

Medical Microanatomy Study Guide 2005

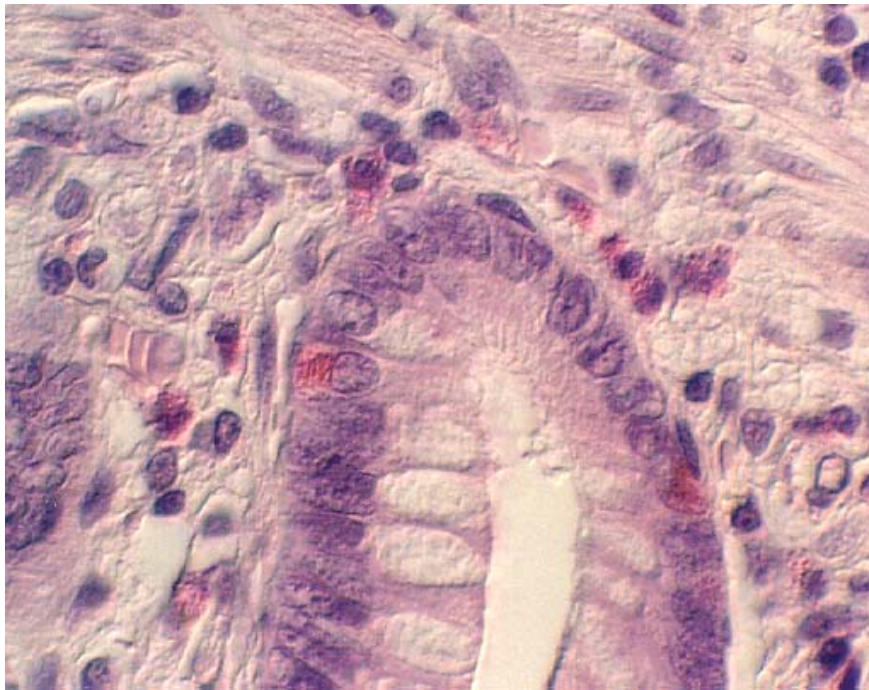


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Course Information

Overall Objectives and Focus

Medical Microanatomy is presented midway in your first year curriculum because it provides a vital bridge between the Cell Biology/Biochemistry of the first 8 weeks and Physiology and Neuroscience during the second semester. It also correlates closely with Gross Anatomy, as you study the organ systems.

An understanding of the function, structure and interrelationships of different organelle and subcellular domains is what you learned in Cell Biology. This information is used again and again as you apply your understanding of cells to the next level of organization in Microanatomy: tissues and organs. Indeed, a third of the questions on the final NBME taken at the end of Microanatomy will come directly from Cell Biology. The remaining will come from the Microanatomy course. Thus, you will need to carry this information forward and retain it. The first week and exams will include reviews of some of the topics. Opportunities to use the material will be presented throughout the course. We will include review sessions the last week to help you do well on this exam.

Thus, the material from the two courses, Cell Biology and Microanatomy, represent a continuum of information to learn and retain. In fact, some of the Microanatomy material will be presented in the Cell Biology course and reviews of this material will continue.

Overview of Course Content

Microanatomy is divided into subdisciplines that are integrated as you learn about each organ system. These are like building blocks, and, early in the course, you will be shown ways to use the basic information to integrate the information in order to remember the structure of organs.

Tissue types:

Once you have mastered the subcellular domains of the cell, the first subdiscipline focuses on how cells are organized in tissues. There are unique molecular and cytochemical markers for these tissue types, as well as unique patterns of embryological development. Learning about the different tissue types will be invaluable in your studies of Pathology and the identification of the origin of tumors.

Three of the tissue types will be presented as part of the Cell Biology course: **Epithelia, Connective Tissue Proper, and Muscle (Skeletal and Smooth)**. You will have an exam over these topics at the end of Cell Biology. Then, we will immediately cover the 4th tissue type, (nervous tissue) during our first week. By the end of the first week, you will have presented to you the 4 basic building blocks of organs.

Specialized Connective Tissues and our Defense system.

After the tissue types are learned, you will learn about specialized connective tissues like bone, cartilage, blood and a relevant system, the immune system. These units complete the study of tissues as they provide interesting information about how our

bodies grow and respond to disease and allergens. Part of the last group includes a study of organs involved in defense and the immune system. So, you will learn about your second group of organs during this period.

Organ systems:

During the second and third parts of the course, you will put the tissues together in solid or hollow organs. You will learn how the 4 basic tissue types work together to help a given organ function. There will be a close correlation with Gross Anatomy. As you dissect a region of the body, for example, you will be studying the histology of the organs in that region.

Importance of histophysiology

A critical subdiscipline of microanatomy is “histophysiology”. It is often the first introduction to function in a particular tissue or organ and is tightly integrated with structure in all presentations. How tissues and organs are structured is the basis for your understanding of their functions. A solid foundation in histophysiology will prepare you well for both Physiology and Pathophysiology next year. We estimate that over half of the board questions on the NBME and other board exams have a histophysiology emphasis, so it is good to build this foundation early, during Microanatomy. Always learn the functions of a region/cell/system. We will work to give you ways to even predict cell function from its structure.

Embryology

The foundation for early embryonic development will be presented in Microanatomy. This is a lecture series that is now focused mainly in the first two weeks. There will be a separate exam over this unit. After the early embryo is “built”, further study of organogenesis will be done in Gross Anatomy. Some of the lecturers will be Microanatomy faculty, however all of this material will be examined with Gross anatomy material. To further focus your learning in this area, a separate study guide will be provided with all of the learning objectives and tools needed to master human embryology. The final NBME exam over embryology will be in the exam given at the end of Gross Anatomy.

Clinical Correlations and Problem Based Learning

Throughout the course you will be presented with clinical vignettes, and examples to help you understand why a core concept needs to be learned. There are many examples in your text. We will also provide opportunities to solve some PBL exercises. This will not be as extensive as in Cell Biology/Biochemistry mainly because we are aware that you will be in class more hours/week during these 10 weeks. Any PBL exercises will be very tightly associated with your basic science learning during this course.

Required Textbooks and Study Guide

The following books are required: (no previous editions allowed)

- 1) **Langman’s Medical Embryology (T.W. Sadler); 9th edition, 2004**

- 2) **Color Textbook of Histology, Gartner and Hiatt, (W.B. Saunders and Co.), 2nd edition, 2001**
- 3) **Histology and Cell Biology, Burns and Cave, 2002, latest edition only.**

You have three excellent texts. In addition, this year we will provide a **Microanatomy Study Guide and an Embryology Study Guide**. Each will contain a complete set of objectives, study hints from each lecturer, and sample questions for each unit or lecture. It is not meant to replace your text! It should guide you through the text to helpful diagrams, pictures, key concepts that you need to know. We want you to use it as a guide to your learning and to practice what you learned. Wherever possible, we will teach you how to remember the material as well as how to learn it. Test yourself by using the objectives as questions. Interact with the material as outlined in the guide and use the sample questions. There are others in the Burns and Cave CD that should also help you practice.

Web Atlas- <http://microanatomy.net> :

Dr. Childs designed a web atlas for the classes at UTMB and she has uploaded it to a new site, making it available for your use. She will upload PowerPoint presentations for this course as well as other helpful study aids. Most of the site contains photos from each of the tissue types and organ systems and it provides a good way to review histology now and in the future.

Lectures

Experienced faculty are lecturing on specific topics that may relate to their expertise. In some cases they have lectured on this topic for many years. That is an advantage in that they have lots of practice teaching the concepts. The purpose of the lecture is to present the core concepts orally and visually in a way that will help you learn it. Perhaps their explanation will be better than that of the textbook. Perhaps they will insert an illustration that is clearer than that in the text. They may also spend more time on a tough concept and ask you to study certain easy concepts in the text on your own.

Finally, the lecture may also present information you need to know that is not in the text. Thus, there is a partnership between the lectures and the text and both are important. This Study guide is designed to provide that link in the partnership. It may include a lecture outline as well as helpful hints that point you to key sections in the text. Both modalities are important to your learning of the material.

PowerPoint presentations: <http://microanatomy.net>

Laboratories

Laboratories are scheduled; however, they recognize you are adult learners. So, if you understand the material and/or have had histology before, you can get the Histology Time computer CD and learn it on your own at home or in the library. However, we will continue the laboratory orientation sessions during the first 20 min of each laboratory.

Students have found these very helpful. Also, the laboratories are offered as great opportunities for those who want or need to come in and interact with faculty and fellow students. It is a great place to get questions answered in an informal environment. Students in the past have enjoyed the CD, Histology Time and find it easy to learn the material from this media. The Histology time program is on all of the computers in the laboratory as well as the Learning Center in the library. You already have experience with it in Cell Biology. The end of this study guide contains all 15 laboratory guides. The section is distinguished by its different colored paper.

If you are using your own computer, the System requirements for the Histology Time CD are:

Macintosh: 120 MHz PowerPc, OS 8.1 or later, 32 Mb or more of installed RAM, 700 Mb hard drive (runs well from CD) We are trying to get an update that will run on OS 10 (without the embedded OS 9.0)

PC/Windows: 166 MHz Pentium Processor or greater, Windows 95, 98, NT, 2000; 32 Mb installed RAM, same as above for hard drive.

The laboratories are greatly improved this year by both equipment and guidance. The learning laboratories on the 8th floor of Ed II now have 160 computers which will provide many more opportunities for students to learn in the lab on their own, if they want to. Also, Dr. Stanley, who will be in charge of the laboratories, has written a study guide for each lab that helps you focus and makes your time more efficient. Finally, we will have some demonstration slides in each laboratory. We will have slide boxes available for those who want to see representative slides in a particular unit. Contact Drs. Childs and Stanley for help with these.

Assessment of your performance

An assessment is really an exam, quiz, or some exercise for which you get a grade (or points). It helps you recognize weaknesses and strengths and also helps faculty recognize areas where we need to spend more time and effort. In the Microanatomy course, the assessments will also recognize that you are adult learners with different learning schedules and we will even respect your chronobiology. This is possible because we are offering self-scheduled exam periods for all but one exam.

Self Scheduling

How does this work? We will advertise the opening of an exam sign up period and you will plan when you want to schedule the exam. Are you a morning person? If so, we will offer times early in the morning on the weekends. Are you a late night person? If so, we offer later evening times that extend even up until midnight. Do you want us to tell you when to take the exam? If so, we have an exam period for those who do not want to self-schedule. The point is, as an adult learner, you will develop a schedule and study pace that will allow you to decide when you want to take the exam, how much time you might need to study, and how to schedule your time with other courses. You will be doing this a lot in your Sophomore year.

Your first self-scheduled exam will be a quiz that will have 25-30 questions covering the first week's material. This will give you practice in scheduling and in handling our exam style. The exams are then scheduled so you will not have to learn more than 2 weeks of new material/exam.

During the exam, you will be allowed a sheet of paper on which you can make notes about your answer. It is important that you note the question key and your answer carefully and compare it with the answer you inserted in the computer. This paper will be turned in to us at the end of your exam and used as a written record of your answers. The questions are delivered randomly, so your answers may not be the final order of the questions in the exam. Therefore, make notes that help you remember them.

Clinical lectures

We will not hold problem based learning exercises in Microanatomy, because you have significantly more class hours to deal with during the next 10 weeks. We want you to have as much time as needed to concentrate on the material in Microanatomy and Gross Anatomy. Faculty are encouraged to give clinical examples in their lecture and their exam questions may include clinically based material that would require a basic science-type answer. In addition, we have added new clinical lectures this year, one in Embryology and one in Reproductive biology. These will be fun and given by experts in the field. We will provide objectives after the lecture and guides so you can apply the material to your basic science learning. There will be 5 questions/clinical lecture on the exam that contains that material.

Comprehension checks

We will hold 3 brief comprehension checks during the course to make certain you understand the material and are keeping up with the reading. These are small quizzes that will be announced during a lecture. They could make a difference, so be on alert for them.

NBME Exam

This is the only exam that is not self-scheduled. The National Board of Medical Examiners exam will cover all material from Cell Biology through Medical Microanatomy. It is a national exam given to medical students all over the country. About 5-10 questions do cover material that we don't teach (found in Medical Neuroscience or Physiology). Don't worry about those, they will be considered in any final point adjustments. The rest of the material we teach is covered well on the exam. As stated earlier, about 30% is Cell Biology and the rest is Microanatomy. Much of the rest is Histophysiology, correlating structure and function. This comprehensive exam will count 20% towards your Microanatomy grade. We will provide reviews and allow nearly a week for studies leading up to the exam. If you have been learning well, this exam will not be as difficult for you, because the questions are focused on core concepts that you will have reviewed several times. The faculty has seen examples of these exams and we make certain that our units present the material.

Appeals

All appeals of questions on the exams are to go directly to Dr. Childs. Because the exams are self scheduled, there will of necessity be a broader time period between the time of the exam and the actual reporting of the grades. We will advertise a period when a written copy of the exam will be available for your review in the Anatomy Office in Ed III. The first wave of appeals are to be emailed to Dr. Childs and/or turned in to the Anatomy Division Office in Ed III. Please do not share your appeals with those who have not taken the exam. You are on the honor system and must not share information at any stage in this process.

Dr. Childs will announce the closing time for the appeals for each exam. The appeals will be reviewed by the lecturer and Dr. Childs and the results reported back (as a collection) to the class. We will make every effort to get your scores back to you as soon as possible, in light of the time needed for self scheduling and appeals. Your computer exam does give you the option of learning your score at the end of the exam, but the key will not be posted until all have taken the exam.

Grading Policy:

Each of the following exercises will give you a set of points to add to your final tally.

Activity	points
Quiz 1	25
Exam 1	40
Embryology	40
Exam 2	60
Exam 3	55
Exam 4	55
Comprehension	15
NBME	75

Required points 365

Important note: Exams 2, 3 and 4 will cover only Microanatomy material. Any embryology material will be covered in Gross Anatomy exams.

Extra points added to final percentage for doing well on NBME

Receive a score at or 10% above the mean on the NBME (e.g. 70-80%) 2 points

Receive a score 20% above the mean on the NBME (e.g. 80-90%) 5 points

Receive a score 30% above the mean on the NBME (e.g. 90%) 8 points

(Note: if you improve as the course develops and do well on the NBME, you can end up with a higher grade, which reflects your improvement. Also, if you do well, this can help

you keep the good grade that you have gotten. So, don't slack off at this point in the course because you could lose a grade letter!)

The grading scale is as follows:		If your points have dropped below the levels needed to maintain a C or better, (assuming you have taken the scheduled exams), you will receive a letter telling you that the exam grades are averaging a D or an F. You will be REQUIRED to attend the tutorial sessions to be announced. Attendance will be taken and an evaluation of your participation will be done by the faculty running the tutorial. The faculty who lecture that week are your tutors. We will share the form that describes the evaluation with you so you know what will be expected of you.
89.58-100%	A	
79.58-89.57	B	
69.58-79.57	C	
65-69.57	D	
below 65	F	

About our teaching faculty...

Most of the Microanatomy Teaching Faculty are very much involved in funded research in diverse areas. They may or may not be teaching you in their research area. One of the things that distinguishes faculty in Anatomical disciplines is their ability to teach multiple organ systems. It is actually a part of their training either as Ph.D. students or as young faculty. In a sense this is good, because these having learned the material in order to teach it makes them very empathetic with those of you who are seeing this for the first time. This makes them eager to share it with you in an informative way. For many of you, this will be your first introduction to some of these organ systems and their functions and we will help you build the foundation you need for pathology and physiology.

The following paragraphs tell you something about each of our faculty. If you are interested in their research area and would like to do a rotation or an honors research program, please feel free to contact them. You will have ample opportunity to get to know them in the laboratory.

E. Robert Burns, Ph.D.

Dr. Burns received his Ph.D. in 1967 from the Department of Anatomy, Tulane University School of Medicine with a minor in human pathology. He completed a NIH Postdoctoral Fellowship in cancer pathology at the George Washington University before joining the UAMS faculty in 1968. His bench research interest is experimental oncology, especially the use of circadian rhythms to enhance the cure rate of chemotherapy drugs. In the mid-1970's he held a Research Career Development Award for 5 years from the National Cancer Institute. Most of his 94 research publications deal with aspects of his cancer research. In 1991, at the request of I. Dodd Wilson, M.D., then Dean of the College of Medicine and now UAMS Chancellor, he switched his emphasis to PreK-14 education outreach, founded and continues to direct the UAMS Partners in Health Sciences (PIHS) program. PIHS is a statewide outreach to PreK-14 teachers and grade 7-14 students in the health sciences utilizing the teaching talents of faculty from all colleges at UAMS. PIHS has been funded by slightly over \$2 million from extramural sources, has reached 17,000 teacher-student participants who have received training in 110

different health science topics taught by 200 different UAMS faculty members. The UAMS PIHS program has received national attention by publication and funding and has involved grade 7-14 students throughout Arkansas, but also in MT, NY, CA, LA, FL, TX, WVa and Taiwan. Dr. Burns has authored/co-authored 4 texts/review books in Histology and currently is serving a 3 year term (2005-2008) as the Charles Hartzell Lutterloh and Charles M. Lutterloh Professor of Medical Education Excellence.

Gwen Childs, Ph.D.

Dr. Childs received her Ph.D. from the University of Iowa in 1972. She has served on the faculty at Northwestern University and the University of Nebraska and from 1980-2000 served on the faculty at the University of Texas Medical Branch in Galveston. She has directed Medical Microanatomy at Nebraska, Northwestern, and she directed the 24 week Basic Science Core courses at University of Texas Medical Branch which was a hybrid curriculum that combined PBL with traditional lecture and lab modalities. She became the Chair of the Department of Neurobiology and Developmental Sciences (formerly Anatomy) in 2000. Her research area is Neuroendocrinology and currently her laboratory has an NIH and an NSF grant to study the regulation and significance of pituitary derived leptin in signalling the nutritional status to the reproductive system. Her lab is exploring the possibility that pituitary leptin might be necessary for the LH surge and ovulation, which may be why fasting, or other eating disorders have such negative effects on the reproductive cycle. They are looking at mechanisms behind the regulation of pituitary leptin and its actions on other pituitary cells. Her other NIH-funded research project focuses on gonadotropes and how they are regulated to bring about non-parallel release of LH and FSH.

Paul Drew, Ph.D.

Dr. Drew received his PhD degree from the University of Maryland and Post-doctoral training at the National Institutes of Health (NIH). His research is funded by the NIH and the National Multiple Sclerosis Society. Dr. Drew is also the Principle Investigator on a multi-investigator grant designed to provide core research facilities for neuroscientists at UAMS, which is funded by the National Institute of Neurological Diseases and Stroke of the NIH

Dr. Drew's Research Interest Include:
Gender Bias in Multiple Sclerosis

The long-term goals of this project are to determine the mechanisms that result in a gender bias in multiple sclerosis (MS). This disease occurs approximately twice as frequently in females than males. Late pregnancy, which is characterized by elevated levels of the female sex steroids estrogen and progesterone, is frequently associated with remission of MS symptoms, and is commonly followed by post-partum disease exacerbation. Sex steroids have been demonstrated to ameliorate experimental allergic encephalomyelitis (EAE), a rodent model of MS. Collectively, these data suggest that sex steroids may modulate the susceptibility to MS.

Regulation of CNS Inflammation by PPAR- γ : Relevance to Multiple Sclerosis

The goal of this project is to determine the mechanisms by which the peroxisome proliferator-activated receptor (PPAR)- γ modulates inflammatory diseases of the CNS, including MS.

Cynthia Kane, Ph.D.

Dr. Kane's laboratory is funded by the NIH National Institute on Alcohol Abuse and Alcoholism to study the molecular and cellular mechanisms which cause Fetal Alcohol Syndrome. The goal of this project is to identify pharmacologic therapeutics to prevent damage to the developing brain. This project uses leading edge technology to studying molecular signaling pathways and gene expression in parallel cell culture, animal, and human models including laser-capture microdissection, DNA microarray, real-time PCR, and other molecular biology methods, proteomic screening and analysis, Western blots, ELISA, immunohistochemistry, immunofluorescence, and quantitative microscopic imaging technology, and biochemical cellular assays for proliferation, survival, apoptosis, and other function metabolic biomarkers. The laboratory would like to recruit a freshman medical student scientist who wants to complete a defined honors research project and be awarded the gold cord for "Honors in Research" upon graduation. Office telephone: 686-7022. Cell phone: 626-9995. Email: kanecynthiaj@uams.edu

Tammy Kielian, Ph.D.

