, immunoassays, thin-layer chromatography,
gas chromatography, high-performance liquid chromatography, mass spectrometry and atomic absorption. (L-2)
10. Discuss the use of the Rumack-Matthew and Done nomograms in assessing acetaminophen and salicylate toxicity. (L-1)
11. Describe the protocols suggested to prevent adulteration of samples during urine collection for workplace drug testing. (L-1)
12. List conditions under which a federally certified laboratory may report a sample as dilute, substituted or adulterated. (L-1)
13. Identify sources of error in specimen collection and handling for the detection of alcohol. (L-1)

Tumor Markers

After completing lecture and reading assignments, the student will, with 75% accuracy:

1. Explain the role of tumor markers in diagnosis and treatment of cancer. (L-1)
2. Name major cancers and their associated tumor markers. (L-1)
3. Define the following terms: oncofetal antigen, carcinoma (tumor)-associated antigen, and tumor-specific antigen. (L-1)
4. Classify the various tumor markers as hormones, oncofetal antigens, mucin-like glycoproteins or genetic markers. (L-1)
5. Describe the major properties, methods of analysis, and clinical use of CEA, AFP, CA 125, CA 19-9, PSA, beta-hCG, and PALP. (L-1,2)
6. Explain the use of enzymes and hormones as tumor markers. (L-1)

Hepatitis and HIV Testing

After completing lecture and reading assignments, the student will, with 75% accuracy:

1. Describe the temporal appearance of HIV serological markers from initial infection to the development of acquired immune deficiency syndrome (AIDS). (L-1,2)
2. Name two confirmatory tests used in HIV serology. (L-1)
3. Identify the principles of methodologies for the determination of HIV. (L-1)
4. Describe the role and order of addition of patient serum, conjugate, and substrate in HIV ELISA and Western blot tests. (L-1)
5. Evaluate sources of error in the determination of HIV antibody. (L-2)
6. Identify the cell which the HIV virus infects. (L-1)
7. Identify the principles of methodology for the determination of hepatitis antigens and antibodies. (L-1)
8. Describe procedures for the determination of hepatitis antigens and antibodies. (L-1)
9. Compare the modes of transmission and clinical manifestations of HAV, HBV, HCV, HDV, HEV and HGV. (L-2)
10. Correlate the course of hepatitis infection to symptoms and serological responses following exposure. (L-2)
Vitamins, Minerals and Trace Elements

After completing lecture and reading assignments, the student will, with 75% accuracy:

1. Characterize the distribution of calcium, phosphate, and magnesium among compartments in the body and among the various forms of each found in the plasma. (L-)
2. Discuss the mechanisms involved in calcium, phosphate, and magnesium homeostasis; predict the effects of the disturbances in these homeostatic mechanisms. (L-2)
3. Predict the effect of abnormal serum albumin concentrations on total serum calcium and total serum magnesium results, and abnormal blood pH on ionized calcium and total calcium results. (L-2)
4. Discuss the diseases/conditions associated with hypercalcemia, hypocalcemia, hyperphosphatemia, hypophosphatemia, hypermagnesemia and hypomagnesemia. (L-1)
5. Identify principles of methodology for the determination of ionized calcium, total calcium, inorganic phosphate and magnesium List reference ranges for each. (L-1)
6. List the fat-soluble and water-soluble vitamins, their functions, and conditions that result from a deficiency. (L-1)
7. Identify laboratory methods for sample collection and determination of trace elements. (L-1)
8. List the nutritive trace elements and describe their primary biochemical roles. (L-1)
9. Discuss the clinical significance of the trace elements. (L-1,2)

LABORATORY ROTATION CLINICAL CHEMISTRY

The goal of this laboratory is to produce knowledgeable and competent technologists in clinical chemistry providing clinical experience and professional guidance.

II. OBJECTIVES:
Upon completion of this laboratory rotation, the student will be able to:

I. GOALS:

1. Identify the main functions of the clinical chemistry laboratory.
2. List the various types of pipettes available and identify a specific use for each.
3. List three types of centrifuges and discuss uses for each.
4. Calculate the final concentration of an analyte after having diluted the sample.
5. Define the term buffer.
6. List the necessary information used in the standardized reporting of a test.
7. Call to the appropriate personnel a patient lab report using correct protocol and procedure.
8. Discuss the procedures for the safe handling of chemicals.
9. Given a chemical, select a course of action for it's safe handling.
10. Discuss the procedures used for fire safety in the laboratory.
11. Correlate the type of fire extinguisher to the correct type of fire.
12. Define the term biological hazard.
13. List the most frequent biohazards encountered in the laboratory.
14. Identify techniques used to minimize laboratory acquired infections.
15. Given a certain biohazard or situation related to a biohazard, select a proper course of action in dealing with the possible problem.
16. Describe the procedure for establishing linearity.
17. Identify basic principles concerning electrophoresis.
18. List those factors that have a role in the migration rates of an electrophoresis procedure.
19. Perform/describe the procedure for hemoglobin and protein electrophoresis.
20. Discuss the purpose of using buffers in electrophoresis procedures.
21. Identify the stains used in HGBE and SPE.
22. Using the Helena REP, scan patterns obtained by the HGBE and SPE procedures.
23. Identify sources of error concerning electrophoresis procedures and select courses of corrective action to resolve each error.
24. Define the term "ion selective electrode".
25. List three classes of ion selective membranes and examples of each.
26. Perform and describe testing procedures for routine electrolyte testing using both the Beckman CX3 and the Baxter PARAMAX.
27. Discuss the measuring principles used by each instrument (CX3, PARAMAX) in measurement of routine electrolytes.
28. Identify possible sources of error that may interfere with the measurement of routine electrolytes on the CX3 and PARAMAX and select proper action that will aid in the correction of the error.
28a. Discuss the pH buffering function and capacity of electrolytes.
29. Correlate abnormal electrolyte results, both increased and decreased, to possible disease states.
30. Discuss the fundamental characteristics and principles of the methodology used in osmometry.
31. Perform and describe testing procedures for osmolality using the Advanced and Wescor instruments.
32. Identify and discuss the colligative properties of solutions.
33. Identify any sources of error concerning the measurement of osmolality and select a course of action to resolve the error.
34. Correlate osmolality values to possible disease states.
35. Discuss the clinical applications for performing serum and urine osmolality.
36. Describe methods and characteristics used in the evaluation and selection of a chemistry analyzer.
37. From receipt of the sample to the reporting of results, operate correctly, the following instruments:

PARAMAX               CX3               Stratus ACA         ETS                IMX TDX                  TDX/FLX

38. Discuss the purpose of reference ranges and explain considerations of the sampling process when establishing reference range.
39. Evaluate and discuss the transferability of reference values from one laboratory to another.
40. Explain the process of reporting critical values in our laboratory and choose correct followup procedures before the reporting of these values.
41. Discuss the importance of delta checks and how the investigation of these values should be followed up before reporting any values.
42. Given appropriate data, construct and interpret a Levy-Jennings chart and select appropriate action for out of control results, shifts, and trends.

43. Given a Levy-Jennings control chart and individual data points, use Westgard rules to interpret the data points as to whether they are in or out of control.

44. Describe the functions of a laboratory information system.

45. Describe the appropriate identification, collection, processing, storage and transport methods for commonly collected laboratory specimens, summarizing the importance of each method.

46. Discuss clinical signs and symptoms, laboratory diagnosis, treatment and prognosis for each of the following:

- Phenylketonuria
- Alkaptonuria
- Homocystinuria
- Cystinuria
- Maple Syrup disease

47. List three methods, including our laboratory method, for measurement of total protein in serum and discuss the principle of each.

48. Identify sources of error for each total protein method and select a course of action to resolve each error.

49. List four methods for the determination of urine protein and discuss the principle of each method.

50. Identify possible sources of error for each urine protein method and select a course of corrective action for each method.

51. Given serum protein electrophoresis patterns, interpret and correlate the patterns to disease states and/or conditions.

52. Compare and label the migration rates and patterns of the five major protein fractions.

53. Identify the normal adult hemoglobins, list the percentages of each, and discuss their structures that make them unique.

54. Identify the embryonic hemoglobins and discuss their structures that make them unique.

55. Compare the migration rates of the following:


56. Define hemoglobinopathy and thalassemia and list examples of each.

57. Given hemoglobin electrophoresis patterns, interpret and correlate the patterns to specific disease states and/or conditions.

58. Identify the most abundant protein found in serum.

59. Describe the functions, clinical significance of increased and decreased levels, and methods of analysis for the following:

- Albumin
- AAT
- Alpha-1-Glycoprotein
- AFP
- Haptoglobin
- Ceruloplasmin
- Transferrin
- CRP
- Alpha-2-Macroglobulin

60. Discuss the clinical significance of protein in urine.

61. Discuss the clinical significance of proteins in CSF and correlate these proteins to disease states and explain the tests used in the diagnosis of these diseases.

62. Identify two methods, including ours, for the determination of CSF protein.

63. Perform and describe the methods used to concentrate protein
64. Perform and describe the procedure for electrophoretic separation of urine and CSF proteins.
65. Recognize normal and abnormal electrophoretic patterns for urine and CSF protein and correlate these abnormal patterns to disease states and conditions.
66. Classify by protein levels, transudates and exudates.
67. Discuss the effect of the following in enzyme reactions: enzyme concentration, substrate concentration, pH, temperature, and inhibitors.
68. Define isoenzyme and discuss clinical applications for the measurement of them.
69. Identify five methods of isoenzyme analysis.
70. Perform and describe the REP procedure for the isoenzyme fractionation of CPK and LDH enzymes.
71. List reference ranges, discuss the clinical significance of and discuss the principle of measurement for the following enzymes:

<table>
<thead>
<tr>
<th></th>
<th>AST</th>
<th>ALT</th>
<th>CPK</th>
</tr>
</thead>
<tbody>
<tr>
<td>LDH</td>
<td>ALP</td>
<td>GGT</td>
<td></td>
</tr>
<tr>
<td>Amylase</td>
<td>Lipase</td>
<td>Trypsin</td>
<td></td>
</tr>
<tr>
<td>Cholinesterase</td>
<td>ACP</td>
<td>ICD</td>
<td></td>
</tr>
<tr>
<td>GLDH</td>
<td>Aldolase</td>
<td>5'NT</td>
<td></td>
</tr>
<tr>
<td>TdT</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

72. Given patterns of CPK fractionation, correlate these patterns to possible disease states and conditions.
73. Given patterns of LDH fractionation, correlate these patterns to possible disease states and conditions.
74. Given both CK and LD fractionation patterns, correlate to possible disease states and conditions.
75. Identify enzymes useful in the diagnosis of AMI and describe how measurement of these enzymes would be useful.
76. Identify and discuss methods for the measurement of AST and ALT.
77. Discuss methods for the measurement of CPK and for the separation and quantitation of CK isoenzymes other than electrophoresis.
78. Discuss methods of measurement for LDH.
79. Describe methods for the determination of ALP.
80. Identify the isoenzymes of ALP and describe methods for their separation.
81. Describe methods for the determination of GT.
82. Describe methods for the determination of amylase.
83. Identify methods for amylase isoenzyme separation and correlate results to disease states or conditions.
84. Describe methods for the determination of lipase.
85. Describe methods for the determination of cholinesterase.
86. Describe methods for the determination of ACP.
87. Evaluate sources of error in enzyme determination and select a course of action to resolve each error.
88. Identify the basic chemical composition of a carbohydrate.
89. Describe and perform glucose measurement using the CX3 and PARAMAX.
90. Identify the basic principles of methodology and list interfering substances for each of the following glucose methodologies:

<table>
<thead>
<tr>
<th></th>
<th>Hexokinase</th>
<th>Glucose oxidase</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Glucose dehydrogenase</td>
<td>O-toluidine</td>
</tr>
</tbody>
</table>

91. Discuss the metabolism of carbohydrates in terms of:

|   | Glycogenolysis | Glycogenesis |
92. Discuss the effects of the following hormones on blood glucose concentration:

- Insulin
- Somatostatin
- ACTH
- HGH
- Cortisol
- Epinephrine
- Glucagon
- Thyroxine
- HPL
- Somatomedins

93. Identify sources of error in the determination of glucose and suggest corrective action to resolve these errors.

94. Discuss those factors (storage, collection, source, etc...) that may affect glucose concentration and suggest ways to minimize the effect these factors have on glucose concentration.

95. State the reference ranges for glucose levels taking into consideration type of specimen (venous, arterial).

96. Discuss the clinical signs and symptoms, etymology, and laboratory findings for the following diseases:

- Insulin dependent diabetes
- Non insulin dependent diabetes
- Gestational diabetes
- Hypoglycemia

97. Contrast HGB A\(_1\)C and glycohemoglobin.

98. Discuss measurement of HGB A\(_1\)C and glycohemoglobin as they relate to glucose level monitoring.

99. Perform and describe the procedure for glycosylated hemoglobin.

100. Perform and describe the procedure for serum ketone determination.

101. Discuss the clinical significance of serum and urine ketones.

102. Describe the principle of the Acetest for serum and urine ketone determination.

103. Correlate the diagnosis of diabetes to results of the following tests:

- Fasting glucose
- Post-prandial glucose
- Post-challenge glucose

104. Identify those conditions that should be met in patient preparation for an oral glucose tolerance tests.

105. Discuss how the following factors affect glucose tolerance:

- Posture
- Nausea
- Anxiety
- Coffee
- Smoking
- Age
- Weight
- Physical activity
- Corticosteroids

106. Given the results of glucose tolerance curves, correlate them to disease states or conditions or the absence of disease.

107. Contrast oral versus venous glucose tolerance testing and discuss reasons why one would be done over the other.

108. Describe specimen requirements and principles of methodology for lactate and pyruvate.

109. Perform and describe the procedure for the determination of lactic acid.

110. Given results for lactic acid, correlate abnormal results to possible disease states.

111. Describe and perform the procedure for lipoprotein electrophoresis.
112. List the five lipoproteins and their apolipoprotein content.
113. Given the electrophoretic bands for lipoproteins, correlate these bands to the lipid type and content of each.
114. Discuss the functions of each lipoprotein.
115. Discuss the types of hyperlipoproteinemia and given the results of lipids, lipoprotein levels, and specimen appearance, interpret these results as to the type of hyperlipoproteinemia present.
116. Correlate genetic etiology and various disease states to the types of hyperlipoproteinemias that may be present.
117. Identify sources of error and select courses of action in specimen collection and testing for the investigation of lipoprotein disorders.
118. Discuss the purposes of the following tests as an aid in the diagnosis of lipoprotein disorders and correlate these results to the type of lipoprotein disorder that may be present:

<table>
<thead>
<tr>
<th>Test</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serum appearance</td>
<td>Cholesterol</td>
</tr>
<tr>
<td>Triglycerides</td>
<td>HDL cholesterol</td>
</tr>
<tr>
<td>LDL cholesterol</td>
<td>Lipoprotein electrophoresis</td>
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<tr>
<td>Ultracentrifugation</td>
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</tbody>
</table>

119. Given the patterns of lipoprotein electrophoresis, be able to compare and contrast these patterns as to the type hyperlipoproteinemia present.
120. Discuss the principles of methodology for the measurement of the following:

<table>
<thead>
<tr>
<th>Test</th>
<th>Principle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lipoprotein electrophoresis</td>
<td>HDL</td>
</tr>
<tr>
<td>Plasma appearance</td>
<td>Cholesterol</td>
</tr>
<tr>
<td>Triglyceride</td>
<td>Apolipoproteins</td>
</tr>
</tbody>
</table>

121. For the following, identify hormones secreted by them, discuss their actions and regulation, and perform and/or discuss methods for their measurement:

<table>
<thead>
<tr>
<th>Gland</th>
<th>Hormone</th>
<th>Action</th>
<th>Regulation</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior pituitary</td>
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<tr>
<td>Posterior pituitary</td>
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<tr>
<td>Pineal gland</td>
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<tr>
<td>Thyroid</td>
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<tr>
<td>Adrenal cortex</td>
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<tr>
<td>Adrenal medulla</td>
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<tr>
<td>Testes</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Ovaries</td>
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</tr>
</tbody>
</table>