Dr. Tammy Kielian, an Assistant Professor in the Department of Neurobiology and Developmental Sciences, received her B.S. in Biological Sciences from the University of Nebraska-Lincoln in 1991, a M.S. in Immunology from Kansas State University in 1994, and a Ph.D. in Microbiology from the University of Kansas in 1998. Following 2 ½ years of postdoctoral training and a promotion to Research Assistant Professor in Neuroimmunology at Dartmouth Medical School, Dr. Kielian joined the faculty of UAMS in 2001. Dr. Kielian is currently the Principle Investigator on two NIH RO1 grants that bring in over \$600,000 in total costs to UAMS annually; one studying the immunopathogenesis of *Staphylococcus aureus* in the central nervous system (CNS) and the other to identify pattern recognition receptors that are involved in the recognition of *S. aureus* by CNS glia (microglial and astrocytes). A new research direction in Dr. Kielian's laboratory examines the role of neuroinflammation on gap junction intercellular communication in glia and how this may impact neuron viability within the infected CNS parenchyma. Dr. Kielian has 29 research publications on her work related to innate immunity in the CNS and has recently been named as a Full Member of the National Institutes of Health Clinical Neuroimmunology and Brain Tumors Study Section, where she performs peer-review for funding applications throughout the country. Dr. Kielian has been an instructor in Microscopic Anatomy since 2002 where she has participated in numerous laboratory sessions pertaining to the immune system as well as delivering lectures on the gastrointestinal and respiratory tracts.

Bruce Newton, Ph.D.

Dr. Newton received a B.S. degree in Biology from Slippery Rock University, Slippery Rock, PA, and a Ph.D. in Anatomy from the University of Kentucky, Lexington, KY. He performed post-doctoral work in Neuroscience at the University of Rochester, Rochester, NY. Dr. Newton's basic science research interests include the gonadal steroid control of spinal cord development, and sexually dimorphic aspects of sensory inputs to autonomic regions of the lumbosacral spinal cord. His educational research examines at how undergraduate medical education impacts vicarious empathy.

Laura Stanley, Ph.D.

Dr. Stanley received a BA from Hendrix College and an MS and PhD from UAMS. She is directing the Laboratory in Medical Microanatomy. Historically, her area of expertise in research has been the study of glial cell cytokines, such as IL-1 and S100, in the development of Alzheimer's disease type neuronal and extracellular neuropathology. She also has clinical interest in the pineal gland and the role of melatonin in migraine headaches having a sleep disturbance component. Currently, she is focusing only on her teaching responsibilities in cell biology, microanatomy, and neuroscience. Her breadth of knowledge has helped many medical classes in these three areas. Contact information: LCStanley7@aol.com, stanleylaurac@uams.edu, 501-454-7724 (cell phone).

Paul Storer, Ph.D.

Dr. Storer has been a postdoctoral fellow for a number of years and this year he is beginning to assist in the Microanatomy and Gross Anatomy laboratories. His expertise is in neurotrauma and multiple sclerosis.

How to Contact us

Concerns about the material.

Lecturers can be reached by calling Mrs Sharon Bennett at 686-7020 and she will forward the phone call. She can also help with scheduling appointments with them or Dr. Childs. Her office is Shorey 9/32. Usually we try to forward this phone to a support person if Mrs. Bennett is not available. However, be sure and leave your name and the time of your call if you happen to get a voice message.

Faculty may also be reached by email and we encourage you to send them your questions before and after the lecture. They are on the global email list and addresses are duplicated as follows:

Gwen Childs, Ph.D. childsgwenv@uams.edu
Cindy Kane, Ph.D. cjkane@uams.edu

Laura Stanley, Ph.D. lcstanley@uams.edu
Donald Cave, Ph.D. dcave@uams.edu
Paul Drew, Ph.D. pddrew@uams.edu
E. Robert Burns, Ph.D. eburns@uams.edu
Tammy Kielian, Ph.D. tkielian@uams.edu

Concerns about the course.

We will have a class course review committee constituted before the first week that includes the class officers and two additional members of your choosing. Regular meetings with this committee will keep Dr. Childs and the course faculty informed about any problems that have arisen or need to be prevented. This group will report regularly to the class and receive their concerns.

The chain of information flow for course concerns is as follows. First, contact Dr. Gwen Childs. If you still have concerns after talking with her, your next step would be to contact the Associate Dean for Undergraduate Medical Education (Dr. Menna). If you are still not satisfied then you are to see the Executive Associate Dean for Academic Affairs (Dr. Wheeler). Finally, if you are still not satisfied, you are to make an appointment to see the Dean of the Medical school, Dr. E. Albert Reece.

How you can help your learning.

First, recognize that you are ultimately responsible for learning this material. The teachers of each unit will work hard to present it in a way that is helpful to learning. However, a passive interaction with the text or a lecture will not guarantee that you have learned it. A simple reading of the text and attendance at lectures is not a guarantee that you will remember it. Also, cramming the night before an exam is a habit that must be broken in medical school. This will not promote the kind of retention you need to pass board exams or fully understand the concepts, let alone use the concepts when explaining a patient's disease to that patient or to a colleague. Thus, the first thing you can do to help yourself is examine your own learning style and study habits and begin immediately to improve them.

What is your learning style?

There are a number of styles of learning and in the following paragraph, only 3 are described. Are you a visual or auditory learner? An auditory learner will likely get a lot out of the lecture. Some auditory learners even feel that "if a professor has not spoken it, they do not feel confident that they have learned it correctly." A visual learner may get a lot out of the textbook and will also enjoy the diagrams, photos and cartoons during the lecture. A visual learner may be tempted to miss the lecture and may miss out on some important discussion and information that would help them understand the material better. Finally, there is another type of learning style which could be characterized as kinesthetic. This learner responds to multiple sensory stimuli and likes to be "turned on" by a lecture or text. They might be bored by a non-stimulating talk or lecture that has a lot of text slides and few graphics. This group of students might enjoy learning in group discussions, sessions in the laboratory, problem solving, etc. If you know this about yourself and are a successful learner, you may have already figured out ways to be

stimulated in a learning experience. Finally, you may have multiple learning styles, with strength in 1-2.

The Microanatomy course respects different types of learners and even caters to them by offering different ways to learn the material. These are called modalities and they include laboratory, text readings, lectures, and problem solving exercises. The same material is thus shown in different formats. It is important for you to recognize where you fit in and what helps you the most. If you are having difficulties, one of the first things a tutor or the course director may ask you is “what is your learning style”? Then, we might show you how to use the modalities that will help you the most. Obviously, we can’t “cure” everything in a given course period, like one lecture that is not as clear or as stimulating as another. However, we can help you learn how to use a study approach that helps you learn the material and is not dependent on any one modality. Maybe we can find a group of successful students that learn the way you do and hold a brief discussion so they could share their ideas about what helps. Also, we at UAMS will help you adapt and maybe improve the diversity of your learning styles. For example, if you are a kinesthetic learner and totally bored by a lecture, we could suggest ways that you may make it stimulating (without disrupting the class) and productive for yourself. If you are a visual learner, we could suggest ways of note-taking that would help during a lecture.

Active vs passive learning.

We hope that you have already learned how to be an “active learner”, whatever your style. If you have not, then that is the first thing you need to accomplish to be successful in medical school. It is vital that you interact with the material, placing it in a context that helps you remember it. There are lots of ways to interact with it and we will provide some stimuli along the way. Here are some things you can do:

- 1) **READ THE TEXT ASSIGNMENT BEFORE THE LECTURE.**
 - a. Before each lecture, read the reading assignment and the tutorials in the Study Guide. Then, as you read, make your own outline. You might also turn the text headings into questions and quiz yourself. This is “active learning” and puts the material into your own words. Find the clinical relevance sections and learn about diseases. This will be stimulating and help you remember the material, since you are ultimately going to use it in that context. Write question about things that are unclear from the text. **Then, bring your text, outline and questions to class and use them actively during the lecture.** How will this help you?
 - b. If you are a visual learner, you will be ahead of the game during the lecture. You won’t have to worry about scribbling notes as you recognize a section that is well described in the text. You can fill in any details in your outline, even if the lecturer does not follow the same outline as the book. You can concentrate on the parts of the lecture that are more difficult, if you are not scribbling.
 - c. Or, use the outlines that we give you, if you don’t want to make your own. Please understand, however, that the more you interact with the material,

the easier it will be to learn. So, making outlines and organizing information is a great learning tool.

- d. If you are an auditory learner, you will enjoy the listening to the lecture more because you will already know something about the topic. You might even anticipate what the lecturer might say, which is good practice of what you have learned. You can raise questions that come up during the lecture (because you will know that they are not answered in the text).
- e. Finally, if you are a kinesthetic learner, then you will have created outlines or diagrams that are unique and stimulating to work with during the lecture. Maybe you drew a flow chart, picture, or diagram, etc. Fill in the parts during the lecture, anticipating what the faculty said. Be alert to clinical vignettes that will turn you on to the material. Remember them and their significance and you are well on your way!
- f. Listen or look to see if your questions are answered during the lecture. If they aren't, raise your hand or come up and see the lecturer. Having a question about the material and getting it answered is a good thing. It actually helps you learn it. All questions are welcome!!

2) EMAIL THE LECTURER.

- a. Before the lecture and after reading the chapter, you can always email the faculty member about anything that is unclear. He/She may be able to answer your question in the email, and they will be alerted as to material that may need more emphasis. That will be a really great way to let the faculty member know that something will be difficult. After the lecture and in the lab you can also find the faculty member and will be able to get more questions answered.

3) RESPECT FACULTY NEED TO SCHEDULE

- a. We love to teach and share ideas. We faculty are very stimulated by students, especially those with questions or who want to explore the significance of the material. This is one of our favorite activities in this department. However, please also recognize that we are running research programs and sometimes we may have to ask you to make appointments, or we might not be at our desk answering emails all day. The lab is a great place to find us. Some of us do answer emails on the weekend and even after midnight...so do not be discouraged. We will give you alternative tutors that will help you, even on the weekends.

4) TEACH EACH OTHER.

- a. Talk to your fellow students about the material and share any questions. They may have different levels of expertise and can help you. Maybe we can set up an FAQ on your website. We would be happy to help with this

if your webmaster would like it. We could share questions and answers that come up about each unit.

5) **TEACHING HELPS LEARNING.**

- a. Practice teaching the material to a class mate. This might be a fun exercise where you decide to divide up the material in a chapter and each present a section to the other. Kinesthetic learners, who are also extroverts, like to interact this way and it might even be an efficient way to learn and remember. Who knows, one of your classmates may explain it better than either the text or the lecturer. There is a big advantage to being taught by someone who has just learned the material, since they know its level of difficulty and will pace their explanations accordingly. Be sure and check the facts, however. The text and the lecturer are the last word.

6) **USE THE GUIDES PROVIDED.**

- a. Use all of the guides, sample questions, and problem solving exercises to help you learn the material and try to learn it as soon after it is presented as possible. Don't wait until the material piles up.

7) **QUIZ YOURSELF AND PRACTICE, PRACTICE, PRACTICE.**

- a. Use your topic outlines and questions to quiz yourself. Make your own diagram, flow charts or tables to help you remember it. Some visual learners actually "take a picture" in their mind of their diagram or flow chart and can "recall the picture". Auditory learners actually replay a tape of what they heard from the teacher in their mind. Kinesthetic learners may remember a relevant problem or case that stimulated them and may put the information in that context. You may have a combination of "remembering" styles and can work with all three approaches. **However you do it, make certain you begin well before the exam and practice, just as if you were solving math problems.**

Be an active learner

The above are only some of the things that describe a person who is an active learner, eager to put the material in a context that they can remember as they study medicine. What is a passive learner? A passive learner may do all of the reading assignments, go over the study guide, attend lecture and think they know the material. Then, when he/she gets a problem to solve on the exam, they are stumped. They did not remember the facts (simple memorization did not help), or they had never used the facts in a way that helped them remember. They relied on sheer memory, maybe crammed in their brain the night before. It would be like taking a math exam without doing any homework or working any problems. You would never do that in a math class and yet learning in Microanatomy is similar. Cramming and memorizing might work for small exams, however it will never work for the really big comprehensive exams that will determine your future.

Going through the motions without interacting with the material will never get you to the place you ultimately want to be. Being a passive learner will also cause a great deal of stress whenever you face big chunks of material that need to be remembered and

you have only a short time to study. This won't happen is if you start the learning process early. So, look for ways to be an active learner and you will actually find medical school more fun and less stressful.

LECTURE AND LAB SCHEDULES AND GUIDES

Week 1 Schedule: Basic tissues and early embryology

Day	Date	Time	Event	Subject	Faculty	Text Assignments
M	Oct. 10	9:00	Intro	Introduction to course	Childs	
M	Oct. 10	10:00	Lecture 1	Nervous System I	Newton	B&C(Ch6); G&H- 183-198, 203-210, 215-217
M	Oct. 10	11:00	Lecture 2	Nervous System II	Newton	See above
T	Oct 11	9:00	Lab 1	Nervous system histology	Stanley, Newton, Childs, Kane	Histology Time CD
T	Oct 11	11:00	Lecture 3	Fertilization and embryogenesis I	Kane	L Ch 1-2
W	Oct 12	10:00	Lecture 4	Embryogenesis II	Kane	L Ch 2-3
W	Oct 12	11:00	Lecture 5	Embryogenesis III	Kane	L Ch 3-4
Th	Oct 13	10:00	Lecture 6	Early Embryology IV	Kane	L Ch 4-6
Th	Oct. 13	11:00	Lecture 7	Embryology of the Peripheral and Autonomic NS- I	Newton	L 433-447, 474-478, 95
Th	Oct 13	4:15	Tutorial		Lecturers	
F	Oct. 14	9:00	Lecture 8	Embryology of the Peripheral and Autonomic NS- II	Newton	L 433-447, 474-478, 95
F	Oct 14	10:00	Lab review	Review of basic tissues	Cave, Childs, Stanley, Burns	G&H85-108; B&C 45-5379-90

Key (colored copies of schedule only): Blue= Microanatomy-Gross Anatomy correlates; Red=Embryology; Green=Tutorials B&C=Burns and Cave; G&H=Gartner and Hiatt; L=Langman

Tutorial: Ed III Conference room.

All Lectures, Clinical Lectures and Reviews: Held in Ed III Building, Room G219 (Pauly Auditorium).

All Laboratories: Self-Study using Downing "Histology Time" CD with faculty present in the 8th floor laboratories Ed II building.

Self Scheduled Quiz 1

Self scheduled Exam on Basic Tissues, 25 questions covering Epithelia (3), Connective tissue (4), Muscle (3), and Nerve-10 lecture, 5 lab. Available Thursday, Oct 13 and through Monday, Oct 17th. At midnight. Allow 1 h.

Lectures 3-7: Embryology I: Fertilization and Week 1
Please see Embryology Study guide.

Lectures 1 and 2: Nervous Tissue I and II

Dr. Newton

Reading Assignment:

Guides to studying this unit

1. As a minimum read the assigned material in Burns and Cave textbook.
2. Helpful figures in Gartner and Hiatt are: 9-2 to 8, 9-13 to 19, 9-21, 9-22, 9-24, 9-30

Learning Objectives

At the end of this unit the student should be able to:

1. Compare and contrast the structural features of individual central nervous system neurons with the different glial cell types associated with these cells.
2. List the key functional role of each type of central nervous system glial cell.
3. Describe the outstanding characteristics of such specialized features of nervous tissue as: axonal transport, conduction of an action potential, myelination and the blood brain barrier.
4. Describe the structural arrangement of a mixed peripheral nerve and label the cellular (neuronal, glial and connective tissue cells) components observed in a tissue section prepared in a longitudinal and a transverse plane.
5. Contrast between sensory and autonomic ganglia according to their location, structural arrangement and functional significance.
6. Describe the general arrangement of the Autonomic Nervous System and contrast between the location and function of sympathetic and parasympathetic components of the system.

Sample Questions

Answers are at the end of this Unit)

1. Your adolescent patient presents with restlessness, malaise and fever a few days after suffering a dog bite on the hand. Restlessness increases in a few days to uncontrollable excitement with excessive salivation and painful spasms of the laryngeal muscles. You suspect early stages of rabies and from your training you remember that the rabies virus can be transported retrogradely through peripheral nerves to reach the spinal cord and brain. What would be the mechanism by which the virus affects salivary glands and laryngeal muscles?

- A. Retrograde transport from the brain through efferent nerves.
- B. Wallerian degeneration of salivary gland and laryngeal motor nerves
- C. Anterograde transport from the brain through efferent nerves
- D. Degeneration of the myelin sheath surrounding salivary and laryngeal motor nerves

2. Which of the following is not a characteristic of a multipolar neuron in the central nervous system?

- A. The perikaryon contains many Nissl bodies
- B. The perikaryon is surrounded by satellite cells
- C. There are more than 2 dendrites extending from the perikaryon
- D. There is only one axon extending from the perikaryon

3. Traumatic brain injury results in the activation of several types of central nervous system glial cells, setting in motion a cascade of events that result in the phagocytosis of damaged cells and tissue from the injury site. Which glial cell has a primary responsibility for removal of this debris?

- A. Astrocyte
- B. Oligodendrocyte
- C. Microglial cell
- D. Schwann cell
- E. Satellite cell

Answers to Questions

1. C, 2. B, 3. C

Lectures 3-7: Embryology I: Fertilization and Week 1
Please see Embryology Study guide.

Week 2: Integument, Blood and lymph vessels, Bone and Cartilage

Day	Date	Time	Modality	Topic	Faculty	Text assignment
M	Oct 17	8:00	Exam	Final seating for Quiz on tissues		
M	Oct 17	9:00	Lecture 9	Embryology: Musculoskeletal System	Kane	L Ch 8-9
M	Oct. 17	10:00	Lecture 10	Integument and Breast	Kane	G&H Ch 14 & 20
M	Oct. 17	11:00	Clinical	Neural Axis Malformations	E. Albert Reece	
T	Oct. 18	9:00	Lab	Integument and Breast	Kane, Stanley, Drew, Childs	
T	Oct 18	11:00	Lecture 11	Blood and lymph vessels	Drew	B&C 123-130 G&H-251-256, 259-267, 270-271
W	Oct. 19	9:00	Lab 3	Blood and lymph vessels	Stanley, Drew, Childs, Kane	
W	Oct. 19	11:00	Lecture 12	Bone and Cartilage	Stanley	B&C Ch 9; G & H Ch 7
Th	Oct 20	9:00	Lecture 13	Bone Development	Stanley	
	Oct 20	10:00	Lab 4	Bone, Cartilage and Bone Development	Childs, Stanley, Drew, Kane	
Th	Oct 20	4:15	Tutorial		Lecturers	
		9:00	Tutorial	Q and A session as needed	All lecturers	
F	Oct 21	10:00	Lab Rev	Catch-up in lab and review	All Lecturers	

Key: (on colored copies of schedule) Blue= Microanatomy-Gross Anatomy correlates; Red=Embryology; Green=tutorials

B&C=Burns and Cave; G&H=Gartner and Hiatt; L=Langman

All Lectures, Clinical Lectures and Reviews: Held in Ed III Building, Room G219 (Pauly Auditorium).

All Laboratories: Self-Study using Downing "Histology Time" CD with faculty present in the 8th floor laboratories Ed II building.

Exam I: Skin, Blood vessels, Lymph vessels, Bone, Cartilage
(7 lectures, 3 labs)+ 5 review questions=40 points; Self schedule
Thursday 4-midnight; Friday 4-6; Sat 10-6; Sunday noon-midnight;
Monday 4—midnight; allow 2 h

Lecture 10: Integument, Including Mammary Gland

Dr. Kane

Reading Assignment:

Gartner and Hiatt Ch 14 & 20

Learning Objectives:

Without reference materials, the student should be able to:

1. Define the functions of the integumentary system
2. Identify and define structural and functional elements in the epidermis, dermis and hypodermis, including
 - a. Molecules and their functions
 - b. All cell types and their functions
 - c. Functional organization and arrangement of tissues
 - d. Structural and functional layers
 - e. Appendages: hair follicles, nails, and glands (including mammary gland)
 - f. Vascularization, including arteriovenous anastomoses
 - g. Innervation, including sensory receptors

Key figures: 14-1, 14-2, 14-3, 14-4, 14-6, 14-7, 14-8, 14-9, 14-10, 14-11, 14-12, 14-14, 14-15, 20-18, 20-19, 20-20

Key tables: 14-1
3. Define regional variation and its functional significance in the normal integument, including thick and thin skin
4. Identify and define structural and functional elements of the mammary gland. In doing so,
 - a. Compare and contrast the prepubertal, resting, pregnant, and postpartum/lactating gland
 - b. Describe the hormonal regulation of each physiologic state
 - c. Compare and contrast the secretory products of each physiologic state
5. Describe common and rare diseases of the integument, including nail defects, acne, psoriasis, warts, keloids, elastosis, seborrhea, keratosis, pemphigoid diseases, basal cell carcinoma, squamous cell carcinoma, melanoma, Kaposi's sarcoma, and breast cancer

Competencies:

1. Apply state-of-the-art knowledge of molecular, cell and tissue biology to describe in detail the structure and function of the integument (including breast) to:
 - a) the general public
 - b) professional peers

2. Given patients with either common or rare diseases of the integument, apply state-of-the-art knowledge to correctly diagnose the condition and appreciate its seriousness.
3. Communicate knowledge-based information to patients regarding the underlying cause and consequences of common and rare diseases of the integument.

Sample questions:

1. When stained immunohistochemically, a malignant fibrous histiocytoma of the connective tissue is found to be positive for keratin. Transmission electron microscopy (TEM) is ordered to confirm the presence of keratin in this tumor of mesodermal origin. Which of the following structures would be seen in or around the tumor cells?

- A. Cell arranged like keratinocytes
- B. Desmosomes
- C. Granules filled with keratin
- D. Intracytoplasmic inclusions filled with keratin
- E. Tonofilaments

Answer: E (excerpted from Burns and Cave text p. 249, Q20; also refer to answer explanation on p. 264)

2. A patient with a deep cutaneous wound over the anterior tibia comes to your office because the wound has failed to heal. You explain that normal wound healing proceeds with proliferation of _____ which resynthesize the extracellular collagen matrix of the dermis. Remodeling of the collagen fibers causes shrinkage of the wound margin and ultimate closure of the wound. Epithelial proliferation and migration across the newly formed dermis progresses to provide the barrier function of the skin.

- A. Fibroblasts
- B. Keratinocytes
- C. Langerhans cells
- D. Lymphocytes
- E. Smooth muscle cells

Answer: A

3. Histologic defects in desmosomes due to autoimmune reaction against desmoglein is characteristic of pemphigus vulgaris disease. The primary consequence of this dysfunction is:

- A. Dyshesion between keratinocytes
- B. Thickening of the stratum basale
- C. Loss of melanocytes
- D. Reduction in keratohyalin granules
- E. Hyperkeratosis

Answer: A (modified from Burns and Cave text p. 249 Q18; also refer to answer explanation on p. 263)

4. During pregnancy, estrogen and progesterone induce growth of mammary glands and production of colostrums. Estrogen and progesterone levels decline a few days after birth. At that time, which of the following hormone(s) stimulates production and secretion of milk from the lactating breast?

- A. Prolactin
- B. Oxytocin
- C. Somatotropin
- D. A and B only
- E. A, B and C

Answer: D

Study Guide:

Read and outline Gartner and Hiatt text Chpt 14, pp. 325-342 and Chpt 20, pp. 483-486 before lecture.

Review by self-study all four basic tissue types, with particular emphasis on epithelial cell and tissue structure and functionality.

Emphasize clinical correlates in both textbooks:

Gartner and Hiatt pp. 330, 334, 337 and 486

Burns and Cave pp. 94-96, 98-99 and 215

Work practice problems in Burns and Cave text CD:

Skin/Connective Tissue = 28Qs

Reproductive System (includes 5 mammary gland Qs)

Helpful Hints:

Many students find it helpful to prepare for Objectives #2 and #4 by drawing from memory simple diagrams of figures in the textbook (refer to key figures above), label the structures with descriptors as in the text, and annotate details to each descriptor regarding:

- a. the structural and functional significance of each molecule, cell and tissue
- b. the functional and regulatory inter-relationships between cells and tissue

In addition, these diagrams can serve as useful instruments for organizing study for the remaining objectives as well as the exam.

Burns and Cave textbook can serve as a good review and as a good 'self-check' of your learning.

Lecture 11: Blood and Lymph Vessels

Paul Drew, Ph.D.

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Reading assignment:

Gartner and Hiatt, Chapter 11- Circulatory System, pp 251-267, 270-271; Burns and Cave, Chapter 11 Cardiovascular System, pp 123-130.

Learning Objectives

At the end of this unit the student should be able to:

1. Label the three layers or tunics of a blood vessel wall and describe the histological features of each layer.
2. Describe the histological features of the major classifications of arteries and veins and list the functional role of the different types of vessels.
3. Distinguish lymphatic vessels from veins and describe how changes in hydrostatic pressure and osmotic pressure affect formation of tissue fluid. Describe how changes in vessel structure/function can lead to increased extracellular fluid or edema.
4. Compare and contrast the structural arrangement and functional significance of continuous, fenestrated and sinusoidal capillaries.

Sample Questions

(Answers are at the end of this Unit)

1. Which of the following would be a distinguishing characteristic of an arteriole?
 - A. The thickness of the tunica media is approximately equal to the diameter of the vessel lumen
 - B. There are multiple layers of endothelial cells lining the lumen
 - C. There are large gaps between adjacent endothelial cells
 - D. There are no muscle fibers present in the tunica media
 - E. Muscle in the tunica media is oriented longitudinally, along the length of the vessel
2. You volunteer for a clinical trial of an experimental drug whose only action is to cause rapid and prolonged (10 minutes) contraction of smooth muscle of metarterioles in the hands. You are convinced that you are taking the experimental drug and not the placebo because one of the following symptoms occurred within 5 minutes of taking your pill. What did you experience?
 - A. Your hands became very swollen
 - B. Your hands became sensitive to light touch

- C. Your hands turned bright red
 - D. Your hands became cold
 - E. There was no detectable effect
3. What type of blood vessel would match the following description? “Elastic fibers present in tunica intima, lumen diameter is larger than the thickness of the tunica media, muscle in tunica media is oriented in a circular plane around the lumen, hydrostatic pressure is low”
- A. Elastic artery
 - B. Muscular artery
 - C. Sinusoidal capillary
 - D. Muscular vein
 - E. Large vein (vena cava)

Answers to questions

1. A, 2. D, 3. D

Lecture 12: Bone and Cartilage

Dr. Laura Stanley

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Microanatomy 2005

Reading Assignment:

Burns & Cave, Chapter 9 pp. 101-106 (to histogenesis of bone), 112-113.

Gartner & Hiatt, Chapter 7 pp. 129-143, 152-154.

Suggestion: Read headings and bold words and study the pictures in Gartner & Hiatt, then read Burns and Cave. After this, go back and read Gartner and Hiatt more thoroughly.

Review: Gartner & Hiatt Chapter 6 pp. 109-112 and 124; Burns & Cave Chapter 5 pp. 56-63 (connective tissue).

Learning Objectives

At the end of this unit, the student will be able to:

1. Compare and contrast bone and cartilage.
2. List the embryonic origins and distinguishing characteristics of osteoblasts, osteoclasts, and osteocytes; and explain the functions of each cell type mentioning associated cellular products.
3. Describe the sources and mechanisms of action of stimulators or inhibitors of osteoclast activity with emphasis on parathyroid hormone and calcitonin.
4. Describe the microanatomical structure of compact and cancellous bone being sure to point out similarities and differences between these two types of bone.
5. Define Haversian and Volkmann's canals and describe how blood vessels reach these two canals from larger arteries that supply compact bone.
6. Distinguish between active and non-active periosteum being sure to mention Sharpey's fibers, and compare and contrast periosteum with endosteum.
7. Compare and contrast the three types of cartilages mentioning characteristic anatomical locations, matrix proteins, presence or absence of perichondrium, and isogenous groups.

Competencies

A patient comes into your clinic complaining of pain and stiffness in the knees upon awakening. You diagnose them as having osteoarthritis, a degenerative condition of

articular cartilage. Using your knowledge of the microanatomy of bone and articular cartilage, how would you explain the pain and stiffness the patient is experiencing?

Rather than using estrogen to treat osteoporosis in a postmenopausal woman, you prescribe bisphosphonate. She asks you how this drug works. What would you tell her?

Lecture Outline

- 1) Comparison of Bone and Cartilage
- 2) Bone
 - a. 2 Types of Bone
 - i. Appearance
 - b. Bone Cells
 - i. Osteoblast
 - ii. Osteocytes
 - iii. Osteoclast
 - c. Compact Bone
 - i. Organization
 - ii. Osteon
 - d. Blood Supply
 - e. Cancellous Bone
 - i. Characteristics
 - f. Periosteum
 - i. Active
 - ii. Mature
- 3) Cartilage
 - a. Distribution
 - b. General Characteristics
 - c. Cells
 - i. Chondroblasts
 - ii. Chondrocytes
 - d. Hyaline Cartilage
 - i. Articular Cartilage
 - ii. Synovial Membrane
 - e. Elastic Cartilage
 - f. Fibrocartilage

Sample Questions

Which of the following is characteristic of hyaline cartilage?

- A. Fewer chondrocytes than fibers
- B. Interterritorial matrix [GAG's] > territorial matrix [GAG's]
- C. Periosteum except at articular cartilage
- D. Isogenous groups arranged in rows
- E. Appositional growth

Answer: E

Production of osteoid could be impaired by all of the following EXCEPT:

- A. Vitamin C deficiency
- B. Osteoprogenitor cells failing to differentiate
- C. Inability to synthesize type IV collagen
- D. Scurvy
- E. Abnormal death of numerous osteoblasts

Answer: C

Lecture 13: Bone Formation

Dr. Laura Stanley

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Microanatomy 2005

Reading Assignment:

Burns & Cave, Chapter 9 pp. 106-113

Gartner & Hiatt, Chapter 7 pp. 144-152

Learning Objectives

At the end of this unit, the student will be able to:

1. Compare and contrast endochondral and intramembranous ossification being sure to name bones of the skeleton formed by each type.
2. List and explain the steps in endochondral ossification.
3. Name the type of cartilage that forms the cartilage model in endochondral ossification, and name the type of ossification by which the bony collar forms around this model.
4. Name and explain the growth zones of the epiphysis or epiphyseal plate during endochondral ossification starting at the articular cartilage and moving toward the bone marrow cavity.
5. Compare and contrast calcification of cartilage and mineralization of osteoid being sure to describe the steps of each.
6. Distinguish between spicules undergoing endochondral ossification or intramembranous ossification by describing the layers of each beginning with the cells lining the layer closest to the marrow cavity and ending with the layer that composes the core of the spicule.
7. Compare and contrast long bone growth in length versus width.
8. Define woven and lamellar bone associated with intramembranous ossification.
9. Explain remodeling and repair of bone.
10. Compare and contrast Osteoprogenitor cells in cancellous and compact bone.
11. Describe the hormonal and nutritional regulation of bone growth being sure to mention each of the following: Somatotropin, Somatomedin, Testosterone, Estrogen, and Vitamins A, C, and D.

Competency

As a pathologist, you use light microscopy to view a slide of undecalcified bone stained with a trichrome stain and see an abnormally thick layer of unmineralized osteoid. What would you suggest testing for in the patient's blood? Could poor diet cause this

condition? Name one organ that might undergo chronic failure leading to this condition?
What endocrine organ might be overactive and cause this condition?

Lecture Outline

1. Two Types of Bone Formation
 - a. Examples of Bones
2. Endochondral Ossification
 - a. Process
 - i. Hyaline Cartilage Model
 - ii. Vascularization of Perichondrium
 - iii. Bony Collar
 1. Calcified Cartilage Spicules
 - iv. Periosteum Vascular Bud
 1. Primary Center of Ossification
 - v. Osteoid Formed
 - vi. Secondary Center of Ossification
 - b. Calcification of Cartilage
 - c. Mineralization of Bone
 - d. Spicule Microanatomy
 - e. Long Bone Growth
 - i. Length vs. Width
 - ii. Epiphyseal Plate
 - f. Summary
3. Intramembranous Ossification
 - a. Process
 - i. Mesenchyme
 1. Primary Bone Formation (woven)
 - a. Primary Ossification Centers
 - b. Woven Bone Spicules
 - c. Bone Marrow
 2. Secondary Bone Formation (lamellar)
 - a. Cancellous
 - b. Compact
4. Miscellaneous Topics
 - a. Osteoid
 - i. Fresh
 - ii. Mineralized
 - b. Comparison of Spicules
 - c. Remodeling of Bone
 - d. Osteoprogenitor Cells
 - i. Cancellous Bone vs. Compact Bone
 - e. Repair of Bone
 - f. Regulation of Bone Growth (formation)
 - i. Hormonal

ii. Nutritional

Sample Questions

The specific characteristic that distinguishes a spicule during endochondral ossification from a spicule undergoing intramembranous ossification is:

- A. Osteoblasts lining the surface of the spicule
- B. A layer of mineralized osteoid
- C. Osteocytes within lacunae
- D. Calcified cartilage
- E. All of the above

Answer: D

Which one of the following results immediately from the formation of the bony collar during endochondral ossification?

- A. Degeneration and death of chondrocytes
- B. Formation of a secondary center of ossification
- C. Osteoid is deposited on calcified spicules
- D. Growth in length of bone
- E. Uncoupling of osteoclast and osteoblast activity

Answer: A

Week 3 Schedule: Blood; Defense/Immune system

<i>Day</i>	<i>Date</i>	<i>Time</i>	<i>Modality</i>	<i>Topic</i>	<i>Faculty</i>	<i>Text assignment</i>
M	Oct 24	8:00	Exam	Last seating for Exam I	Childs/ Stanley	
M	Oct. 24	10:00	Lecture 14	Blood	Drew	B&C Ch 12; G&H Ch 10
M	Oct. 24	11:00	Lecture 15	Blood cell development/bone marrow	Drew	
T	Oct 25	9:00	Lab 5	Blood, Blood cell development/bone marrow	Drew, Stanley, Kielian, Burns	
T	Oct 25	11:00	Lecture 16	Defense I	Drew	G&H Ch 12; B & C Ch 13
W	Oct 26	8:00-11:00	GROSS ANATOMY			
Th	Oct 27	9:00	Lecture 17	Defense II	Drew	
Th	Oct 27	10:00	Lab 6	Defense II	Drew, Stanley, Kielian, Burns	
*Th	Oct 27	4:15	Tutorial		Lecturers	
F	Oct. 28			No Microanatomy class – Gross Anatomy exam		

Self scheduled Early Embryology Exam:

8 lectures X 5 questions/lecture=40 questions. Allow 1 h and self scheduling all week, beginning Monday PM, October 24th.

Lecture 14 and 15: Blood/Bone Marrow

Paul Drew, Ph.D.

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Reading assignment:

Gartner and Hiatt, Chapter 10- Blood and Hemopoiesis, pp 219-250; Burns and Cave, Chapter 12- Blood Cells and Their Formation, pp 133-145.

Learning Objectives:

- 1) Describe the constituents of blood. Define and possess a working knowledge of the terms: Formed Elements, Plasma, Plasma Proteins, and Serum.
- 2) Describe the relative size, number and life span of peripheral blood cells (Hint: See Burns and Cave, Table 12-1). Define and possess a working knowledge of the terms: Hematocrit, Blood count, and Differential Count. Understand the potential clinical relevance of abnormal Hematocrits, Blood Counts, and Differential Counts.
- 3) Define the function of Erythrocytes (RBCs). Relate the structure of erythrocytes to their function. Discuss mutations in erythrocyte-associated proteins such as hemoglobin and spectrin, and the clinical consequence of these mutations.
- 4) Possess a working knowledge concerning Anemias. Hint: See Burns and Cave Table 12-2.
- 5) Define the structure and function of Platelets.
 - Discuss the biogenesis of platelets- ie platelets are derived from fragments of megakaryocyte cytoplasm.
 - Morphology of Platelets: Define Granulomere, Hyalomere, granules associated with platelets.
 - Discuss the function of platelets and the clinical significance of 1) altered platelet function and 2) altered relative number of platelets in peripheral blood.
- 6) Compare and contrast the morphological and functional characteristics of leukocytes (WBCs) including granulocytes (Hint: see burns and Cave, table 12-3), lymphocytes, and monocytes. Consider the clinical consequence of altered function or relative abundance of individual types of leukocytes.

- 7) Define inflammation. Identify the classic signs of inflammation. Compare and contrast Acute Inflammation vs. Subacute Inflammation vs. Chronic Inflammation. Define how changes in the relative abundance of immature (band/stab) leukocytes in the peripheral blood may be important in clinical diagnosis of inflammatory disorders.
- 8) Describe the temporal pattern of blood formation prenatally and postnatally in the human- Blood islands, Liver and Spleen, Red Bone Marrow. Discuss Extramedullary Hematopoiesis.
- 9) Describe the histology of red bone marrow- Stroma, Parenchyma, Hematopoietic cords, sinusoids.
- 10) Describe the relative distribution of hematopoietic cells within bone marrow parenchyma. Discuss the potential clinical relevance of altered Myeloid/Erythroid cell ratio (M/E ratio) in the bone marrow parenchyma.
- 11) Students must understand the “Stages of Hematopoiesis”. These stages are outlined in Burns and Cave, pp 140-142. Burns and Cave, Fig 12.1 is particularly helpful as an aid to understanding this material.
- 12) Students must understand the “Histology of Blood Cell Precursors”. This material is outlined in Burns and Cave, pp 142-144. Burns and Cave, Fig 12.1 is particularly helpful as an aid to understanding this material.
- 13) Clinical Correlates: Describe how abnormal hematopoiesis may result in blood disorders including leukemias. Describe the potential clinical utility of hematopoietic stem cells.
- 14) Students must be able to identify specific mature cells from blood preparations and immature cells from bone marrow preparations. Students must also understand the structure and function of these cells, as outlined above. In addition to the Gartner and Hiatt, and the Burns and Cave texts, the Histology Times program will be particularly valuable as an aid in identifying blood and bone marrow cells. However, it should be understood that images used for examination purposes are not restricted to these sources.

Competencies:

- 1) Apply knowledge concerning blood to diagnose abnormalities of the blood, and furthermore, to explain these abnormalities to a patient.
- 2) Apply knowledge concerning hematopoiesis to diagnose and treat diseases associated with aberrant hematopoiesis.

Sample Questions:

- 1) Hereditary spherocytosis involves a genetic defect, which results in which of the following?
- A) Change in the structure of the protein spectrin
 - B) Decrease in the area of the hyalomeres
 - C) Change in the structure of the globin protein
 - D) Decrease in the diameter of the affected cell
 - E) Increase in the size of the hyalomere region of the cell

(Answer: A; modified from Burns and Cave, question #48, p. 252)

- 2) An 18-year-old patient undergoing chemotherapy for metastatic melanoma develops severe neutropenia. Which of the following agents would most likely be administered to treat this side effect of chemotherapy?
- A) Colony-forming unit-erythrocyte (CFU-E)
 - B) Colony-forming unit-granulocyte macrophage (CFU-GM)
 - C) Erythropoietin (EPO)
 - D) Granulocyte colony-stimulating factor (G-CSF)
 - E) Monocyte colony-stimulating factor (M-CSF)

(Answer: D; modified from Burns and Cave, question #10, p. 278)

Lectures 16 and 17: Defense System

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Reading assignment:

Gartner and Hiatt, Chapter 12- Lymphoid (Immune) System, pp 273-299; Burns and Cave, Chapter 13- Immune System, pp 146-160; Drew Handout- Defense System, pp 1-7.

Learning Objectives:

- 1) Describe the general functions of the immune system.
- 2) Describe the function of individual cells of the immune system. Hint: see Burns and cave, Table 13-1.
- 3) Compare and contrast Innate vs. Adaptive Immunity.
- 4) Compare and contrast the two forms of Adaptive Immunity: Humoral vs. Cell-Mediated Immunity.
- 5) Describe “Clonal Expansion of T and B-lymphocytes” and the importance of clonal expansion in host immune response. In your description, include concepts including “lymphocyte activation”, “clonal expansion of lymphocytes”, “ gene rearrangement”, “antigen specificity”, “antigen receptors” (ie T-cell and B-cell receptors), “effector lymphocytes”, “and memory lymphocytes”.
- 6) Describe Immune Tolerance.
- 7) Discuss Antigen Presentation. Include in your discussion terms including “antigen presenting cells”, “antigen”, “epitope”, “T-cell”, “TCR”, and “MHC”. Compare and contrast antigen presentation by MHC class I vs. MHC class II molecules (i.e. on which APCs are these molecules expressed, which MHC presents exogenous vs. endogenous antigens, and which MHC presents antigen to CD4⁺ vs. CD8⁺ T-cells).
- 8) Compare and contrast different T-cell subsets (T-helper 1, T-helper 2, cytotoxic T-cells, T suppressor cells, T memory cells) and their role in host immune response.
- 9) Discuss diseases resulting from aberrant immune function, which are described in your assigned readings.