122. For the above glands, correlate levels of measured, secreted hormone to possible disease states and for these disease states list signs and symptoms and suggest followup testing to aid in the confirmation of these disease states.
123. Perform and describe procedures for the measurement of Na, K, Cl, and CO₂.
124. Correlate clinical conditions associated with increased and decreased plasma levels of Na, K, Cl, CO₂.
125. Discuss the methodology used to measure Na, K, Cl, CO₂ and identify the principle for each.
126. Define NPN.
127. Discuss the clinical utility of plasma urea measurement.
128. Perform and/or discuss the methods of measurement for urea, describe the principles of each method, identify sources of error and suggest action to resolve these errors.
129. Discuss the clinical utility of plasma creatinine and creatinine clearance tests.
130. Perform and/or discuss the methods for measurement of creatinine and describe the principle of each method.
131. Given appropriate data, calculate a creatinine clearance.
132. Contrast urea and creatinine measurement as they relate to renal disease.
133. Discuss the clinical significance of increased and decreased
uric acid levels.
134. Perform and/or describe measuring methods for uric acid,
describe the principle of each method, identify sources of
error and suggest action to resolve these errors.
135. Compare the distribution of calcium and phosphorous in the body and discuss the physiology of each.
136. Perform and/or describe methods for measurement of calcium and phosphorous and describe the principle of each method.
137. Contrast calcium and phosphorous levels as they relate to levels of: calcitonin, PTH, Vit. D, and describe how each
affects the regulation and metabolism of calcium and phosphorous.
138. Correlate increased or decreased levels of calcium and phosphorous to possible disease states.
139. Discuss the process of bilirubin metabolism in the liver.
140. Define jaundice and differentiate between unconjugated and
conjugated hyperbilirubinemia and list causes of each.
141. Identify conditions in which urobilinogen is increased and
decreased in urine and feces.
142. Perform and/or describe methods of measurement for total
bilirubin, conjugated bilirubin, unconjugated bilirubin
and describe the principles of each.
143. Given the appropriate data, calculate an indirect bilirubin.
144. Identify sources of error in specimen collection and handling of samples for bilirubin measurement and
suggest actions to correct these errors.
145. Perform and/or describe methods for the measurement of ammonia
and describe the principle of the methods.
146. Correlate abnormal levels of ammonia to possible disease states.
147. Identify four sources of error in specimen collection and handling when measuring ammonia and select corrective action to correct these errors.
148. For the following diseases or conditions, correlate results
of the following analytes: LDH, GGT, AST, ALT, ALP, Ammonia,
bilirubin (serum, urine), urobilinogen (urine, feces) and state whether they will be increased, decreased, or
greatly increased.

- Hemolytic anemia
- Neonatal jaundice
- Crigler-Najjar syndrome
- Gilbert's disease
- Viral hepatitis
- Reye's syndrome
- Drug induced hepatitis
- Liver tumors
- Cirrhosis
- Cholestatic disease

149. List reference ranges for tests performed on the PARAMAX and
select courses of action for values obtained outside these ranges.
150. For the tests performed on the PARAMAX, Describe methodologies
for each and list the principles of each test.
151. Discuss the clinical utility of the chloride sweat test.
152. Given results of the Chloride sweat test, be able to compare
these results to disease states.
153. Perform and/or describe the procedure for the collection of sweat by iontophoresis.
154. Identify sources of error in the collection of sweat and the
determination of sweat chloride and suggest action to correct
these errors.
155. List reference ranges for the tests performed on the CX3 and
choose appropriate action when values fall outside of these
ranges.
156. For the tests performed on the CX3, discuss methods of measurement and define the principle of each method.
157. Perform and/or describe the procedure for the measurement of Delta-ALA in urine and discuss the principle of methodology for the procedure.
158. Perform and/or describe the procedure for the measurement of porphobilinogen in urine and discuss the principle of methodology for the procedure.
159. Perform and/or describe the procedure for the determination of porphyrins in blood, urine, and feces and discuss the principle of methodology for the procedures.
160. Identify methods for the separation and identification of specific porphyrins.
160a. Correlate and classify disease states as they relate to abnormal porphyrin levels.
161. Define TDM, toxicology, and pharmacokinetics and identify biological specimens of choice for each.
162. Perform the procedures for measuring drug levels performed in our laboratory, discuss the principles used for each measuring method, consequences of toxic levels, and proper periods of collection for each.
163. List six cardioactive drugs and discuss their therapeutic action.
164. List six anticonvulsants and discuss their therapeutic action.
165. Name a common bronchodilator and discuss its therapeutic action.
166. Identify methods for the determination of ethanol.
167. Identify sources of error in specimen collection and handling in ethanol measurement and suggest corrective action for these errors.
168. Perform and/or describe the procedure for the measurement of vitamin B12 and Folate and describe the principle of the method.
169. Identify three major causes of Vit. B12 and Folate deficiencies and two causes of elevation.
170. List causes for false elevation of B12 and Folate levels.
171. Identify the two subunits of the HCG molecule and compare the clinical utility in the measurement of each.
172. Perform and describe the procedure for the measurement of HCG and discuss the principle of the method.
173. List conditions where measurement of HCG would be clinically useful and given results of HCG measurements be able to correlate to these conditions.
174. Perform and describe the procedure for the determination of the HIV antibody and describe the principle used for the method.
175. Evaluate sources of error in the determination of the HIV antibody and suggest a course of action to resolve these errors.
176. Identify cells which the HIV virus attacks.
178. Define AIDS and ARC.
179. Correlate patterns of clinical illness in HIV infection to serological responses following exposure.
180. Given a positive result for the EIA procedure for HIV, suggest appropriate followup testing for this situation.
181. Perform the procedure for Hepatitis A and B antigens and antibodies and be able to discuss the principle of each method.
182. Compare the clinical manifestations and modes of transmission for Hepatitis A and B.
183. Correlate the course of Hepatitis B infection to signs, symptoms, and serological responses following exposure.
184. Discuss the clinical utility of the following tests: HBsAg HBeAb HBCAb(IgM) HBsAb HIVAb HBCAb Western Blot
185. Perform and describe the procedures and discuss the clinical usefulness of the following: Plasma HGB PKU G-6-PD Plasma ketones
Upon completion of lecture and reading assignments, the student will, with 75% accuracy, be able to:

**PHYSICAL EXAMINATION**

1.1. List the common terminology used to report normal urine color. (L-1)
1.2. Discuss the relationship of urochrome to normal urine color. (L-1)
1.3. Describe how the presence of bilirubin in a specimen may be suspected. (L-1)
1.4. Discuss the significance of cloudy red urine and clear red urine. (L-1,2)
1.5. Name two pathologic causes of black or brown urine. (L-1)
1.6. Discuss the significance of Pyridium in a specimen. (L-1)
1.7. Define appearance. (L-1)
1.8. List the common terminology used to report appearance. (L-1)
1.9. Describe the appearance and discuss the significance of amorphous phosphates and amorphous urates in freshly voided urine. (L-1,2)
1.10. List three pathologic and four nonpathologic causes of cloudy urine. (L-1)
1.11. Define specific gravity and tell why this measurement can be significant in the routine analysis. (L-1)
1.12. Describe the principles of physics used in measuring specific gravity by the urinometer and refractometer. (L-2)
1.13. Given the calibration temperature and specimen temperature, calculate a temperature correction for a specific gravity reading determined by a urinometer. (L-2)
1.14. Given the concentration of glucose and protein in a specimen, calculate the correction needed to compensate for these high molecular-weight substances in the urinometer specific gravity reading. (L-2)
1.15. Name two nonpathogenic causes of abnormally high specific gravity readings. (L-1)

**CHEMICAL EXAMINATION**

2.1. Describe the proper technique for performing chemical tests on urine by reagent strip and give possible errors if this technique is not followed. (L-1)
2.2. List four causes of premature deterioration of reagent strips and explain how to avoid the problem. (L-1,2)
2.3. List five quality control procedures routinely performed with reagent strip testing. (L-1)
2.4. Name two reasons for measuring urinary pH and discuss their clinical applications. (L-1,2)
2.5. Discuss the principle of pH testing by reagent strip methods. (L-2)
2.6. Describe three renal causes of proteinuria and two nonrenal reasons for proteinuria. (L-1)
2.7. Explain the "protein error of indicators" and list any sources of interference that may occur with this method of protein testing. (L-1,2)
2.8. Name two confirmatory tests for urine protein performed in the urinalysis laboratory and name any sources of error associated with these procedures. (L-1)
2.9. Describe the unique solubility characteristics of Bence Jones protein and explain how they can be used to perform a screening test for the presence of this protein. (L-1,2)
2.10. Explain why glucose that is normally reabsorbed in the proximal convoluted tubule may appear in the urine. (L-2)
2.11. State the renal threshold levels for glucose. (L-1)
2.12. Describe the principle of the glucose-oxidase method of reagent strip testing for glucose and name possible causes of interference with this method. (L-1)
2.13. Describe the copper reduction method for detection of urinary reducing substances and list possible causes of interference. (L-1)
2.14. Compare and contrast the advantages and disadvantages of the glucose oxidase and copper reduction methods of glucose testing. (L-2,3)
2.15. Name three reasons for the appearance of ketonuria. (L-1)
2.16. List the three "ketone bodies" appearing in urine and describe their measurement by the sodium nitroprusside reaction and possible causes of interference. (L-1,2)
2.17. Differentiate between hematuria and hemoglobinuria and explain the clinical significance of each. (L-2,3)
2.18. Describe the chemical principle of the reagent strip method for blood testing and list possible causes of interference. (L-1)
2.19. Discuss the presence of myoglobin and its role in the chemical testing for urinary blood. (L-2)
2.20. Describe the degradation of hemoglobin to bilirubin, urobilinogen, and finally urobilin. (L-1)
2.21. Differentiate between conjugated and unconjugated bilirubin, including their relationship to urinary excretion of bilirubin. (L-2,3)
2.22. Describe the relationship of urinary bilirubin and urobilinogen to the diagnosis of bile duct obstruction, liver disease, and hemolytic disorders. (L-1)
2.23. Name the earliest test to detect urinary bilirubin. (L-1)
2.24. Discuss the principle of oxidation tests and diazotization tests for urinary bilirubin, including possible sources of error. (L-1,2)
2.25. State the advantage of performing an Ictotest for detection of urine bilirubin. (L-1)
2.26. Name two technical errors that may produce false-negative bilirubin reactions. (L-1)
2.27. Give two reasons for increased urine urobilinogen and one reason for an absence of urine urobilinogen. (L-1)
2.28. Name the chemical contained in Ehrlich's reagent. (L-1)
2.29. Give the proper method for collecting and preserving specimens to be tested for urine urobilinogen. (L-1)
2.30. Describe the Watson-Schwartz test used to differentiate among urobilinogen, porphobilinogen, and Ehrlich-reactive compounds. (L-1)
2.31. Discuss the principle of the nitrite reagent strip test for bacteriuria. (L-2)
2.32. List three possible causes of a false-negative result in the reagent strip test for nitrite. (L-1)
2.33. Compare reagent strip testing for urine specific gravity with urinometer and refractometer testing. (L-3)
2.34. Give the principle of the reagent strip test for leukocytes. (L-1)
2.35. Discuss the advantages and disadvantages of the reagent strip test for leukocytes. (L-2,3)