- 10) Discuss the range of complexity of lymphoid cells and tissues: i.e. single lymphoid cells vs. diffuse lymphatic tissue vs. individual lymph follicles (nodules) vs. aggregated lymph follicles vs. lymphoid organs. Where are these structures located and how do they respond to a challenge to the immune system?
- 11) Discuss development of T-cells and B-cells.
- 12) Describe the structure and function of the thymus. Also be prepared to identify thymus, identify specific regions of the thymus such as cortex vs. medulla, and specific structures within the thymus such as Hassall's corpuscles.
- 13) Describe the structure and function of lymph nodes. Be prepared to identify lymph nodes, and discuss the location of specific cells such as T-cells and B-cells in this tissue. Identify and discuss the relevance of primary vs. secondary lymph nodules within lymph nodes. Describe the path of lymph through the lymph node.
- 14) Describe the structure and function of the spleen. Be prepared to identify spleen, and discuss the location of specific cells such as T-cells and B-cells in this tissue. Describe the path of blood through the spleen.

Competencies:

- 1) Apply knowledge concerning the immune system to diagnose, treat, and explain immune system disorders to patients.

Sample questions:

- 1) Which of the following would correctly describe any B lymphocyte seen in the peripheral blood?
 - A) Actively producing humoral antibody
 - B) Differentiated in red bone marrow
 - C) Differentiated in the thymus
 - D) Well-developed Golgi apparatus
 - E) Well-developed rough endoplasmic reticulum (RER)

(Answer: B; modified from Burns and Cave, question #9, p. 278)

- 2) An 8-year-old boy is diagnosed with homozygous sickle cell anemia. In which area of the body will the abnormal blood cells resulting from this condition be destroyed by phagocytosis?
 - A) Cord of Billroth of the spleen
 - B) Hematopoietic cord in bone marrow
 - C) Marginal zone of the spleen
 - D) Medullary region of the thymus

E) Paratrabecular sinus in the lymph node
(Answer: A; modified from Burns and Cave, question #49, p. 253.)

Defense System Handout

Defense System I

The defense or immune system protects an individual from insults including:

- 1.) Pathogens- bacteria, viruses, fungi, and parasites.
- 2.) Environmental agents including allergens.
- 3.) Tumors.

The Lymphoid System- Components:

- 1.) Lymphoid organs- lymph nodes, spleen, thymus.
- 2.) Diffuse lymphatic tissues-
Diffuse lymphoid tissue may exist as:
 - 1.) clusters of lymphoid cells.
 - 2.) single lymph nodules.
 - 3.) groups of lymph nodules as seen in tonsils, appendix, and Peyer's patches of the ileum.

Diffuse lymphoid tissue is found in loose areolar connective tissue under all epithelia except endothelium. In the integument this is the papillary layer of the dermis. In wet epithelia this is the lamina propria. Diffuse lymphoid tissue is particularly prevalent in the mucosa of the gastrointestinal and respiratory systems.

Diffuse lymphoid tissue is collectively referred to as mucosa-associated lymphoid tissue (MALT). MALT is comprised of:

- 1.) Gut-associated lymphoid tissue (GALT)- include tonsils, appendix, and Peyer's patches.
 - 2.) Bronchial-associated lymphoid tissue (BALT).
- 3.) Free lymphoid cells- Although most immune cells are located in lymphoid organs or diffuse lymphoid tissue, lymphoid cells also circulate in the blood, lymph and organs. These cells patrol the vasculature and respond to foreign antigens.

Cells of the Immune System:

- 1.) Lymphocytes
 - a.) T-cells
 - b.) B-cells
 - c.) Null cells- i.e. Natural killer (NK) cells
NK cells are lymphocytes that do not possess surface molecules common to either T or B- lymphocytes. NK cells are cytotoxic principally to tumor and virus infected cells and kill these cells in a non-MHC restricted manner. NK cells utilize proteins called perforins and fragmentins to kill

cells. NK cells are also capable of killing cells which are coated with antibodies in a process called antibody-dependent cell-mediated cytotoxicity (ADCC).

The function of T and B- lymphocytes will be discussed in detail below.

2.) Monocytes

- a.) Blood monocytes
- b.) Tissue macrophages (Histiocytes)
 - Alveolar macrophages-Lung
 - Kupffer cells-Liver
 - Microglia-Brain
 - Langerhan's cells-Epidermis

c.) Dendritic cells

Collectively, cells of the monocyte lineage perform a variety of functions in the immune response including 1.) phagocytosis of pathogens and cellular debris; 2.) antigen presentation; 3.) cytotoxicity-as effectors of ADCC; and 4.) activation of T_H1 cells and self-activation of macrophages via cytokine production (macrophage activation results in increased phagocytosis and ADCC). Lymphoid dendritic cells serve as antigen presenting cells but are not known to be phagocytic.

3.) Granulocytes

- a.) Neutrophils- Phagocytosis
- b.) Eosinophils- Killing of antibody-coated parasites
- c.) Basophils-Unknown function but may be similar to Mast cells

4.) Others

a.) Mast cells- release substances including histamine. Important in allergy and anaphylactic shock.

-Lymphocytes, monocytes, and granulocytes are derived from progenitor cells in the bone marrow. All of these cells mature and differentiate in the bone marrow except lymphocytes of the T-cell lineage which mature in the thymus.

Antigen Presentation

Antigen Presentation- The display of antigen in the form of peptides bound to major histocompatibility (MHC) molecules on the surface of antigen presenting cells (APC). Antigen must be presented by MHC molecules to be recognized by T-cells. The MHC/peptide complex on the APC is specifically recognized by T-cell receptors on the surface of T-cells.

Antigen- Antigens are immunogens (frequently proteins or peptides) which are molecules capable of eliciting an immune response by two distinct mechanisms. Antigens elicit the production of an antibody by B-cells or plasma cells. In addition, antigens complex with MHC molecules on the surface of APCs and are presented to T-cells (antigen presentation).

Epitope- Each antigen can have multiple antigenic determinants called epitopes, each capable of eliciting the production of an antibody.

Antibody- Plasma proteins called immunoglobulins which are produced by cells of the B-cell lineage in response to immunization with an antigen. Antibodies specifically bind to the antigen which elicited their production. Antibodies bind to and neutralize their specific antigen including those found on pathogens. Antibody binding facilitates the removal of the pathogen by immune cells including phagocytic cells.

Antigen Presenting Cells- Examples include macrophages, dendritic cells and B-cells.

Major Histocompatibility (MHC) - MHC proteins are cell surface proteins capable of binding antigen and subsequently presenting the antigen to T-cells. Two types of MHC molecules exist. MHC class I is expressed on most somatic cells. Endogenous antigens (viral and tumor antigens for example) are processed (degraded to form small peptides) and presented by MHC class I molecules. MHC class II is expressed principally on antigen presenting cells. Exogenous antigens are endocytosed or phagocytosed by APCs, processed and transported with MHC class II to the surface of the APCs. Both MHC class I and II present antigen to T-cells.

Innate Immunity-

- 1.) Does not require previous exposure to antigen;
- 2.) Does not increase following repeat exposure to an antigen;
- 3.) Does not discriminate between antigens;
- 4.) Does not provide long-term protection from disease mediated by a given pathogen.

Innate immunity is principally mediated by phagocytic cells including neutrophils and monocytes/macrophages which are collectively referred to as inflammatory cells. In innate immunity an antigen (for example, antigens present on the surface of bacteria) binds receptors on the surface of these inflammatory cells resulting in activation of the cells. Activated inflammatory cells produce cytokines and chemokines which stimulate phagocytosis by the inflammatory cells and chemoattraction of other immune cells.

Adaptive Immunity-

- 1.) Not innately present in individuals, but instead is acquired following exposure to antigens.
- 2.) Provides amplified response upon subsequent exposure to the same antigen due to immunological memory (described below).
- 3.) Discriminates with exquisite detail between antigens.
- 4.) Provides long-term protection against re-infection by the same pathogen.

Adaptive immunity is principally mediated by T and B-lymphocytes. Adaptive immunity involves **activation** and **clonal expansion** of lymphocytes which **specifically** recognize a given antigen. Clonal expansion results in the production of **effector** and **memory** lymphocytes (described below).

Types of Adaptive Immunity

Humoral Immunity- Adaptive immunity which is mediated by antibodies produced by cells of the B-cell lineage. Humoral immunity can be transferred to naive recipients with immune serum containing specific antibody.

Structure of Antibodies

- Y shaped molecules.
- Composed of two long “heavy” chains and two shorter “light” chains.
- Antibody constant regions- Most of the amino acid sequence of immunoglobulin molecules is relatively constant. Minor sequence variations result in the occurrence of only five different immunoglobulin molecules (IgA, IgD, IgE, IgG, and IgM). These immunoglobulin molecules can be secreted and circulate in the vascular system. In addition, IgD and IgM immunoglobulins can be retained in the plasma membrane of B-cells where they function as antigen receptors.
- Antibody variable regions- Some immunoglobulin amino acid sequence is highly variable. These variable regions allow for specific interactions with antigens.
- F_C fragment- The stem of the Y-shaped immunoglobulin molecule (majority of the constant region).
- F_{ab} fragment- The two fragments which form the “fork” in the Y-shaped immunoglobulin molecule (contains the variable region). Each F_{ab} fragment consists of a portion of an immunoglobulin heavy chain and a complete light chain. Antibodies bind antigens via F_{ab} fragments. The extreme sequence variability within the F_{ab} fragments allows for specific binding to highly variable antigens.

B-cell Activation

- Naive B-cells in the bone marrow produce IgM immunoglobulins which are incorporated into the plasma membrane. The IgM molecules serve as B-cell antigen receptors.
- Immunoglobulin molecules are inherited as **gene segments**. During B-cell development, one member of each gene segment is joined randomly in a process called **somatic gene rearrangement**. The result is that each B-cell expresses a unique antibody on its surface. Collectively, these different B-cells can recognize a tremendous variety of antigens.
- During B-cells development, those B-cells which are contacted by “self” antigens are deleted (killed). This leads to **immune tolerance** against “self” antigens.
- Antigen binding to immunoglobulin receptors on B-cells triggers B-cells to differentiate in a process called blast transformation. During blast transformation enhanced endocytosis, increased RNA synthesis, nuclear

hypertrophy, euchromatinization, and increased cell mass results in the formation of B-lymphoblasts.

- Increased DNA synthesis and mitosis results in the production of many additional B-cells each expressing the same antigen receptor. This is **clonal expansion**.
- Blast transformation and clonal expansion results in the production of mature B-cells which may differentiate into antibody secreting plasma cells which function as **effector B-cells** (cells which function immediately in the adaptive immune response). In addition, **memory B-cells** are produced. These cells rapidly and robustly respond to future exposure to the antigen which elicited their clonal expansion.
- See Burns and Cave, Fig13.1, pg 148 for illustration of B-cell activation.

Cell-mediated Immunity- Adaptive immunity principally mediated by T-cells. Cell-mediated immunity includes all adaptive immunity that can not be transferred to naive recipients by humoral antibodies. Cell-mediated immunity requires the presence of immune cells.

Structure of T-cell receptors

-T-cell receptors are members of the immunoglobulin superfamily of proteins. Like immunoglobulin molecules, they possess both constant and variable regions. T-cell receptor genes are inherited as gene segments and undergo somatic gene rearrangements like immunoglobulin genes discussed above. This results in each T-cell having a distinct receptor which recognizes a specific antigen. Thus, collectively, T-cells are able to interact with a tremendous variety of antigens.

- T-cells only interact (via T-cell receptors) with antigen when presented by MHC on the surface of antigen-presenting cells. Thus, T-cells are said to be **MHC restricted**.

T-cell activation

-T-cell activation occurs in much the same way as B-cell activation outlined above, except T-cell differentiation and activation occurs in the thymus.

- As seen with B-cell activation, somatic gene rearrangement, immune tolerance, clonal expansion, and production of effector and memory cells occurs during T-cell activation.

See Burns and Cave, Fig13.1, pg 148 for illustration of T-cell activation.

T-cell subsets

1.) T-helper cells

a.) T-helper 1 or T_H1 cells

- T_H1 cells “help” regulate cell-mediated immune responses.
- Upon activation, T_H1 cells secrete molecules called cytokines.
- T_H1 cells are $CD4^+$ T-cells (CD=cluster of differentiation)
- **T_H1 cells “help” cytotoxic T-cells lyse viral infected and tumor cells.** This occurs through production of cytokines by

T_H1 cells which result in the proliferation and activation of cytotoxic T-cells. Activated cytotoxic T-cells kill virus and tumor cells through release of perforin and fragmentin proteins.

-T_H1 cells also produce cytokines which “help” activate macrophages. Activated macrophages are more phagocytic and capable of killing agents including bacteria in their phagosomes.

b.) T-helper 2 or T_H2 cells

-T_H2 cells help regulate humoral responses.

-T_H2 cells produce cytokines which “help” B-cells respond to antigen stimulation. Ultimately, this results in the production of effector (antibody producing plasma cells) and memory B-cells.

-T_H2 cells are also CD4⁺ T-cells.

2.) Cytotoxic T-cells (T_C)

-Upon activation and proliferation by T_H1 cytokines, T_C kill viral infected and transformed cells.

-T_C are CD8⁺ T-cells

3.) T suppressor cells (T_S)

-Suppress the activity of other immune cells.

-May play a role in preventing autoimmune diseases.

-T_S cells are CD8⁺ T-cells.

-Controversy exists as to whether T_S cells exist.

4.) T memory cells

-Long-lived cells which provide rapid and robust secondary response if challenged by the same antigen which elicited a primary response.

Diseases Resulting From Aberrant Immune Function

- 1.) Acquired immunodeficiency syndrome (AIDS). Results from infection with human immunodeficiency virus type I (HIV). HIV infection results in decreased numbers of T-helper cells and thus both suppressed cell-mediated and humoral responses. AIDS is characterized by abundant secondary infections.
- 2.) Bare lymphocyte syndrome- Patients lack MHC class II expression on cells and have decreased levels of CD4⁺ T-helper cells. Results in defects in both cell-mediated and humoral immunity.
- 3.) DiGeorge’s syndrome- Congenital absence of thymus (and parathyroid). Results in deficient cell-mediated immunity and possibly deficient humoral immunity.
- 4.) Autoimmune diseases- Autoimmune diseases are generally believed to result from immune cells (principally T-cells) mistakenly recognizing “self” antigens as “foreign” antigens. Results in immune mediated destruction of normal tissues.

Week 4 Schedule: Respiratory, Ear, Eye, Endocrine System

Day	Date	Time	Modality	Topic	Faculty	Text assignment
M	Oct 31		Exam	Last seating for Embryology exam		
M	Oct 31	10:00	Lecture 18	Eye	Burns	G& H 512-524; B & C Ch 19-I
M	Oct 31	11:00	<i>Gross Anatomy</i>	<i>Embryology of body cavities/ respiratory/serous membranes</i>	<i>Tank</i>	
T	Nov. 1	9:00	Lecture 19	Ear	Burns	G524-534 (omit Fig. 22-19); B&C Ch 19-II
T	Nov 1	10:00	Lab 7	Eye and Ear	Childs, Burns Stanley,	
W	Nov 2	9:00	Lecture 20	Respiratory system	Kielian	B& C Ch 10; G& H 343-362
W	Nov 2	10:00	Lab 8	Respiratory system	Kielian, Stanley, Drew, Childs	
Th	Nov 3	10:00	Lecture 21	Endocrine I (incl embryology)	Childs	
		11:00	Lecture 22	Endocrine II (incl embryology)	Childs	
Th	Nov 3	4:15	Tutorial		Lecturers	
F	Nov 4	9:00	Tutorial	Catch up in the lab/review	All Lecturers	
F	Nov. 4	11:00				

Code: (on colored copies of schedule) Blue= Microanatomy-Gross Anatomy correlates; Red=Embryology; Green=tutorials

B&C=Burns and Cave; G&H=Gartner and Hiatt; L=Langman

Exam II: Blood/blood cell dev.; Immune system/ Respiratory/Ear and Eye

Self schedule: Thurs 4—midnight; Friday 4-6; Saturday 10-6; Sunday noon—midnight; Monday 4—midnight; Wednesday 8—10 (final seating)

7 lectures and 4 labs=55 questions + 5 review questions=60 total questions. Allow two hours.

Lecture 18: Eye

Dr. Burns

Reading Assignment:

Gartner & Hiatt (2nd): 512-524; Burns & Cave Chapter 19-I.

Learning Objectives:

Compare and contrast in writing and/or by constructing diagrams, i.e. describe:

- A. *The path a beam of light from the tear film to the outer segments of the rods and cones and identify every structure the light passes through and how that beam of light can be modified by the action of the structures it passes through or are nearby.*
- B. *The sequence of events/structures that are involved in the transmission of a nerve impulse from the photoreceptive cells to the optic nerve.*
- C. *The formation, circulatory pathway and exit of aqueous humor.*
- D. *The histo-physiological events involved in accommodation for near and far vision.*

Use the handout and B & C reading assignment as your guide to the breadth and depth of what you will be expected to know and understand regarding this topic. In other words, if it isn't covered in the handout or in B & C, but it is covered in G & H, do not worry about that G & H material. Use G & H and Histology Times for actual images of these structures, but be guided in that endeavor by the outline and B & C reading assignment.

Lecture outline

- I. General
 - A. 3 layers (inner to outer)
 1. Photosensitive retina
 - a. Receptors
 - b. Transmitters of visual information via
 - c. Optic nerve to brain: optic nerve exits eye at optic papilla or disc. No receptors here, this is the blind spot.
 - d. Non-photosensitive parts of the retina are found on the ciliary body and on the iris.
 - e. The junction between the photosensitive retina and the non-photosensitive retina is a serrated junction the ora serrata.
 2. Vascular middle coat, the uvea
 - a. Choroid: highly vascular (nutrition to outer half of retina)
 - b. Ciliary body (special part of uvea peripheral to lens): ciliary processes project toward lens and give rise to acellular strands connecting the ciliary processes with the

capsule of the lens. These strands are the suspensory ligaments of the lens, also known as the “zonules of Zinn”.

- c. Iris (special part of uvea anterior to lens)
 - 1) Opening in center is pupil
 - 2) Constrictor muscle of pupil
 - 3) Dilator muscle of pupil
 - 4) Pigment containing cells
 - B. Tough, fibrous corneal coat: protection and shape
 - C. Cavities and chambers:
 - 1. Anterior chamber
 - a. Posterior to cornea and anterior to iris
 - b. Contains aqueous humor
 - 2. Posterior chamber
 - a. Bounded by iris, lens and ciliary body
 - b. Contains aqueous humor
 - c. Where do anterior and posterior chambers communicate with each other?
 - 3. Vitreal cavity
 - a. Posterior to lens and ciliary body, anterior to retina
 - b. Contains vitreous humor
- II. Path light takes from the environment to the receptors in the retina (with some side trips)
- A. Cornea (avascular, nourished by diffusion from tears and aqueous humor)
 - 1. St. sq. wet. epithelium
 - a. Repairs quick
 - b. Many free nerve endings (very sensitive)
 - 2. Basement membrane (of Bowman)
 - 3. Substantia propria
 - a. Thin lamellae of collagen fibers, each layer has different direction of fibers
 - b. Fibroblasts
 - 4. Basement membrane (of Descemet)
 - 5. Endothelium
 - B. Aqueous humor in anterior chamber
 - C. Pupil of iris (side trip)
 - 1. Anterior surface of iris is discontinuous layer of fibroblasts and melanocytes.
 - 2. Loose, pigmented, vascular C.T. core
 - 3. Posterior surface covered by double layer of heavily pigmented epithelium which some authors refer to as the iridial portion of the retina.
 - 4. Sphincter of pupil is flat ring of smooth muscle around margin of pupil.
 - a. Innervated by parasympathetic postganglionic neurons from ciliary ganglion via the short ciliary nerves.

- b. Short ciliary nerves also innervate ciliary muscle so it and sphincter of pupil work in concert, i.e. during accommodation for near vision there is contraction of ciliary muscle (releases tension on suspensory ligaments of lens, lens fattens and sphincter of pupil contracts, limiting amount of light entering eye).
 - 5. Dilator of pupil = smooth muscle radially arranged around pupil
 - a. Innervated by sympathetic postganglionic neurons
 - b. Eye drops to dilate eyes contain epinephrine = sympathicomimetic
- D. Lens (avascular, nourished by diffusion)
 - 1. Biconvex, covered with a capsule
 - a. Thick carbohydrate rich layer on outer surface of entire lens
 - b. Flat cuboidal epithelium (ant. 1/2 only)
 - c. At equator of lens, cells are columnar, becoming lens fibers (6 sided prisms) Natural elasticity allows lens to change shape (fatten or thicken) when tension on ciliary zonules is released by contraction of ciliary m. As one ages, this elasticity decreases, thus the need for "Ben Franklin" reading glasses at age 40 – 50+.
 - 3. (Side trip) lens held in place or suspended from circular ciliary body by a system of fibers which constitutes the ciliary zonule or zonule of Zinn.
 - a. Ciliary processes: about 70 radially arranged ridges on surface of ciliary body. Give rise to zonule fibers of the ciliary zonule.
 - b. Ciliary muscle: smooth muscle arranged in several planes; in general, contraction of ciliary muscle releases tension on ciliary zonule, lens assumes its natural or unstretched-out shape (accommodation for near vision; read for long periods your eyes "get tired", rest eyes (rest ciliary muscle) by looking up and away from book).
 - c. Ciliary portion of retina (non-photosensitive) covers ciliary body and processes. This epithelium is 2 cells thick (only the outer ones are pigmented). This epithelium produces the aqueous humor.
 - d. Aqueous humor
 - 1) Formed on surface of ciliary body
 - 2) Fills and passes through posterior chamber to
 - 3) Anterior chamber
 - 4) Leaves anterior chamber via the trabecular meshwork, a labyrinthine system of minute passages amongst endothelial-lined trabeculae at

inside of limbus of eye (area where cornea merges with sclera).

- 5) Canal of Schlemm: a flat, endothelial-lined vessel full of aqueous humor
- 6) Aqueous veins arise from canal of Schlemm which empty into episcleral veins
- 7) Compromise the exit of aqueous humor through numbers 4, 5, and 6 above, the result will be glaucoma.
- 8) The increased intra-ocular pressure in glaucoma can compromise the blood supply to the retina. This can result in blindness.

E. Vitreous body

1. Gelatinous mass
2. Structure-less 99% H₂O

F. Retina (ten layers from inside to outside)

1. Inner limiting membrane
2. Layer of optic nerve fibers: axons of ganglion cells converging toward optic papilla
3. Layer of ganglion cells: 3rd order, multipolar neurons, i.e. the terminal neuron of the retina
4. Inner plexiform layer: area of many synapses between second-order neurons and the ganglion cells
5. Inner nuclear layer: nuclei of the second-order neurons (bipolar)
6. Outer plexiform layer: area of many synapses between rods and cones (first order neurons) and second order neurons
7. Outer nuclear layer: nuclei of rods and cones (bipolar)
8. Outer limiting membrane: actually a row of junctional complexes between cells which appears as a line on LM.
9. Layer of rod and cone inner and outer segments
10. Pigmented epithelium: absorbs light
 - a. Prevents reflection from uvea and sclera
 - b. Protects sensitive ends of rods and cones
 - c. Phagocytosis of apical, discarded lamellae from rods and cones

III. Neuron Path that visual information takes from rods and cones to optic nerve (reverse of "F" above.

A. Rods (first order neuron)

1. Outer segment
 - a. Slender cylinder
 - b. Large number of parallel lamellae arranged perpendicular to long axis of cylinder: rhodopsin
2. Inner segment: usual complement of cytoplasmic organelles

- B. Cones (morphologically similar to rods but have larger inner segments): 3 basic types
 - 1. Red absorbing
 - 2. Blue absorbing
 - 3. Green absorbing
 - C. Inner nuclear layer (second order neuron)
 - D. Ganglion cell layer (third order neuron)
- IV. Fovea centralis
- A. Just lateral to optic papilla
 - B. Region of most distinct vision
 - C. All layers missing out to outer nuclear layer: free passage of rays of light to cones
 - D. One area of fovea centralis is rod-free = pure cones.
- V. Accessory organs of eye
- A. Eyelid (pin from anterior to posterior)
 - 1. Integument
 - a. Hairs
 - 1) Small and all over
 - 2) Large hairs at edge of lid are the eyelashes
 - b. Sebaceous glands associated with eyelashes are called the glands of Zeis
 - c. Sweat glands
 - 1) Small and un-named
 - 2) Glands of Moll: ducts open into eyelash follicle
 - d. A sty is an infected gland of Moll or Zeis (Zeisian Sty)
 - 2. Orbicularis oculi (sk. mus.)
 - 3. Palpebral fascia (tarsal plate)
 - a. Superiorly attached to strands of smooth muscle (Müller's muscle)
 - b. Glands of Meibom (sebaceous): openings form a single row in front of free edge of lid (behind or posterior to eyelashes). Oily secretion keeps tears in eye.
 - 4. Palpebral conjunctiva
 - B. Lacrimal gland
 - 1. Serous
 - 2. Tears: bactericidal

Some interesting clinicopathological conditions associated with the eye.

- A. Horner's ptosis: drooping of upper eyelid due to destruction of cervical sympathetic ganglia (e.g. carcinoma of the apex of lung)
- B. Burns' amaurosis or amblyopia (look it up, you'll enjoy it).
- C. Aniridia
 - 1. Deletion of chromosome #11
 - 2. 90% of pts. with aniridia have Wilm's tumor

3. Wilm's tumor is a tumor of the kidney seen primarily in infants probably arising from embryonic nephrogenic tissue.
- D. Squamous cell carcinoma of the epithelium of the cornea or bulbar or palpebral Conjunctiva

Lecture 19: Ear

Dr. Burns

Reading assignment:

G & H p. 524-534 (omit Fig. 22-19); Burns & Caver Chapter 19-II.

Learning Objectives:

Compare and contrast in writing and/or by constructing diagrams, i.e. describe

- A. *The path sound waves from the external ear through the middle ear into the inner ear to the organ of Corti and the round window.*
- B. *The conversion of the sound waves to a wave of depolarization in the hair cells in the organ of Corti to the neuron cell bodies of the spiral ganglion.*
- C. *The histo-physiological events associated with the perception of sound waves of different frequency.*
- D. *The histo-physiological events associated with linear and circular movements of the head.*

Include in your study all of the content contained in the outline whether it is included in the histology text or not and omit all content contained in the textbook that is not contained in the outline.

Use the handout and B & C reading assignment as your guide to the breadth and depth of what you will be expected to know and understand regarding this topic. In other words, if it isn't covered in the handout or in B & C, but it is covered in G & H, do not worry about that G & H material. Use G & H and Histology Times for actual images of these structures, but be guided in that endeavor by the outline and B & C reading assignment.

Lecture Outline

- I. Three major divisions
 - A. Outer ear
 1. Auricle
 - a. Elastic cartilage
 - b. Integument
 2. External auditory meatus
 - a. Elastic cartilage (externally); bony canal (internally)
 - b. Integument
 - 1) Sebaceous glands
 - 2) Modified sweat glands called ceruminous glands
 - 3) i) & ii) combined secretion is ear wax
 - B. Middle ear
 1. Auditory (Eustachian) tube

2. Tympanic cavity
 - a. Auditory ossicles
 - 1) Malleus
 - 2) Incus (M-I-S; from lateral to medial)
 - 3) Stapes
 - b. Chorda tympani
 - c. Tendons of tensor tympani (CN V) and stapedius (CN VII)
 - 1) These muscles contract in a reflex fashion in response to loud sounds (not fast enough for sudden loud sounds like a gun shot) and thereby can lessen the vibration of the ossicles
 3. Tympanic membrane
 - a. C.T. core (mesoderm)
 - b. Covered laterally by thin skin (ectoderm)
 - c. Covered medially by simple cuboidal epith. (endoderm)
- C. Inner ear
1. Membranous labyrinth: complicated system of ducts: semicircular ducts, sacculus, utricle, and cochlear duct
 - a. Filled by endolymph
 - b. Constructed of ectodermally derived, simple squamous epithelium with patches of special sensory epithelium, e.g.
 - 1) Maculae of utricle and saccule
 - 2) Cristae of each ampulla of each of the 3 semicircular ducts
 - c. Surrounded by perilymph
 - d. Suspended in a system of bony canals called the
 2. Bony labyrinth
 - a. e.g. semicircular canals
- II. Macula (of utricle; of saccule)
- A. Columnar sustentacular cells
 - B. Hair cells: microvilli embedded in gelatinous mass which contains otoliths (crystals of calcium carbonate)
 - C. When the head is inclined, the weight of the otoliths causes a change in position of the jelly of the maculae, thus position in space is perceived.
- III. Crista ampullaris (one for each semicircular duct)
- A. Hair cells with microvilli embedded in a gelatinous mass called the cupula
 - B. When head rotates the cupula is moved, the hairs of the hair cells are distorted and rotation is perceived.
- IV. The bony cochlea is filled with perilymph (high in Na⁺)
- A. Divided by the basilar membrane into 2 subdivisions
 1. Scala vestibuli
 2. Scala tympani
 - B. The scala vestibuli is separated from the cochlear duct by the vestibular membrane.

- C. Attached to the basilar membrane is the organ of Corti
 - D. The cochlear duct is filled with endolymph (high in K⁺)
 - E. Sources of endo- and peri-lymph
 - 1. Endolymph
 - a. In general, most cells of the membranous labyrinth are geared up ultrastructurally for synthesis and secretion and are believed to be directly involved in the metabolism of endolymph.
 - b. Thus, the stria vascularis, the spiral prominence (both are components of one wall of the cochlear duct), and the extrasensory cells of the cristae and maculae, as well as the other cells of the membranous labyrinth, are involved in the production of endolymph.
 - c. Stria vascularis is the only place in the body where blood capillaries are normal components of an epithelium.
 - 2. Perilymph
 - a. Source in debate
 - b. Possibly an ultrafiltrate of blood
 - c. Or possibly derived from CSF
 - d. Perilymphatic spaces are functionally connected to the subarachnoid space.
- V. Organ of Corti
- A. Supporting cells
 - B. Hair cells
 - 1. Inner
 - 2. Outer
 - 3. Inner and outer hair cells separated by a tunnel (inner tunnel)
 - C. Tectorial membrane: a cuticle type arrangement into which the tips of the hair cells are embedded.
- VI. Histophysiology of hearing
- A. Vibrations in air - tympanic membrane - auditory ossicles (amplitude of vibrations increased about 10x by M-I-S) - foot of stapes - oval window - perilymph of scala vestibuli - vestibular membrane - endolymph of cochlear duct, basilar mem. and scala tympani to round window (rapidly bulges and retracts in rhythm with pressure changes in perilymph).
 - B. Pressure changes cause oscillations of basilar membrane. A specific pitch (frequency) results in greater movement in one specific area of basilar membrane. e.g. high tones cause maximal vibration of basilar membrane nearest round window; low tones cause maximal vibration near helicotrema (at apex of cochlea where scala v. and scala t. communicate with each other).
 - C. When basilar membrane moves, hair cells of organ of Corti move and the hairs of the hair cells are distorted. Stimulus conducted over nerve fibers to the spiral ganglion; from spiral ganglion to brain where the original vibrations are interpreted as sound.

Sample questions Eye and Ear

1. Match:

- | | |
|----------------------|---|
| ___ Aniridia | A. Deletion of chromosome #11, also associated with Wilm's tumor |
| ___ Blind spot | B. Mass of smooth muscle which, when contracted, causes lens to thicken |
| ___ Fovea centralis | C. Absence of ganglion cell layer and inner nuclear layer |
| ___ Canal of Schlemm | D. Optic nerve exits eye |
| | E. Located in limbus area of eye |

2. The contraction of the ciliary muscle causes which one of the following reactions?

- A. Dilation of the pupil
- B. Thinning of the lens
- C. Thickening of the lens
- D. Constriction of the canal of schlemm
- E. None of the above

3. Choose the correct pathway for the circulation of aqueous humor: 1) anterior chamber, 2) pupil, 3) formation by ciliary process, 4) canal of Schlemm, 5) episcleral veins:

- A. 1 - 2 - 3 - 4 - 5
- B. 3 - 2 - 1 - 4 - 5
- C. 1 - 5 - 3 - 4 - 2
- D. 1 - 5 - 4 - 2 - 3
- E. 3 - 4 - 5 - 1 - 2

4. Give the correct sequence for a nerve impulse passing through the retina:

- ___ Outer nuclear layer
- ___ Multipolar neuron
- ___ Inner plexiform layer
- E Optic disc (blind spot)
- ___ Outer segment of a cone

5. Arrange the following items in proper sequence for normal hearing:

- A Sound vibrations in air
- ___ Tympanic membrane
- ___ Foot plate of stapes
- ___ Perilymph of scala vestibuli
- ___ Scala tympani

6. The crista ampullaris:

- A. Is located in the vestibule
- B. Functions to detect rotational movements of the head
- C. Is stimulated by movements of the endolymph
- D. Is part of the cochlear duct
- E. Both B and C are correct

7. Match:

- | | | |
|-----|----------------|-----------------------------|
| ___ | Otoliths | A. Macula of utricle |
| ___ | Cochlear duct | B. Membranous labyrinth |
| ___ | Organ of Corti | C. Inner & outer hair cells |
| ___ | Ossicles | D. Middle ear |
| | | E. Crista ampullaris |

Answers to sample questions on the Histology of the Eye and Ear:

1 – A D C E; 2 – C; 3 – B; 4 – B D C E A; 5 – A B C D E; 6 – F; 7 – A B C D

Lecture 20: Respiratory System

Dr. Kielian

Reading Assignment: Guides to studying this unit

1. Read the assigned material in Burns and Cave (key on Table 10-1 and Figure 10-2) and Gartner and Hiatt textbooks.
2. Helpful Figure in Gartner and Hiatt textbook is 15-4. Study Table 15-1. Clinical correlations on pages 352, 355, 360
3. Helpful Figures in Kierszenbaum textbook (on reserve in library) are: 13-4, 13-5, 13-7, 13-9, 13-10, 13-11, 13-12, 13-14, 13-15, 13-16, 13-18, 13-21, and 13-22. (these will be shown as part of lecture material).

Learning Objectives

At the end of this unit the student should be able to:

1. List the structure and function of cells comprising the olfactory epithelium.
2. Contrast between conducting and respiratory portions of the Respiratory System, including key structural and functional changes occurring along different regions of each portion.
3. Recognize distinguishing features of different types of bronchi, bronchioles and alveoli.
4. Label structural components of the respiratory membrane (air-blood barrier) and describe functional roles of type I pneumocytes, type II pneumocytes and alveolar macrophages.
5. Describe primary changes in respiratory system tissue leading to or resulting in cystic fibrosis, asthma, respiratory distress syndrome and emphysema.

Sample Questions

(Answers are at the end of this Unit)

1. During the last trimester of pregnancy your patient is exposed to a toxic chemical that easily crosses the placenta to reach her unborn child. This chemical selectively effects type II pneumocytes and Clara cells, causing their immediate death and prevents formation of any new cells of this type. At birth the child experiences respiratory distress syndrome because of the absence of what compound?

- A. Hemoglobin
- B. Oxygen
- C. Elastin
- D. Surfactant
- E. Myosin

2. Which of the following would distinguish a respiratory bronchiole from a terminal bronchiole?

- A. The respiratory bronchiole will have thicker smooth muscle layers than the terminal bronchiole
- B. There will be alveoli extending from the respiratory bronchiole but not the terminal bronchiole
- C. There will be more numerous goblet cells in the respiratory bronchiole
- D. The respiratory bronchiole will not have type I pneumocytes but the terminal bronchiole will

3. The following is description of what structure or organ in the respiratory system?
“Lumen lined by respiratory epithelium surrounded by a complete C-shaped ring of hyaline cartilage”

- A. Esophagus
- B. Trachea
- C. Primary Bronchus
- D. False vocal fold
- E. Terminal bronchiole

Answers to questions

- 1. D
- 2. B
- 3. B

Lectures 21, 22, and 23: Endocrine System

Dr. Childs

Reading assignment:

Gartner and Hiatt, pp 301—324, pp 269, Pp 418—421, 388-391; Burns and Cave pp 216—226; 224; 131, 126-127; pp 114-226

Learning Objectives/Lecture outline.

Lecture 21: Introduction—Neuroendocrinology and the Pituitary Gland. Bring your text. Pp 301—310.

A. Introduction to Endocrinology

1. Distinguish the endocrine and exocrine glands.
2. Distinguish: autocrine, endocrine, paracrine, juxtacrine and intracrine modes of communication.
3. Define a hormone and its possible chemical compositions and actions
4. Describe how hormones may affect a target cell (review signaling pathways).
5. Define feedback mechanisms, including negative feedback, positive feedback, short loop feedback.

B. The Pituitary Gland (see especially Figure 13-1).

1. Describe the major regions and subdivisions of the pituitary (hypophysis).
2. Discuss the different embryologic origins of the adenohypophysis and neurohypophysis and diagram the process.
3. Describe the blood supply to the adenohypophysis and tell why it is important.
4. Define the general origin and function of the major releasing hormones and release inhibiting hormones that affect the anterior lobe cells.
5. List the two types of acidophils and their regulators and hormones produced.
6. List the three types of basophils and their regulators and hormones produced.
7. Define the function of each of the pituitary hormones.
8. Describe the basic set of organelles important in the production of pituitary hormones.
9. Describe chromophobes and give examples.
10. Describe what would happen to each of the anterior lobe cell types if the stalk were sectioned (and the blood vessels not allowed to grow back).
11. Define the pars tuberalis.
12. Define the pars intermedia, its product, and its significance in the human.
13. Describe the blood supply to the neurohypophysis.
14. Trace the route from the origin to the ending of the axons in the pars nervosa (the Hypothalamohypophyseal tract).

15. List the hormones secreted from the neurohypophysis and describe their functions.
16. Describe the function of the cells in the neurohypophysis.

Lecture 22. Thyroid and Parathyroid pp 310-316; note Figure 13-9).

1. Locate the thyroid gland.
2. Identify the major regions of the thyroid gland.
3. Describe how the thyroid follicular (Principal cells) cells are organized and define colloid.
4. Discuss where (cytologically and chemically) the thyroid hormones (thyroxine and tri-iodothyronine) are stored.
5. Define the chemistry and function of the thyroid hormones (T3 and T4)
6. Name thyroid hormone target cells.
7. List the steps that follow from a cold stimulus to the stimulation by thyroid stimulating hormone to the production and storage of T3 and T4.
8. Discuss the organelles and subcellular domains involved in the production and storage of thyroid hormones.
9. List the steps and organelles required to release T3 and T4 from the cell.
10. Discuss how thyroid hormones feedback on the hypothalamus and pituitary gland.
11. Locate the parafollicular cells.
12. Describe the function of the parafollicular cells and name the hormone produced.
13. Discuss the outcome of low iodine in the diet, underproduction of thyroid hormones, or overproduction of thyroid hormones.
14. Locate the parathyroid gland.
15. Identify the principal cells of the parathyroid gland and their secretory product.
16. Describe the chemistry and functions of parathyroid hormone.
17. List each of the thyrocalcitonin and parathyroid hormone target cells.
18. Discuss calcium feedback on parathyroid hormone and thyrocalcitonin producing cells.

Lecture 23: Adrenal, Cardiovascular, GI tract and Pineal, Adipocyte

A. Adrenal pp 316--321

1. Locate the adrenal gland. Tell why it is called the “suprarenal gland” in humans?
2. Define the regions of the adrenal gland.
3. Describe the blood supply to the adrenal gland and discuss the significance of the first passage through the cortex.
4. Distinguish the zona glomerulosa, zona fasciculata, and zona reticularis.
5. Name the principle hormone produced (by class) by each zone.
6. Describe the organelles used for the production of each class of steroid hormones.
7. Name the target cells for each of the adrenal hormones.
8. Discuss the regulation of each of the zones in the adrenal cortex.
9. Describe adrenal cortex feedback to the pituitary.
10. Describe the function of each major class of hormone produced by the adrenal cortex.
11. Describe the cells of the adrenal (suprarenal) medulla.