MICROSCOPIC EXAMINATION

3.1. List eight formed elements found in urinary sediments. (L-1)
3.2. Discuss the methods used by commercial systems to standardize the microscopic examination. (L-2)
3.3. Name the four elements measured in the Addis count and recognize their normal values. (L-1,2)
3.4. Describe the eight standard steps for performing the microscopic Urinalysis. (L-1)
3.5. Distinguish between relative centrifugal force and revolutions per minute. (L-2,3)
3.6. Correlate physical and chemical urinalysis results with microscopic observations. (L-2,3)
3.7. Differentiate among phase-contrast, interference-contrast, and polarized microscopy. (L-2,3)
3.8. List the normal values for red blood cells, white blood cells, and hyaline casts. (L-1)
3.9. Discuss the significance of red blood cells in the urinary sediment. (L-2)
3.10. Differentiate between red blood cells, yeast, and oil droplets. (L-3)
3.11. Discuss the significance of white blood cells in the urinary sediment. (L-2)
3.12. Name, describe and give the origin of the three types of epithelial cells found in the urinary sediment. (L-1,2)
3.13. Differentiate between leukocytes and renal tubular epithelial cells. (L-3)
3.14. Discuss the significance of oval fat bodies. (L-2)
3.15. List four conditions necessary for urinary cast formation. (L-1)
3.16. Name the major protein found in casts. (L-1)
3.17. Discuss the significance of hyaline, red blood cell, white blood cell, epithelial cell, granular, waxy, fatty, and broad casts. (L-2)
3.18. List and describe the normal crystals found in acidic urine. (L-1,2)
3.19. List and describe the normal crystals found in alkaline urine. (L-1,2)
3.20. Describe and state the significance of cystine, cholesterol, leucine, tyrosine, sulfonamide, radiographic dye, and ampicillin crystals. (L-1,2)
3.21. Discuss the procedures and documentation for quality control of specimens, methodology, reagents, control materials, instrumentation, equipment, and reporting of results in the urinalysis laboratory. (L-2)
3.22. Correlate laboratory findings in the urinalysis laboratory to various disease states. (L-2,3)
CLAB 478- LABORATORY ADMINISTRATION

Credit: 3 SCH
Catalog description:

Text(s): Principles of Clinical Laboratory Management, Jane Hudson, Pearson Prentice Hall, 2004

Method of Evaluation: 4 exams @ 100 points each
Grading scale (7 point scale):
400 – 372 = A  
371 - 344 = B  
343 – 316 = C  
315 – 288 = D  
287 – below = F

Make-up exams: Make up exams will be given to students with official university excuses. For any other excuse, a make-up exam can only be taken if the instructor approves the excuse. These exams could differ in format from the original exam and the maximum score a student can receive on this exam is 90%. These make-up exams must be taken during the week prior to finals week. In order to take a make-up exam, the student must schedule the exam at least one week prior to the date the exam is to be taken.

Academic misconduct: Any student sharing work with another student, talking during an exam, looking on another students paper or viewing notes or any other type of medium other than that provided by the instructor, will constitute cheating. Group projects are only those designated by the instructor. Any student found cheating or enabling another student to cheat will be given an “F” for the course and the student will not be allowed to return to class. The students academic advisor or department head will be notified in writing of the students unethical behavior.

Accommodations: Any student with disability which requires accommodation should present a letter from the Louisiana Tech Office of Disability Support in order for accommodations to be arranged. No accommodation will be made until a letter is received.

Course objectives:
1. Describe various healthcare delivery systems and the impact external forces have on these institutions.
2. Examine different healthcare reimbursement systems and describe the different payers involved in healthcare. Identify the factors which affect reimbursement.
3. Identify various accreditation standards affecting healthcare facilities, specifically in the clinical laboratory setting.
4. Explain the components of quality improvement and select techniques used in maintaining healthcare quality.
5. Discuss issues related to maintaining and choosing laboratory information systems.
6. Identify regulatory compliance issues and steps to maintain compliance.

Unit I: Health care delivery systems
Unit II: Reimbursement systems used in healthcare
Unit III: Accreditation and regulatory standards
Unit IV: Regulatory compliance issues
Unit V: Performance improvement
Unit VI: Information management
CLAB 483 AND 484 - CLINICAL PARASITOLOGY LECTURE AND LAB

After completing Parasitology, the student will, with 75% accuracy:

1.1. Describe proper specimen collection, preparation, and handling in the parasitology laboratory. (L-1, L-2)
1.2. Accept or reject specimens based upon laboratory policy and recommendations. (L-3)
1.3. Compare and contrast the various types of specimen preservatives for the examination of parasites. (L-2)
1.4. Discuss the purpose and procedure for calibrating an ocular micrometer. (L-1)
1.5. Calculate the calibration of the ocular micrometer in microns when given the ocular units and stage units in millimeters. (L-2)
1.6. State the protocol for parasitology work-ups for formed, soft and liquid stools according to the SFMC Parasitology Manual, and discuss the rationale for the differences. (L-1, L-2)
1.7. List the parasite forms (stages) that are more likely to be found in formed, soft and liquid stools. (L-1)
1.8. Discuss the principle of the rapid test for *Clostridium difficile* toxin. (L-2)
1.9. Perform the procedure for the rapid test for *Clostridium difficile* toxin and properly interpret the results. (L-2)
1.10. Correlate a positive test result for *Clostridium difficile* toxin with a specific disease state. (L-2)
1.11. Outline the procedure for the modified acid fast stain for stool specimens. (L-1)
1.12. Perform the procedure for fecal fat, and properly interpret the results. (L-2)
1.13. Correlate abnormal results for fecal fat with disease states. (L-2)
1.14. Outline the procedure and state the purpose for performing the Gastroccult test. (L-1)
1.15. Perform the Hemoccult test for occult blood in stools, including quality controls, and properly interpret results. (L-2)
1.16. State the basic principle of the Hemoccult test. (L-1)
1.17. List causes of false positive and false negative results for the Hemoccult test. (L-1)
1.18. Describe, perform and interpret the following preparations or stains. (L-2)
   a. direct iodine
   b. M.I.F.
   c. Direct saline
   d. Trichrome
1.19. Describe and perform the zinc sulfate flotation procedure. (L-1, L-2)
1.20. Compare the zinc flotation method with other concentration methods according to the parasitic elements that may be detected. (L-2)
1.21. Outline the procedure and state the purpose for the Pinworm Strip test. (L-1)
1.22. Perform the procedure and properly interpret the results for reducing substances in the stool. (L-2)
1.23. List the reducing substances that yield a positive test with the Clinitest method. (L-1)

1.24. Perform the procedure and properly interpret the results for the Rotovirus Latex Detection test. (L-2)

1.25. List three methods that detect rotovirus. (L-1)

1.26. Describe the method used in the SFMC laboratory to detect rotovirus. (L-2)

1.27. Outline the procedure for and state the principle of the stool trypsin test. (L-1)

1.28. Correlate results of the stool trypsin test to health and disease states. (L-2)

1.29. Outline the procedure for fecal WBC’s. (L-1)

1.30. Correlate the results of the fecal WBC test to disease states. (L-2)

1.31. Outline the procedure for and state the purpose of the Enterotube (String) Test. (L-1)

1.32. List three parasites that may be detected by the String Test. (L-1)

1.33. Describe the disease, clinical relevance, direct smear morphology, and permanent stain morphology, and then identify, from smears or Kodachromes and case histories, the following intestinal Protozoa, group amebae:
   a. Entamoeba bistolytica
   b. E. coli
   c. E. gingivalis
   d. Iodamoeba butschlii
   e. E. hartmanni
   f. E. polecki
   g. Endolimax nana
   h. Blastorystis hominis

1.34. Describe the disease, clinical relevance, direct smear morphology, and permanent stain morphology, and then identify, from smears or Kodachromes and case histories, the following intestinal Protozoa, group flagellates:
   a. Giardia lamblia
   b. Trichomonas hominis
   c. Dientamoeba fragilis
   d. Chilomastix mesnili

1.35. Describe the disease, clinical relevance, direct smear morphology, and permanent stain morphology, and then identify, from smears or Kodachromes and case histories, the following intestinal Protozoa, group ciliates:
   Balantidium coli

1.36. Describe the disease, clinical relevance, direct smear morphology, and permanent stain morphology, and then identify, from smears or Kodachromes and case histories, the following miscellaneous intestinal Protozoa:
   a. Cryptosporidium parvum
   b. Sarcocystis
   c. Isospora belli
   d. Microsporidia

1.37. Describe the disease, clinical relevance, direct smear morphology, and permanent stain morphology; and then identify, from smears or Kodachromes and case histories, the following miscellaneous Protozoa:
   a. Naegleria fowleri
   b. Trichomonas vaginalis
   c. Acanthamoeba
1.38. Describe the disease, clinical relevance, direct smear morphology, and permanent stain morphology, and then identify, from smears or Kodachromes and case histories, the following tissue Protozoa:
   a. *Toxoplasma gondii*
   b. *Pneumocystis carinii*

1.39. Describe the disease, clinical relevance, Wright stain smear morphology, and permanent stain morphology; and then identify, from smears or Kodachromes and case histories, the following organisms from the *Protozoa*, genus *Plasmodium*:
   a. *Plasmodium vivax*
   b. *P. malariae*
   c. *P. ovale*
   d. *P. falciparum*

1.40 Describe the disease, clinical relevance, Wright stain smear morphology, and permanent stain morphology; and then identify, from smears or Kodachromes and case histories, genus *Babesia*

1.41. Describe the disease, clinical relevance, Wright stain smear morphology, and permanent stain morphology; and then identify, from smears or Kodachromes and case histories, the following intestinal nematodes:
   a. *Leishmania donovani*
   b. *L. tropica*
   c. *L. braziliensis*

1.42. Describe the disease, clinical relevance, Wright stain smear morphology, and permanent stain morphology; and then identify, from smears or Kodachromes and case histories, the following organisms from the *Protozoa*, genus *Trypanosoma*:
   a. *Trypanosoma gambiense*
   b. *T. cruzi*
   c. *T. rhodesiense*