12. Name the major hormones produced by the medullary cells and discuss their function.

B. Cardiovascular endocrine cells (pp 269; Figure 11-18)

1. Locate the cardiac muscle cells specialized for the production of atriopeptin, atrial natriuretic polypeptide, cardiodilatin, and cardionatrin.
2. Distinguish these specialized endocrine cells from cardiac muscle fibers; be able to identify them.
3. Describe the general function of these polypeptide and peptide hormones.

C. Endocrine Pancreas. Pp 418—420 (Table 18-1 is good summary)

1. Locate and be able to identify the endocrine portion of the pancreas.
2. Name the cell types found in the Islet of Langerhans and their hormone products.
3. Describe how you would distinguish the different cells in the Islet of Langerhans.
4. Describe functions for each of the hormones in the endocrine pancreas.
5. Describe the organelles needed for the production and storage of the hormones of the endocrine pancreas.
6. Distinguish paracrine from endocrine types of communication and how it relates to the pancreas.
7. List target cells for each of the endocrine pancreas cell types.
8. Describe how hormones from the endocrine pancreas reach their target cells (list the target cells).
9. Discuss how the α , β and G cells are regulated.
10. Distinguish Types I and II Diabetes.

D. Enteroendocrine cells (Diffuse Neuroendocrine system) of the GI tract. Pp 388-391. (see Table 17-2)

1. Locate these cells and describe how you would identify them.
2. Distinguish types that reach the GI tract lumen vs those that border the lamina propria.
3. Distinguish a paracrine effect from an endocrine effect.
4. Identify and locate the cells and hormones that act on secretion from GI tract cells.
5. Describe the organelles involved in the production of these hormones.
6. Identify and locate the cells and hormones that act on motility (muscle, peristalsis)

E. The Adipocyte as an Endocrine cell. Pp 114-116 and lecture

1. Describe the hormones produced by adipocytes and their functions with respect to eating behaviors and metabolism
2. Describe how fat cells are regulated and how exercise and other hormones might break down fat stores.

F. Pineal Gland (pp 321—324)

1. Locate the pineal gland
2. Describe the principle cell type.
3. Describe the hormone secreted by the pinealocyte and its function
4. Identify and define interstitial cells

5. Discuss the regulation of the pineal and how it functions throughout the day and night.
6. Describe the organelles involved in the production of pineal hormones.
7. Discuss what might happen in constant light or constant dark periods.
8. Discuss the role of the pineal in puberty.

Endocrine System Competencies.

- 1) With a working knowledge of each of the endocrine gland hormone functions, target cells and regulation, be able to predict the outcome of:
 - a. a tumor producing too much of the hormone
 - b. a disease that ablates the endocrine gland or cell type
 - c. a genetic deficiency in a particular cell type.
 - d. a dietary deficiency that fails to provide a necessary ingredient for the production of a particular hormone.
- 2) Based on a pathologists' report about the type of chromophil in a pituitary tumor, be able to narrow down which serum hormones might be high as well as which serum hormones to assay.
- 3) With a working knowledge of negative feedback mechanisms, be able to predict the result of a thyroid follicular tumor or adrenal cortical tumor.
- 4) Describe what cutting the infundibular stalk will do to anterior and posterior pituitary functions. Discuss how a pituitary tumor might have the same effect.
- 5) Describe the cells involved in regulating blood glucose levels and how this can be affected in Types I and II diabetes.
- 6) Describe the cells involved in regulating serum calcium and how they may impact the function of bone, intestine and kidney cells.
- 7) Define and describe the neuroendocrine and endocrine cellular and hormonal circuitry that responds to cold, stress and light.
- 8) Describe to a patient why exercise is important to the maintenance of body composition and the roles played by the endocrine system.

Sample Questions:

Endocrine system

In your first case in Cell Biology (No pain in the neck), Sara Jackson presented with a lump in her neck. You did a needle biopsy followed by surgery and the final diagnosis was medullary carcinoma in spite of the fact that the needle biopsy report initially stated that it was follicular carcinoma. If you immunocytochemically labeled a biopsy from Ms. Jackson's tumor, what hormone (s) would you expect to find?

- a. thyrocalcitonin
- b. thyroid stimulating hormone
- c. thyroxine
- d. a and c.
- e. a, b, and c.

Answer: a (a medullary carcinoma should have calcitonin producing cells)

If you cut the infundibular stalk and prevented any regrowth of vessels and nerves, which of the following pituitary “cell types” might undergo hyperplasia (an increase in cell number):

- a. growth hormone cells
- b. oxytocin neurons
- c. prolactin cells
- d. chromophobes
- e. basophils

Answer: c (only prolactin cells are under chronic inhibitory control)

Which of the following are true with respect to parathyroid hormone?

- a. Parathyroid hormone (PTH) is produced by chief cells in the stomach.
- b. Immunolabeling for PTH would find it in “parafollicular cells” in the thyroid.
- c. PTH is regulated by TSH from the anterior pituitary.
- d. PTH target cells include cells in the kidney and in the GI tract.
- e. PTH acts to lower blood calcium

Answer d.

Organelles used to make hormones may vary widely depending on the chemistry of the hormone produced.

- a. Steroid hormones are produced by the following organelles:
- b. Smooth endoplasmic reticulum
- c. Ribosomes and rough endoplasmic reticulum
- d. Mitochondria
- e. a, b. and c.
- f. a and c.

Answer: e

Week 5 Schedule: Endocrine, Cardiovascular System

Day	Date	Time	Modality	Topic	Faculty	Text assignment
M	Nov 7	10:00	<i>Gross Anatomy</i>	<i>Embryology of GI tract</i>	<i>TBA: GA faculty</i>	
M	Nov 7	11:00	<i>GROSS/MICRO</i>	Histology of Heart; <i>Embryology: Dev of Heart I</i>	Burns	G:173-177, 267-270 B&C, Ch 11 & L 223-254 (omit molecular)
T	Nov 8	9:00	Lecture 23	Endocrine III: incl GI, cardiac	Childs	
T	Nov. 8	10:00	Lab 9	Endocrines	Burns, Stanley, Childs, TBA	
W	Nov 9	8:00	Exam II	Last seating		
	Nov 9	10:00	<i>Gross Anatomy</i>	<i>Embryology: Development of Heart II</i>	Burns	L 223-254 (omit molecular)
W	Nov 9	11:00	<i>Gross Anatomy</i>	<i>Embryology: Development of Great Vessels</i>	Burns	L 101-103,256-264 (omit "cardinal v."),267-273
Th	Nov 10	9:00	Clin Lecture 3	Heart Defects	(Bornemeier – ACH)	
	Nov 10	10:00	Lab 10	<i>Histology of Heart; Optional Models of Dev. Of Heart</i>	Burns, Stanley	
Th	Nov10	4:15	Tutorial	Tutorial	Lecturers	
F	Nov 11		Holiday	Veterans Day		

Key: Blue= Microanatomy-Gross Anatomy correlates; Red=Embryology; Green=tutorials
B&C=Burns and Cave; G&H=Gartner and Hiatt; L=Langman

Embryology of GI tract and Heart.

Please see Embryology Study Guide

Week 6 Schedule: GI and Urinary systems

<i>Day</i>	<i>Date</i>	<i>Time</i>	<i>Modality</i>	<i>Topic</i>	<i>Faculty</i>	<i>Text assignment</i>
M	Nov. 14	10:00	Lecture 25	GI system I	Kielian	B&C Chapter 14 and G&H Chapter 16 (omit teeth; p. 366-374)
M	Nov 14	11:00	Lecture 26	GI system II	Kielian	B&C Chapter 14 and G&H Chapter 17
T	Nov 15	9:00	Lecture 27	GI III	Kielian	B&C Chapter 14 and G&H Chapter 18
T	Nov. 15	10:00	Lab 11	GI system	Stanley, Drew Kielian, Kane	
W	Nov 16	9:00	Lab 12	GI	Kielian, Stanley, Drew, Kane	
W	Nov 16	11:00	Lecture 28	Urinary system	Kane	G&H Ch 19
Th	Nov 17	9:00	Gross Anatomy	Embryology: Development Urinary System	Kane	L Ch 14
Th	Nov 17	10:00	Lab 13	Urinary	Stanley, Kane, Childs, Drew	
Th	Nov 17	4:15	Tutorial	Review as needed		
F	Nov 18	9:00	*Clin lecture 4	Diseases of the Urinary System	Wheeler-Int. Med.	
F	Nov 18	10:00	Tutorial	Catch up in the lab	All lecturers	

Exam III: Endocrine (all) Heart Histology (not embryology), GI
6.5 lectures + 3.5 labs= 50 questions + 5 review questions. Wednesday 4—midnight; Thursday 4--midnight, Friday, 4—6; Saturday 10-6; Sunday noon—midnight; Monday 4—midnight; Wed 8-midnight; Through the following weekend; final seating is Monday after Thanksgiving.

Lectures 25 and 26: Digestive System I and II

Dr. Kielian

Reading Assignment: Guides to studying this unit

1. Read the assigned material in Burns and Cave (key on Table 14-1) and Gartner and Hiatt textbooks.
2. Helpful Figures in Gartner and Hiatt textbook are: 17-1, 17-3, 17-13, 17-21, 17-22. Study Table 17-3.
3. Helpful Figures in Kierszenbaum textbook (on reserve in library) are: 15-7, 15-17, 16-2, 16-5, 16-8, 16-9, 16-10, 16-11, 16-12 (these will be shown as part of lecture material).

Learning Objectives

At the end of this unit the student should be able to:

1. Describe the histological organization of the tongue and its specialized regions involved in taste sensation and the structural and functional differences of upper, middle and lower esophagus.
2. List the different layers of the alimentary canal (the tubular portion of the digestive system), including the functional role of the cells and tissue comprising each layer.
3. Distinguish the gross and microscopic regions of the stomach, list the function of different cell types comprising the mucosal layer and describe the basic principles of digestion. This description will include information about the mechanical, chemical and enzymatic breakdown of ingested food and the role of enteroendocrine cells in promoting or inhibiting specific actions affecting digestion. Hormones with specific effects on digestion will be identified.
4. Distinguish the gross and microscopic regions of the small intestine, list the function of different cell types comprising the mucosal layer and describe the basic principles of absorption of digested food materials. This will include information about the role of enteroendocrine cells in promoting or inhibiting specific actions affecting absorption. Hormones with specific effects on absorption will be identified.
5. Distinguish the gross and microscopic regions of the large intestine down to and including the anal canal, list the function of different cell types comprising the mucosal layer and describe the basic principles of absorption and excretion of waste products related to this organ. Hormones with specific effects on excretion will be identified.
6. Distinguish parietal, chief, and Paneth cells from one another at the electron microscopic (EM) level.
7. Identify Peyer's patches and describe the processes involved in antigen transport and processing from the intestinal lumen.

Sample Questions

(Answers are at the end of this Unit)

1. Which region of the digestive system would be most affected by sudden paralysis of smooth muscle?

- A. Upper 1/3 of esophagus
- B. Middle 1/3 of esophagus
- C. Lower 1/3 of esophagus
- D. Tongue
- E. External anal sphincter

2. The selective inhibition of goblet cell secretions would result in the most profound loss of function of what region of the digestive system?

- A. Fundic stomach
- B. Duodenum
- C. Jejunum
- D. Ileum
- E. Colon

3. If you were interested in reducing the acidity of stomach fluids you would select a treatment that would increase the production of what compound?

- A. Cholecystokinin
- B. Secretin
- C. Urogastrone
- D. Gastrin

4. If you wanted to facilitate relaxation of the pyloric sphincter you would prescribe a treatment that would increase the production of what compound?

- A. Cholecystokinin
- B. Secretin
- C. Urogastrone
- D. Gastrin

Answers to questions

- 1. C
- 2. E
- 3. C
- 4. D

Lecture 27. Digestive System III – Glands

Dr. Kielian

Reading Assignment: Guides to studying this unit

1. Read the assigned material in Burns and Cave and Gartner and Hiatt textbooks.
2. Helpful Figures in Gartner and Hiatt textbook are: 18-1, 18-5, 18-11, 18-14.
3. Helpful Figures in Kierszenbaum textbook (on reserve in library) are: 17-2, 17-4, 17-10, 17-11, 17-13 (these will be shown as part of lecture material).

Learning Objectives

At the end of this unit the student should be able to:

1. Describe how histological characteristics of salivary glands differ from other. Contrast these glands with histological features of exocrine pancreas glands.
2. Identify the components of the hepatic lobule and distinguish between the classical lobule, portal lobule and liver acinus based upon structural arrangement and functional emphasis.
3. Describe the cytoarchitecture of individual hepatocytes and their relationship to adjacent hepatocytes, blood vessels and bile ducts. List the functional activities of hepatocytes.
4. Identify histological features of the gall bladder.
5. Describe the functional roles of the exocrine pancreas, liver and gall bladder in aiding the digestive process and associate these roles with the regulation of digestion, absorption and excretion.
6. Identify the characteristic features of hepatocytes at the electron microscopic (EM) level.

Sample Questions

(Answers are at the end of this Unit)

1. The absorption of dietary proteins by enterocytes is facilitated by the presence of which of the following?
 - A. Gastrin
 - B. Trypsin
 - C. Cholecystokinin
 - D. Immunoglobulin G
 - E. Bile
2. An experimental drug that you are testing causes the production of thick mucus saliva. What organ/region has been targeted by this drug?

- A. Parotid salivary gland
 - B. Pancreas
 - C. Sublingual salivary gland
 - D. Olfactory epithelium
 - E. Brunner's glands
3. Which of the following statements is true concerning the classical liver lobule?
- A. The arrangement of this lobule emphasizes the exocrine function of the liver
 - B. The arrangement of this lobule emphasizes the endocrine function of the liver
 - C. There is no involvement of vascular components in this lobular arrangement
 - D. The Kupffer cell has a key role in function of the classical liver lobule
4. During an abdominal surgical procedure there is a complication resulting in damage to the portal vein. While excessive bleeding is kept under control the surgeon does not realize that blood flow to the liver through this vessel has been blocked. What is the immediate result of this blunder?
- A. There is a diminished supply of nutrients to the liver
 - B. Bile is no longer produced by hepatocytes
 - C. Only oxygen poor blood reaches the liver leading to hepatocyte cell death
 - D. The liver is drained of blood

Answers to questions

- 1. B
- 2. C
- 3. B
- 4. A

Lecture 28: Histology: Urinary System

Dr. Kane

Reading Assignment:

Gartner and Hiatt, Chapter 19

Learning Objectives:

Without reference materials, the student should be able to:

1. Define the functions of the urinary system
2. Identify and define structural and functional elements in the kidney, ureter, bladder and urethra, including
 - a) Molecules and their functions
 - b) All cell types and their functions
 - c) Functional organization and arrangement of tissues

Key figures: 19-1, 19-2, 19-3, 19-4, 19-5, 19-7, 19-8, 19-10, 19-11, 19-12, 19-13, 19-14, 19-16, 19-17, 19-20, 19-21, 19-22

Key tables: 19-1, 19-2, 19-3
3. Describe the filtration of blood and the formation of urine in the kidney. In doing so,
 - a) Diagram and describe kidney structure and function at the EM, histologic and gross levels
 - b) Describe vascular flow and its significance to kidney function, including the juxtaglomerular apparatus and the renal corpuscle
 - c) Describe ultrafiltrate formation and its modification in the uriniferous tubule
 - d) Compare and contrast the flow of water, salts and macromolecules within each region of the nephron and renal interstitium
 - e) Define the countercurrent multiplier system and the countercurrent exchange system and describe their functions
 - f) Describe the normal hormonal regulation of kidney function
 - g) Compare and contrast diuresis and antidiuresis
4. Describe common and rare diseases of the urinary system, including diabetes insipidus, glomerulonephritis, polycystic kidney disease, albuminuria, nephrotic syndrome, lipoid nephrosis, bladder cancer, chronic essential hypertension, and urinary incontinence

Competencies:

1. Apply state-of-the-art knowledge of molecular, cell and tissue biology to describe in detail the structure and function of the urinary system to:
 - a) the general public
 - b) professional peers

2. Given patients with either common or rare diseases of the urinary system, apply state-of-the-art knowledge to correctly diagnose the condition
3. Communicate knowledge-based information to patients regarding the underlying cause and consequences of common and rare diseases of the urinary system

Sample questions:

1. The hypertonic quality of the interstitium of the renal medulla affects which of the following?
 - A. Resorption of water from the proximal convoluted tubule
 - B. Resorption of water from the straight collecting tubules
 - C. Resorption of water from the thick ascending portion of Henle's loop
 - D. Resorption of salt from the straight collecting tubules
 - E. Resorption of salt from the distal convoluted tubules

Answer: B (modified from Burns and Cave text p. 283, Q46; also refer to answer explanation on p. 304)

2. The majority of the water and salt in the glomerular ultrafiltrate is resorbed in which region of the uriniferous tubule?
 - A. Proximal convoluted tubule
 - B. Descending limb of Henle's loop
 - C. Ascending limb of Henle's loop
 - D. Distal convoluted tubule
 - E. Collecting tubule

Answer: A

3. Diabetes insipidus leads to hypotonic urine and dehydration. This is due to failure of ADH to regulate water resorption in which region of the uriniferous tubule?
 - A. Afferent arteriole
 - B. Proximal convoluted tubule
 - C. Ascending limb of Henle's loop
 - D. Distal convoluted tubule
 - E. Collecting tubule

Answer: E

Study Guide:

Read and outline Gartner and Hiatt text Chpt 19, pp. 435-460 before lecture

Emphasize clinical correlates in both textbooks:

Gartner and Hiatt pp. 436, 442, 456, and 459

Burns and Cave pp. 186-187 and 189

Work practice problems in Burns and Cave text CD:

Renal/Urinary System = 8Qs

Week 7 Schedule: Study week and Vacation

Day	Date	Time	Modality	Topic	Faculty	Text assignment
M	Nov 21					
T	Nov. 22			Gross Anatomy exam		
W	Nov 23					

Thursday and Friday: Thanksgiving Holiday

Week 8 Schedule: Reproductive Biology

Day	Date	Time	Modality	Topic	Faculty	Text assignment
M	Nov 28	8:00	Exam	Exam III last seating		
M	Nov 28	10:00	Lecture 29	Female Reproductive System I (Ovary)	Childs	B&C 199-215; G&H 461-486
M	Nov 28	11:00	Lecture 30	Female Reproductive System II (Uterus and tubes)	Childs	
						See above
T	Nov 29	9:00	Lecture 31	Placenta	Childs	See above
T	Nov 29	1000	Lab 14	Female Reproductive system	Childs Stanley, Burns, Kane	
W	Nov 30	9:00	Lecture 32	Male Reproductive System	Childs	B& C 190-198; G&H 487-508
W	Nov 30	10:00	Clinical	Maternal-Fetal Medicine	Dr. Helen Kay	
Th	Dec 1	9:00	Gross Anatomy	Development of Reproductive system		L 321-362
Th	Dec 1	10:00	Lab	Male Reproductive system	Childs Stanley, Burns, Kane	
Th	Dec 1	4:15	Tutorial	Review as needed		
F	Dec 2	9:00	Movie	Journey into Life		
		10:00	Lab 16	(Catch up in lab)	Childs Stanley, Burns, Kane	

Key: Blue= Microanatomy-Gross Anatomy correlates; Red=Embryology; Green=tutorials
B&C=Burns and Cave; G&H=Gartner and Hiatt; L=Langman

Exam IV: Urinary and Reproductive System

7 lectures + 3 laboratories=50 questions + 5 review=55 questions

Self schedule beginning 12/2/2005 4—6; 12/3/2004 10—6; 12/4/2004 noon—midnight; 12/5/2004; 8- midnight; 12/6/2004 8—midnight Allow 2 hours Over Urinary and Reproductive Last seating in LRC: Tuesday 8 AM.

Lectures 29, 30, and 31: Female Reproductive

Dr. Childs

Reading Assignment

Read Chapters 561-472 in Gartner and Hiatt and the chapter on the female reproductive system in Burns and Cave. Oviduct and Uterus: pp 472-478; pp 482-483; Implantation and development of the Placenta Reading assignment: Langman section and pp 478-482, Gartner and Hiatt

Learning objectives and lecture outline

OVARY

1. Identify the anatomical parts of the female reproductive system.
2. Define the life stages of the ovary, including events during fetal life, menarch and menopause.
3. Discuss when oogonia stop dividing and the meiotic stage they are in when they stop.
4. Discuss the relationship between sufficient sleep and the normal onset of puberty
5. Describe how the frequency of GnRH pulses differentially affect LH vs FSH secretion.
6. Define menopause and perimenopause.
7. Describe the general organization of the ovary, including the definition of a germinal epithelium.
8. Define the stages of follicular development. Distinguish the following types of follicles: primordial, primary, Multilaminar primary, and secondary follicles.
9. Describe the role of Follicle stimulating hormone on the development of the follicles. Discuss how FSH is regulated.
10. Describe the partnership between the theca interna and granulosa cells in the development of the follicle and important feedback to the pituitary and hypothalamus.
11. Distinguish the role of LH and FSH as the follicle develops and the importance of feedback to each.
12. Define the route and structures used for communication between the granulosa cells and the oocytes.
13. Describe how you might tell if a follicle will mature and ovulate.
14. Define the dominant follicle and discuss how it promotes its own ovulation
15. Define the crucial development steps in the oocytes and follicle just before ovulation including the steps stimulated by LH.
16. Discuss the following: if only one follicle can be dominant/month why begin with so many?
17. Describe the timing of when the primary oocyte becomes a secondary oocyte.

18. Define the term “germinal vesicle breakdown” and discuss how it is used in in vitro fertilization.
19. Define the formation and function of a corpus luteum.
20. Define a corpus albicans and an atretic follicle.
21. Discuss the types and sources of hormones involved at each stage of development:
 - a. Primordial to Primary follicle
 - b. Unilaminar Primary to multilaminar secondary
 - c. Secondary to Graafian follicle
 - d. Corpus luteum
 - e. new crop of follicles for next cycle

Oviduct and Uterus

Assigned reading: pp 472-478; pp 482-483;

1. Describe the wall of the oviduct .
2. Describe each region of the oviduct and its function.
3. Discuss how the mucosa is structured to assist fertilization and transport.
4. Describe the function of the ciliated cells and the direction of movement.
Describe what happens to cilia if the estrogen levels are not maintained.
5. Define Peg cells
6. Discuss the mechanics of how the oviduct works
7. Define the anatomical regions of the uterus.
8. Describe the wall of the uterus.
9. Define the adventitia and note where it is a serosa.
10. Define the myometrium and how it is regulated, hormonally.
11. Define the endometrium, the regions of the endometrium and the functional significance of each.
12. Describe the vascular supply to the endometrium.
13. Define the time and events during the menstrual phase of the menstrual cycle.
14. Define the events during the proliferative phase of the menstrual cycle.
15. Define the events during the secretory phase of the menstrual cycle.
16. Review the hormonal changes during the cycle that lead to changes in the ovary and uterus.
17. Describe the structure and function of the cervix.
18. Describe the wall of the vagina.
19. Describe the external genitalia.

Implantation

Reading assignment: pp 478-482, Gartner and Hiatt

1. Describe the parts of the ovarian follicle that are released during ovulation?
2. Describe each region of the oviduct and its function
3. Discuss where fertilization takes place.
4. Define the role of the Peg cells in the fertilization process.
5. Define the role of the ciliated cells in the oviduct.

6. Define the role of the zona pellucida in the fertilization process.
7. Discuss what helps the sperm get close to the oocyte?
8. Define the acrosome reaction.
9. Discuss two mechanisms whereby polyspermy is prevented?
10. Describe the process that is triggered when the sperm enters the egg?
11. Discuss how the diploid zygote formed?
12. Discuss the route of transport of the embryo to the uterus and how long it takes.
13. Distinguish a morula from a blastocyst.

Placenta formation

(Review your previous lectures and check out the section in Langman)

1. Discuss the structure is involved in implantation.
2. Discuss how the embryonic placenta affect the uterine endometrium.
3. Define the role of the cytotrophoblast and syncytiotrophoblast. in the development of the placenta?
4. Discuss how the uterine endometrium is organized to protect and nourish the embryo. Describe the three regions.
5. Discuss how the placenta is differentiated with respect to the region of the uterus.
6. Describe the formation of the chorion and chorionic villi. Define their function.
7. Describe the cellular barrier to nutrients, comparing that of the young placenta with that of the old placenta.
8. Compare and contrast the mechanism of nourishment to the embryo and fetus: pre-vascular (stromal cells); early invasive into maternal vessels; early and late placenta.
9. Define the hormones that are produced by the syncytiotrophoblast and their function.
10. Discuss the hormone that signals pregnancy and rescues the corpus luteum.
11. In a discussion, compare the formation of the placenta in monozygotic and dizygotic twins.

Competencies

1. Be able to describe the hormonal changes during the menstrual cycle to a patient, including how birth control pills disrupt the cycle and prevent pregnancy.
2. Describe how each of the pituitary hormones helps a follicle develop.
3. Describe the probability of infertility with increasing age to a lay audience and relate to oocyte development.
4. Describe the events that happen at puberty and relate these events to the need for adequate sleep in the pre-pubertal child.
5. Discuss the process of in vitro fertilization relating each step to how the mother is prepared to receive the embryo.
6. Be able to set up tests for fertility knowing the normal relative changes in LH, FSH, estrogen, and progesterone.
7. Be able to read, interpret, and evaluate a basal body temperature chart including the reason for the change in temperature.

8. Be able to evaluate a section of the uterine mucosa to help predict fertility problems. Understand how the changes in the epithelium relate to the ability of the uterus to support a pregnancy.

Sample questions:

1. In multilaminar primary and secondary (antral) follicles, the theca and granulosa cells work together as follows:

- A. Theca cells produce androgen precursors which are converted by granulosa cells to estrogens
- B. Theca cells and granulosa cells both make contact (via gap junctions) with the Oocyte at all levels of development
- C. Both cell type contribute constituents of the zona pellucida
- D. Theca cells produce inhibin and granulosa cells produce activin and together they regulate Follicle stimulating hormone.
- E. Granulosa cells produce androgen precursors which are converted by thecal cells to estrogens.

Answer A.

2. The following are characteristic of a dominant follicle:

- A. Oocyte, corona radiata and cumulus cells are mostly floating in the follicular fluid.
- B. Estrogen:androgen ratio is <1
- C. Meiosis inducing factor expression is rising in granulosa cells
- D. A., B. C.
- E. A. and C only

Answer E.

3. The oviduct supports the oocytes and developing embryo by:

- A. The production of meiosis inducing factor after stimulation by LH
- B. Ciliated cells that beat to help the sperm move towards the oocytes
- C. Undergoing a decidual reaction to nourish the embryo
- D. Nutritive Secretions from Peg cells in the mucosa
- E. Producing human chorionic gonadotropin which stimulates the corpus luteum.

Answer D

4. The secretory phase of the endometrium has the following characteristics:

- A. Glands are straight with mitotic figures and a few droplets of glycogen
- B. Stroma has undergone the decidual reaction
- C. Glands express high levels of p27, an inhibitor of Cyclin E.
- D. Stromal cells are luteinized
- E. Epithelial cells secrete high levels of human chorionic gonadotropin.

Answer C.

5. Once it reaches the uterus, the following can nourish the embryo and fetus.

- A. Nutrients from lacunae fed by maternal vessels to primary villi
- B. Glycogen from decidual cells through invading syncytiotrophoblast
- C. Vessels in tertiary villi
- D. A, B, C.
- E. A and C only

Answer D.

Week 9 Schedule: Review and Exam IV

<i>Day</i>	<i>Date</i>	<i>Time</i>	<i>Modality</i>	<i>Topic</i>	<i>Faculty</i>	<i>Text assignment</i>
M	Dec. 5					
T	Dec 6	8:00-10	Exam	Last seating for Exam IV		
W	Dec 7					
Th	Dec. 8			Study day		
F	Dec 9			Gross Anatomy exam		

Week 10 Schedule: Final exam week Tutorials to be scheduled to cover all topics

<i>Day</i>	<i>Date</i>	<i>Time</i>	<i>Modality</i>		
M	Dec 12	9:00-4:00 PM	Tutorial	REVIEW FOR NBME ALL WEEK NO ICM CLASSES or EXAMS TO BE SCHEDULED!!!	
T	Dec 13	9:00-4:00 PM	Tutorial	REVIEW FOR NBME ALL WEEK NO ICM CLASSES or EXAMS TO BE SCHEDULED!!!	
W	Dec 14	9:00-4:00 PM	Tutorial	REVIEW FOR NBME ALL WEEK NO ICM CLASSES or EXAMS TO BE SCHEDULED!!!	
Th	Dec 15	9:00-4:00 PM	Tutorial	REVIEW FOR NBME ALL WEEK NO ICM CLASSES or EXAMS TO BE SCHEDULED!!!	
F	Dec. 16	1:30-5:00	FINAL EXAM	NBME SHELF EXAM for “Histology & Cell Biology” Actual exam time ~2.5 hrs (~120 Qs = 20% of final course grade)	All students

GUIDE TO THE USE OF THE LABORATORY: Medical Microanatomy 2005

Labs for microscopic anatomy will be 1 – 3 hours long and will meet in the laboratory on the 8th floor of ED II. **Histology Time**, a computerized lab program, will be provided on computers in the laboratory for students to use at their own pace during lab time. Faculty will be in the laboratory during the labs to lend guidance, clarify the material, and answer questions.

Use of **textbooks** and **lecture material** in conjunction with the Histology Time program is expected. Light microscopy (**LM**) derived photographic images on the CD should be studied together with similar photographic images and diagrams of these images in the textbooks. In addition, LM images should be mentally connected with the textbook images of the same structures taken using electron microscopy (**EM**), including transmission electron microscopy (**TEM**), scanning electron microscopy (**SEM**), and freeze fracture techniques.

Textbooks and lecture material should be used during lab to correlate structure with function. In this way, long-term retention will be enhanced and knowledge will be obtained to answer exam questions that not only ask for identification of structures but require knowledge of specific functions.

Students are to use the Histology Time program in the following manner:

- 1) Open the **table of contents** by clicking on the microscope icon in the lower right hand corner of the Histology Time title screen.
- 2) Single click on the title of the **chapter** to be covered during lab as noted in the laboratory instruction pages of this study guide. Refer to number 8 below if you choose the wrong chapter.
- 3) Always study the introductory composite screen for each chapter.
- 4) Click on the “Go To” icon and select the relevant **topics** as noted in the laboratory instruction pages.
- 5) Study the introductory composite screen for each topic covered in the main chapter.
- 6) When additional topics are used in chapters other than the main chapter, do not spend time reading the detailed information in boxes for these additional topics. Such material will usually be covered at another time.
- 7) Click on the “Go To” icon, and study each of the **subtopics** listed under a particular topic.
 - a. If a topic only includes a composite screen and no subtopics, go to the next topic.
 - b. Study the **examples** for each subtopic if provided.
 - i. Study only 5 examples unless a particular cell, tissue, or structure is difficult for you to identify.

- 8) Self examination features are found at icons on the left side of the screen as designated by the following titles:
- a. **Quiz Time**
 - i. Use the Quiz Time exam for each main chapter covered. When individual specific topics are used in chapters other than the main chapter, do not use the Quiz Time exam except in the main chapter.
 - ii. Quiz Time is excellent as it provides photomicrographs and relevant questions to help the student develop skills at identifying cells, tissues, and structures.
 - iii. The total number of questions and the number of the question being viewed is given at the top, right corner of the screen when this feature is opened.
 - iv. Work through as many of the questions as possible during the lab period. Some files of questions are so large that they will cause the computer to freeze up when the upper numbers of questions are reached. Please, be patient with this problem.
 - v. Wrongly answered questions should be flagged by clicking on the “**Flag**” icon. These missed questions can be restudied by clicking on the “**Find Flags**” icon when the last question number is reached as indicated in the top, right corner of the screen. Do not go beyond the last numbered question before clicking on the Find Flags icon, or the flagged questions will be lost.
 - b. **MC Exam**
 - i. Do not use this exam.
 - c. **K Exam**
 - i. Do not use this exam.
- 9) To switch to a different chapter, click on the word “**Chapters**” in the bar at the top of the screen.
- 10) To close the program, click on the word “**File**” in the bar at the top of the screen and choose “**Quit.**”

Note: The Histology Time program is merely a tool to aid the student in learning the material as directed by the faculty through lectures and this course study guide.

LAB 1: Peripheral Nervous System (Week 1)

Dr. Newton

Reading Assignment:

HISTOLOGY TIME (HT) CHAPTER: NERVOUS TISSUE

Learning Objectives:

The student will be able to:

1. Draw a peripheral nerve as seen in both cross section and longitudinal section being sure to include the following labels where appropriate: epineurium, perineurium, endoneurium, axon, myelin, Schwann cell nuclei, fibroblast nuclei, and node of Ranvier.
2. In photomicrographs on the HT program and in textbooks, locate (point to) both longitudinal- and cross-sections of peripheral nerve and be able to identify (point to) the various components of peripheral nerve as listed in objective #1.
3. List distinguishing features of sensory and autonomic ganglia and use this list to identify (name) ganglia seen in photomicrographs. To aid in the identification of ganglia of the Auerbach's plexus and Meissner's plexus, the type of tissue external to each kind of ganglion should be mentioned in the list.
4. Within autonomic and sensory ganglia viewed in photomicrographs, identify (point to) neurons, Schwann cells, satellite cells, and nerve fibers, noting morphological differences in neuronal cell types characteristically found in these autonomic or sensory ganglia and the differing arrangements of the satellite cells.
5. Identify (point to) Pacinian corpuscles and Meissner's corpuscles in photomicrographs, and at the same time, describe the functions and locations of these mechanoreceptors.
6. As an introduction to the Central Nervous System (CNS), distinguish, in photomicrographs on the HT program and in textbooks, the difference between CNS neurons and astrocytes, as well as note the morphology and size differences in several different neuronal types.

Relevant Topics:

Central Nervous System

Pyramidal Cells
Microglial Cells
Cerebellum
Purkinje Cells
Multipolar Neuron - Section
Multipolar Neurons – Nissl

Peripheral Nervous System

Peripheral Nerve Organization
Peripheral Nerve
Myelin Sheath
Axons
Dorsal Root Ganglia
Autonomic Ganglia: Encapsulated
Autonomic Ganglia: Myenteric Plexus (Auerbach's)
Autonomic Ganglia: Submucosal Plexus (Meissner's)
Sensory Receptors: Pacinian Corpuscle
Sensory Receptors: Meissner's Corpuscle

Helpful Hints:

- Notice the difference between Xs and Ls of bundles of smooth muscle as observed in Cell Biology and Xs and Ls of peripheral nerve in the present lab. Peripheral nerve is wavy in Ls and sometimes looks like “crushed ice” in Xs. Axons appear relatively uniform in size and shape in Xs; whereas, smooth muscle cells appear in varying sizes in Xs based on where the Xs was taken on the spindle shaped smooth muscle cells. There are no nuclei found within axons; whereas, smooth muscle cells have centrally located nuclei.
- Satellite cells around dorsal root ganglia (DRG) neurons are more organized than satellite cells around autonomic ganglia neurons because of the round shape and single process of pseudounipolar DRG neurons as opposed to the oval shape and multiple processes of multipolar autonomic ganglia neurons. DRG neurons typically have an abundance of lipofuscin pigment.
- The myenteric plexus (Auerbach's) is between the longitudinally and circularly arranged layers of smooth muscle. The submucosal plexus (Meissner's) is surrounded by loose collagen.
- Neurokeratin is a protein artifact of fixation.
- The neurolemma consists of the plasma membrane of the Schwann cell, not the neuron.
- Neurons usually have prominent nucleoli within their nuclei.
- Purkinje, pyramidal, and alpha motor neurons are the largest neurons in the CNS with much cytoplasmic staining.
- Purkinje neurons are found in the cerebellum, pyramidal neurons in the cerebrum, and alpha motor neurons in spinal cord.
- Granule cell neurons are very small (some < the diameter of an RBC) with very scanty cytoplasm. They are best seen in the cerebellum where millions of them comprise the “granule cell layer.”

- Astrocytes have very large numbers of processes (arms) that arise from their cell bodies. They are best seen with silver stains or with immunohistochemical markers. In H&E and cresyl violet stained tissue, usually only the nuclei are visible.

LAB 2: Integument and Breast (Week 2)

Dr. Kane

Reading Assignment

HT CHAPTERS: INTEGUMENT and FEMALE REPRODUCTIVE SYSTEM
(Breast)

Learning Objectives:

The student will be able to:

1. Identify (point to and name) the layers of the integument as seen in photomicrographs of both thick and thin skin on the HT program and in textbooks and to explain how the epidermis and the dermis connect together. Note: the hypodermis is subcutaneous, superficial fascia.
2. Identify (point to and name) the layers of the dermis and epidermis in photomicrographs while describing their functions and identifying (naming) specific cell types and connective tissue fibers seen in each of these layers.
3. In photomicrographs of epidermis, identify (point to and name) cells containing melanin, cells with keratohyalin granules, cells with many intercellular bridges, and keratin-containing dead cells while telling what layer contains each cell type.
4. Compare and contrast the histology of thick and thin skin as seen in photomicrographs, and give anatomical locations for each of these skin types.
5. By correlating material in the HT program and textbooks, classify the specific cells seen in photomicrographs of the integument according to their mitotic activity using the following terms as appropriate: continuous replicator, vegetative intermitotic, differentiating intermitotic, reverting postmitotic (resting cell), fixed postmitotic (nonreplicator).
6. Identify (point to and name) specialized structures of the integument seen in photomicrographs while describing the functions of these structures and telling which layer(s) of the integument contain them. Specialized structures include: sweat glands, hair, sebaceous glands, Meissner's corpuscles, Pacinian corpuscles.
7. Distinguish the ducts from the secretory portions of sweat glands seen in photomicrographs, and briefly describe the process of eccrine (merocrine) secretion used by both merocrine and apocrine sweat glands.
8. When studying photomicrographs of sweat glands, identify (point to) myoepithelial cells, and describe both the strategic location and the important function of these cells.
9. When hair follicles are observed in photomicrographs, identify (point to) the microanatomical components of the follicles (bulb, papilla,

root/matrix, internal root sheath, external root sheath, connective tissue sheath, keratinized hair shaft) and associated structures (arrector pili muscles, ducts of apocrine sweat glands and sebaceous glands) using information gathered from both the textbook and the HT program.

10. Identify (point to and name) the microanatomical components of the nail in photomicrographs while stating the function of each component. Components include: nail matrix, nail plate, eponychium, and hyponychium.
11. Using textbook illustrations as guides, identify (point to) the following histological components of the mammary gland in photomicrographs on the HT Program and in textbooks: nipple, lactiferous sinuses, lactiferous ducts, lobule, intralobular (loose) connective tissue and ducts, interlobular (dense irregular) connective tissue, and adipocytes. Myoepithelial cells are identifiable only in textbook illustrations.
12. Through observing ducts alone or ducts together with secretory units in photomicrographs of mammary glands, classify the glands as either inactive or active, respectively. If the gland is active, tell what hormones are responsible for the proliferation of alveoli and connective tissue and for milk production and secretion.
13. Identify (point to) the secretory product within alveoli of active (lactating) mammary gland as seen in photomicrographs while stating what secretory mechanisms are responsible for the cellular secretion of milk proteins and lipids.

Relevant Topics (by Chapter):

INTEGUMENT

Thick Skin

- Overview
- Interpapillary Ridges
- Epidermal Layers

Dermal Papillae

Thin Skin

- Overview
- Epidermal Layers
- Dermis: Papillary Layer
- Dermis: Reticular Layer (1 and 2)

Sweat Glands

- Eccrine Glands
- Apocrine Sweat Glands
- Myoepithelial Cells

Hair

- Overview & Follicle
- Bulb
- External Root Sheath
- Arrector Pili Muscle

Sebaceous Glands

Nails
Sensory Structures

FEMALE REPRODUCTIVE SYSTEM

Mammary Gland

Nipple

Inactive Mammary Gland

Proliferative Mammary Gland

Lactating Mammary Gland

Helpful Hints:

- Knowing the functions of the two skin types and the various specialized structures of the integument will make it easier to remember their structural organizations and locations as viewed in lab.
- In the normal condition, the papillary layer of the dermis contains more cells of the immune system and more capillaries than do the reticular layer of the dermis and the epidermis. Defense cells would be expected to be part of the integument since it functions in protection, and they would be expected to be strategically located in the papillary layer of the dermis because this layer is composed of loose connective tissue through which they can easily migrate and monitor the epidermis from below, where they are ready to attack any foreign invaders that make it through the epidermis such as in a wound situation. Capillaries in the papillary layer of the dermis provide a means for nutritive products to diffuse to the near-by, avascular epidermis.
- Although melanocytes make melanin, they transport it immediately to keratinocytes. Therefore, melanin is visible in keratinocytes not in melanocytes.
- The stratum lucidum, present in thick skin, is not usually visible in photomicrographs of sections of the epidermis but can be seen in textbook illustrations.
- Nuclear chromatin patterns, cytoplasmic staining, and cell shape provide clues relating to the function of cells and their role in the function of the structures they compose. For example in sweat glands, heterochromatin is found in the nuclei of the cells that make up the ducts which function as the passage way of excretory products out the gland; whereas, euchromatin is found in the nuclei of cells that form the alveoli which function in the production of sweat.
- Although active mammary glands are further classified as proliferative and lactating in the HT program, use of these more specific classifications is unnecessary for the purposes of this lab when identifying mammary glands in photomicrographs. Use of the terms active mammary gland and inactive mammary gland will suffice.