1.43. Describe the disease, clinical relevance, direct smear morphology, and permanent stain morphology; and then identify, from smears or Kodachromes and case histories, the following intestinal nematodes:
   a. *Ascaris lumbricoides*
   b. *Enterobius vermicularis*
   c. *Trichuris trichiura*
   d. *Ancylostoma duodenale*
   e. *Necator americanus*
   f. *Strongyloides stercoralis*

1.44. Describe the disease, clinical relevance, direct smear morphology, and permanent stain morphology; and then identify, from smears or Kodachromes and case histories, the following tissue nematodes:
   a. *Trichinella spiralis*
   b. *Toxocara canis*
   c. *Dracunculus medinensis*

1.45. Describe the disease, clinical relevance, direct smear morphology, and permanent stain morphology; and then identify, from smears or Kodachromes and case histories, the following filarial nematodes:
   a. *Wuchereria bancrofti*
   b. *Loa loa*
   c. *Brugia malayi*
   d. *Onchocerca volvulus*
1.46. Describe the disease, clinical relevance, direct stain smear morphology, and permanent stain morphology, and then identify from smears or Kodachromes and case histories, the following intestinal cestodes:
   a. *Diphyllobothrium latum*
   b. *Taenia solium*
   c. *Taenia saginata*
   d. *Hymenolepis nana*
   e. *Hymenokpis diminuta*
   f. *Dipylidium caninum*

1.47. Describe the disease, clinical relevance, direct stain smear morphology, and permanent stain morphology, and then identify, from smears or Kodachromes and case histories, the following tissue cestodes (larval forms): *Echinococcus granulosus*

1.48. Describe the disease, clinical relevance, direct stain smear morphology, and permanent stain morphology; and then identify, from smears or Kodachromes and case histories, the following intestinal trematodes: *Fasciolopsis buski*

1.49. Describe the disease, clinical relevance, direct stain smear morphology, and permanent stain morphology; and then identify, from smears or Kodachromes and case histories, the following liver and lung trematodes:
   a. *Clonorchis sinensis*
   b. *Fasciola hepatica*
   c. *Paragonimus westermani*

1.50. Describe the disease, clinical relevance, direct stain smear morphology, and permanent stain morphology; and then identify, from smears or Kodachromes and case histories, the following blood trematodes:
   a. *Schistosoma mansoni*
   b. *S. haematobium*
   c. *S. japonicum*

1.51. Describe the disease, clinical relevance, and morphology; and then identify, from macroscopic examination or Kodachromes and case histories, the following species from the phylum *Arthropoda*, class *Insecta*:
   a. *Phlebotomus* (sandflies)
   b. *Chrysops* (deer flies)
   c. *Anopheles* (mosquito)
   d. *Glossina* (tsetse flies)

1.52. Describe the disease, clinical relevance, and morphology; and then identify, from macroscopic examination or Kodachromes and case histories, the following species from the phylum *Arthropoda*, class *Arachnida*:
   a. *Loxosceles reclusa* (brown recluse spider)
   b. *Latrodectus mactans* (black widow spider)
   c. *Sarcoptes scabiei* (mite)
After completing reading assignments, lectures, classroom discussions, and guided laboratory practice, the student will, with 70% accuracy:

1. Define the vocabulary terms listed on pages 38-45 of the Phlebotomy Handbook. (L-1)

2. Describe the typical duties of a phlebotomist. (L-1)

3. Differentiate the various departments in the hospital or other health care facility and in the laboratory. (L-1)

4. List the procedures and laboratory tests that are performed in each department of the laboratory. (L-1)

5. State the specimen requirements for various laboratory tests (e.g. anticoagulant, color of test tube top, blood to anticoagulant ratio). (L-1)

6. State the most important step in performing a venipuncture. (L-1)

7. Explain how to identify both outpatients and inpatients. (L-1)

8. List and describe the steps involved in performing a venipuncture. (L-1)

9. Identify the best way to prevent the spread of infection. (L-1)

10. Describe how and where the tourniquet should be applied. (L-1)

11. State the maximum time that the tourniquet should be applied and the results of exceeding this limit. (L-1)

12. Describe the following patient conditions or situations and suggest ways of performing venipunctures safely and of good specimen quality:
    a. scar tissue
    b. hematoma
    c. rolling veins
    d. collapsing veins
    e. mastectomy
    f. IV fluid infusion
    g. Obese patient
    h. Dialysis
    i. Phlebitis
    j. Thrombophlebitis
13. State three reasons why alcohol should be allowed to air dry before performing a venipuncture. (L-1)

14. Describe how the vein should be anchored and discuss the rationale behind this. (L-2)

15. State the recommended order of draw and the purpose of this order. (L-1)

16. State the protocol for inverting anticoagulated and gel tubes. (L-1)

17. State the anticoagulant or other contents for each color of tube top and the purpose of each. (L-1)

18. Describe how the venipuncture site should be cared for after the needle is removed for the following: (L-1)
   a. “typical patient”
   b. outpatient
   c. patient on “blood thinner”

19. List the minimum information that must appear on a specimen label in order to be acceptable. (L-1)

20. Discuss sources of error in patient and specimen identification. (L-2)

21. Discuss complications that can occur with phlebotomy procedures. (L-2)

22. Describe the circulatory system, including the components and function of each. (L-2)

23. Compare and contrast blood, plasma and serum. (L-2)

24. Outline the procedure for collecting blood cultures. (L-1)

25. Discuss laboratory safety. (L-2)

26. Properly perform 50 venipunctures. (L-2)