LAB 3: Blood and Lymph Vessels (Week 2)

Dr. Stanley

Reading Assignment

HT CHAPTERS: CARDIOVASCULAR SYSTEM, LYMPHATIC SYSTEM, and DIGESTIVE SYSTEM (Lacteals):

Learning Objectives:

The student will be able to:

1. Identify (point to and name) vessels in photomicrographs on the HT program and in textbooks while classifying each as one of the following: elastic artery, muscular artery, arteriole, capillary, post-capillary venule, muscular venule, muscular vein, large vein, or lymph vessel.
2. Compare the sizes of the vessels listed in objective #1, and tell where each vessel fits into the pattern of blood flow from the heart into specific tissues and back to the heart.
3. Identify (point to) valves in lymph vessels and in blood vessels in photomicrographs, and describe their histological features. The direction of blood or lymph flow with respect to the orientation of the valve flaps is to be included in the description of the valves.
4. Identify (point to) and state the function of blind-ending lymph capillaries named lacteals found within the center of intestinal villi.
5. In photomicrographs of cross sections and longitudinal sections of blood vessels, identify (point to and name) the three distinct wall layers, and describe the specific composition of each layer using the illustration on page 124 of the Burns and Cave textbook as a guide. Distinguishing characteristics such as each of the following should be included when describing the wall layers of specific vessels:
 - i. Longitudinally arranged smooth muscle in the tunica adventia of large veins.
 - ii. Numerous fenestrated elastic lamina in the tunica media of elastic arteries.
 - iii. Numerous layers of smooth muscle cells in the tunica media and large numbers of elastic lamina in the tunica adventitia of muscular arteries.
 - iv. Absent external elastic lamina in the tunica media of arterioles.
 - v. Absent tunica media and adventia in capillaries.
 - vi. One to two layers of smooth muscle cells in the tunica media of muscular venules.
6. Compare and contrast fenestrated, continuous, and sinusoidal capillaries, and identify (point to) capillaries in photomicrographs noting differences in cell junctions seen in EM's.

7. Distinguish between post-capillary venules characterized by numerous red blood cells in a large lumen and sinusoidal capillaries with relatively fewer red blood cells in a similarly large lumen as seen in photomicrographs.
8. Compare the thickness of the tunica media to that of the tunica adventia within the wall of muscular veins as well as within the wall of large veins when viewed in photomicrographs.

Relevant Topics (by Chapter):

CARDIOVASCULAR SYSTEM

Elastic Arteries
Muscular Arteries
Arterioles
Capillaries
Sinusoidal Capillaries
Post-Capillary Venules
Muscular Venules
Small & Medium Muscular Veins
Large Vein
Valves

LYMPHATIC SYSTEM

Lymph node
 Sinuses Overview
 Afferent Vessels
 Efferent Vessels

DIGESTIVE SYSTEM

Small Intestine
Villi
 Villus Core

Helpful Hints

- As in every microanatomy lab, it is important to study textbook EM's as well as LM's and to relate function to the histological structure.
- Only the structural organization of lymph vessels is to be studied, not the pathway of lymph through lymphatic organs.
- Lymphatic ducts are not shown on the HT program but are considered to have a similar appearance and structure to large veins having longitudinally oriented smooth muscle fibers in the tunica adventitia. Lymphatic ducts lack the presence of red blood cells.

- Vessels typically run in neurovascular bundles consisting of a vein, artery, and nerve. Therefore, when trying to decide if a vessel is an artery or a vein, look for the accompanying vessel and compare the lumen diameter to wall thickness ratio of one vessel to the other. This ratio is normally larger in veins than in arteries. The lumen of veins usually contains red blood cells; whereas, the lumen of arteries usually does not. Look for the peripheral nerve that accompanies the vessels, and review the histology of the nerve.
- The red blood cell is typically used as a histological ruler, meaning that by knowing the size of a red blood cell (7.5 microns in diameter) it is possible to comparatively estimate the size of other structures. For example, the diameter of a capillary is approximately the size of one red blood cell, 7.5 microns.
- When identifying arterioles, remember that the diameter of the lumen of an arteriole is about the same size as the width of its wall, arterioles do not have an external elastic lamina, and the internal elastic lamina is only present in the larger arterioles. The tunica media of arterioles is said to consist of from 1 to 5 layers of smooth muscle depending on sources of information. The actual number is not as important as the fact that arteriole smooth muscle fibers help regulate blood flow into the tissues and organs. Metarterioles empty into capillary beds and have a discontinuous layer of smooth muscle.

LAB 4: Bone, Cartilage, Bone Development (Week 2)

Dr. Stanley

Reading Assignment

HT CHAPTERS: BONE and Cartilage

Learning Objectives, Bone:

The student will be able to:

1. Compare and contrast cancellous (spongy) and compact bone and identify (point to and name) each type in photomicrographs on the HT program and in textbooks. A list of anatomical locations should be included when comparing and contrasting these two types of bone.
2. Identify (point to) the interstitial lamellae (the oldest lamellae) in photomicrographs of ground bone sections of compact bone, and describe how these lamellae formed.
3. Describe the cells, fibers, and intercellular matrix (ground substance) seen in compact bone stating their distinguishing characteristics including but not limited to:
 - a. The morphology of osteocytes and where they reside
 - b. The chemical composition of the matrix
 - c. Type of collagen fibers
4. In photomicrographs of sections of compact bone, identify (point to) osteons and the following components of osteons:
 - a. Haversian Canals (describe their contents)
 - b. Concentric Lamellae (state which concentric lamella is the youngest)
 - c. Lacunae (name what these contain in the living condition)
 - d. Canaliculi (describe their contents and function)
 - e. Cementing lines (describe what these connect)
5. In photomicrographs of compact bone, identify (point to) Volkmann's canals, and compare and contrast these with Haversian canals.
6. Identify (point to and name) each of the three types of bone cells in photomicrographs, and state their distinguishing characteristics, embryonic origins, and functions given in lecture and in the textbook. Particular chemical factors that stimulate or inhibit these cells should be mentioned as well as roles cells have in disease.
7. In photomicrographs of longitudinal sections of compact bone, identify (point to) periosteum, Sharpey's fibers, and endosteum being sure to distinguish active and non-active periosteum and to identify (point to and name) the layers of the periosteum.

Learning Objectives, Bone Formation:

The student will be able to:

1. Write a list of characteristics of intramembranous and endochondral bone formation, and use this list to aid in the identification of these two types of formation in photomicrographs. Examples of human bones formed by intramembranous or endochondral bone formation should be included in the list.
2. When viewing photomicrographs of developing bone (intramembranous and endochondral), identify (point to) blood vessels, and state their role in bone development.
3. Identify (point to and name) cells involved in bone development, and compare and contrast them with cells seen in mature bone. Functions of cells should be stated, and the roles of mesenchymal cells and chondrocytes in bone development should be compared and contrasted.
4. In photomicrographs of bone being formed by intramembranous ossification, identify (point to) osteoid and bone, and state differences between fresh osteoid, mineralized osteoid, and bone as learned in lecture and in textbooks.
5. In photomicrographs of long bone undergoing endochondral ossification:
 - a. Identify (point to and name) the cartilage comprising the cartilage model.
 - b. Distinguish between the primary and secondary centers of ossification, and describe how they are formed.
 - c. Identify (point to and name) each of the following growth zones visible in both the epiphyseal cartilage and epiphyseal plate:
 - i. Resting chondrocytes
 - ii. Proliferating chondrocytes
 - iii. Hypertrophying chondrocytes
 - iv. Calcifying/calcified cartilaginous spicules
 - d. Describe the process occurring in each identified growth zone.
 - e. When viewing a calcified cartilaginous spicule, identify (point to) each of the following: fresh osteoid (only seen on EM's), mineralized osteoid, and calcified cartilage.
 - f. Identify (point to) each of the following:
 - i. Bone marrow cavity (explain how it forms)
 - ii. Synovial cavity and articular cartilage
 - iii. Metaphysis, diaphysis, and epiphysis
 - iv. Bony collar (explain its role in long bone development and the significance of it being infiltrated by blood vessels)
6. When only a single bony spicule is visible in a photomicrograph of developing bone, tell if this spicule is undergoing endochondral or

intramembranous ossification by determining if the center of the spicule contains calcified cartilage or mineralized bone, respectively.

Learning Objectives, Cartilage:

The student will be able to:

1. Identify (point to) hyaline cartilage, elastic cartilage, and fibrocartilage in photomicrographs on the HT program and in textbooks, and write a list of the distinguishing characteristics and anatomical locations of each type of cartilage.
2. Identify (point to) isogenous groups (nests or rows) of chondrocytes while naming the type of cartilage in which they are found and describing the process that leads to their formation.
3. In photomicrographs of bone and cartilage, identify (point to) lacunae and compare and contrast them in bone and cartilage.
4. When viewing photomicrographs of hyaline cartilage, locate (point to) territorial (capsular) and interterritorial matrix; tell why territorial matrix stains more intensely than interterritorial matrix; and identify (point to and name) the cells that produce the matrix.
5. In photomicrographs of cartilage, identify (point to) perichondrium, and name two specific cases where perichondrium is absent.
6. Locate (point to) elastic fibers in elastic cartilage.
7. In photomicrographs of sections of fibrocartilage stained with trichrome stain, identify (name) the numerous blue stained fibers.

Relevant Topics (by Chapter):

BONE

- Osteons
- Lacunae & Canaliculi
- Cementing Lines
- Vascularization

Compact Bone

Spongy Bone

Intramembranous Bone

Overview

- Bony Spicules
- Osteoid

Endochondral Bone 1

- Primary Ossification Center

- Bony Collar

- Epiphyseal Cartilage

- Secondary Ossification

Endochondral Bone 2

- Epiphyseal Plate

Calcified Cartilage Spicules
Periosteum
Active
Quiescent

CARTILAGE

Hyaline Cartilage
Epiphyseal Plate
Fetal Bone
Articular Cartilage
Chondrocytes
Elastic Cartilage
Fibrocartilage

Helpful Hints:

- Another name for osteon is Haversian system.
- Decalcified bone and ground bone (calcium still present) are two different histological preparations of compact bone which allow for visualization of different components of bone. For example, cementing lines are most easily seen in sections of decalcified bone; canaliculi are most visible in sections of ground bone. In decalcified bone, collagen fibers remain and are eosinophilic so the bone appears pink.
- The terms spicules and trabeculae are both used in reference to cancellous bone. Spicules have the appearance of peninsulas; whereas, trabeculae refer to spicules that anastomose with each other and give cancellous bone a meshwork appearance.
- During bone development spicules have different appearances depending on if they are undergoing endochondral or intramembranous ossification. In contrast, mature spicules have the same appearance, and it is not possible to know by appearance alone whether mature spicules originated by intramembranous or endochondral ossification.
- The terms “epiphyseal cartilage” and “epiphyseal plate” both refer to the site of endochondral ossification in the epiphysis. However, when only a primary ossification center exists (diaphyseal), the term epiphyseal cartilage is used. When both a primary (diaphyseal) and a secondary (epiphyseal) ossification center are present, the term epiphyseal plate is used.
- Collagen fibers of both elastic and hyaline cartilage consist of type II collagen; whereas, the collagen fibers of fibrocartilage consist of type I collagen as do those of bone.

LAB 5: Blood, Blood Cell Development/Bone Marrow (Week 3)

Dr. Drew

Reading Assignment

HT CHAPTERS: CIRCULATING BLOOD and BONE MARROW

Learning Objectives

The student will be able to:

1. Immediately distinguish between a blood smear and a bone marrow smear as seen in photomicrographs on the HT program and in textbooks.
2. When viewing photomicrographs of blood smears:
 - a. Identify (point to) red blood cells and white blood cells, and state the function of red blood cells.
 - b. Tell if each identified white blood cell is an agranulocyte or granulocyte.
 - c. State the specific name of each identified white blood cell as neutrophil, eosinophil, basophil, lymphocyte, or monocyte; and write a list of their distinguishing characteristics and functions being sure to include the contents of granules in the granulocytes.
 - d. Compare and contrast the sizes of blood cells seen in photomicrographs using the red blood cell (7.5 microns) as a reference and stating the approximate diameter of each cell type in microns. For example, when a neutrophil is identified, look at the red blood cells around it, and estimate how many red blood cells it would take to span the width of the neutrophil. Be sure to do this for each white blood cell type.
 - e. State the normal differential count percentage for each identified white blood cell.
 - f. Identify (point to) platelets, and state their origin and functions.
 - g. Match photomicrographs of LM's of adult blood cells on the HT program to EM's when found in the textbook, and state ultrastructural features (EM) of each cell type visualized.
3. When viewing photomicrographs of bone marrow smears:
 - a. Identify (point to) developing blood cells, and state whether each identified cell is undergoing granulopoiesis or erythropoiesis.
 - b. Distinguish between developing and mature blood cells.
 - c. Identify (name) each developing blood cell as one of the following: blast cell, promyelocyte, myelocyte, metamyelocyte, band (stab), basophilic erythroblast,

- polychromatophilic erythroblast, or orthochromatophilic erythroblast.
- d. Identify (point to) the basophilic cytoplasm of the earliest cells undergoing erythropoiesis, and tell why the cytoplasm stains blue.
 - e. Identify (point to) azurophilic and specific granules in cells undergoing granulopoiesis, and tell if specific granules are neutrophilic, basophilic, or eosinophilic (only obvious in the more mature cells).
 - f. Identify (point to) nucleoli in cell nuclei, and tell at what stage of erythropoiesis and granulopoiesis these disappear.
 - g. Match photomicrographs of LM's of developing blood cells on the HT program to EM's when found in the textbook, and state ultrastructural features (EM) of each cell type visualized.
4. Write a list of the distinguishing characteristics for each cell stage of erythropoiesis using the HT program and the textbook as guides.
 5. Write a list of the distinguishing characteristics for each cell stage of granulopoiesis being sure to highlight the following:
 - a. Nucleoli are present in myeloblasts and promyelocytes but not in subsequent stages beginning with the myelocyte.
 - b. Myeloblasts have neither azurophilic nor specific granules.
 - c. Promyelocytes have the most numerous azurophilic granules.
 - d. The myelocyte is the first stage to have specific granules (neutrophilic, basophilic, or eosinophilic) and has many fewer azurophilic granules than the promyelocyte.
 - e. Metamyelocytes have eccentrically located, deeply indented nuclei.
 6. Distinguish between a bone marrow smear and sectioned bone marrow, and identify (point to) megakaryocytes, hematopoietic tissue, fat cells, sinusoidal capillaries, marrow cavity, and bone spicules in sectioned bone marrow.
 7. Distinguish yellow from red bone marrow in photomicrographs, and state where red bone marrow is located in the body.
 8. Identify (point to) the single but lobulated, polyploid nucleus within megakaryocytes seen in photomicrographs of sectioned bone marrow, and state the function of these cells.

Relevant Topics (by Chapter):

CIRCULATING BLOOD

Erythrocytes
Neutrophils
Eosinophils
Basophils
Lymphocytes
Monocytes

Platelets

BONE MARROW

Erythropoiesis

- Proerythroblast
- Basophilic Erythroblast
- Polychromatophilic Erythroblast
- Orthochromatic Erythroblast

Granulopoiesis

- Myeloblast
- Promyelocyte
- Myelocyte
- Metamyelocyte
- Band Cell

Megakaryocyte

Sectioned Bone Marrow

Helpful Hints

- A normal differential count for a blood smear should be approximately: 70% neutrophils (1% may be bands or stabs), 3% eosinophils, 1% basophils, 20% lymphocytes, and 6% monocytes.
- Granulocytes are named based on the staining properties of their granules being neutral, basophilic, or eosinophilic.
- Hemopoiesis includes: erythropoiesis, granulopoiesis, monopoiesis, and lymphopoiesis; however, only erythropoiesis and granulopoiesis are to be studied in lab.
- It is not necessary to distinguish between a myeloblast and a proerythroblast; these early cells can both be referred to as “blast cells.” Younger cells have prominent nucleoli and are relatively larger compared to more mature cells. Identification of cells in the more mature stages is easier than identification of cells in the younger stages so learn the more mature stages first.
- Development of blood cells is a process so cells that have just entered a particular stage will look larger and less mature than cells that are nearing the end of that stage. For example, an early promyelocyte will be closer in size to a myeloblast; whereas, a late promyelocyte will be closer in size to a myelocyte.
- Metamyelocytes and orthochromatophilic erythroblasts are the first cells of each line considered to be fixed postmitotic cells. All of the earlier cells to be identified in lab, beginning with the blast cells, can still divide and are considered to be differentiating intermitotics.

- Nomenclature for cells during erythropoiesis varies dependent upon the source. Some authors use the term “normoblast” instead of “erythroblast” in naming each stage. For example a polychromatophilic erythroblast would be called a polychromatophilic normoblast. Other authors use the terms rubriblast, prorubricyte, rubricyte, and metarubricyte instead of proerythroblast, basophilic erythroblast, polychromatophilic erythroblast, and orthochromatophilic normoblast, respectively. Some authors use “cyto” in terminology for blood cell development, such as erythropoiesis being written “erythrocytopoiesis,” but this does not change the meaning of the terms.
- Reticulocytes are newly formed red blood cells that have just left the orthochromatophilic erythroblast stage and have a distinct cytoplasmic reticular network of rRNA which appears blue when stained supervitally with cresyl blue or methylene blue. Although these cells are not readily visible in routinely stained blood smears in photomicrographs on the HT program, be aware of their existence and function in erythropoiesis as mentioned in lecture.
- Azurophilic (blue-purple) granules are lysosomes and are considered to be “non-specific” granules; whereas, “specific granules” contain numerous enzymes and proteins specific to the function of the cells and stain neutral, basophilic, or eosinophilic.
- The specific stages of hemopoiesis cannot be easily identified in sectioned bone marrow so there is no need to attempt such identification.

LAB 6: Defense/Immune System (Week 3)

Dr. Drew

Reading Assignment

HT CHAPTER: LYMPHATIC SYSTEM

Learning Objectives:

The student will be able to:

1. Write a list of lymphatic tissues and organs using the following headings and placing each tissue or organ under the appropriate one: least complex, moderately complex, most complex.
2. When studying photomicrographs on the HT program and in textbooks, identify (name) each tissue or organ listed in objective #1.
3. When diffuse lymphatic tissue is identified in photomicrographs on the HT program and in textbooks, describe its location such as in the connective tissue below the stratified squamous epithelium, infiltrating the epithelium, or below the simple columnar epithelium.
4. Distinguish between primary and secondary lymphatic nodules, and state the differences between lymphocytes found in the germinal center and in the corona of a secondary lymphatic nodule.
5. Identify (name) tonsils seen in photomicrographs as palatine, pharyngeal, or lingual by observing the type of epithelium lining each tonsil; and identify (point to) important characteristics such as crypts and lymphatic nodules in all three types and extensive infiltration of the epithelium.
6. When lymph nodes are viewed in photomicrographs, describe the flow of lymph through the lymph node, and identify (point to) each of the following:
 - a. Capsule
 - b. Cortex
 - c. Paracortex
 - d. Lymphatic Nodules
 - e. Lymphocyte
 - f. Reticular Cell
 - g. Plasma Cell
 - h. Medulla
 - i. Afferent Lymphatic (with valves)
 - j. Subcapsular Sinus
 - k. Paratrabecular (Trabecular) Sinus
 - l. Trabeculum
 - m. Medullary Cords
 - n. Medullary Sinus
 - o. Efferent Lymphatic (with valves)
 - p. Hilus
 - q. Reticular Fibers (special stains)

7. Identify (point to and name) specific areas of the lymph node telling if each area contains B and/or T lymphocytes.
8. When spleen is identified in photomicrographs, identify (point to) and state the function of the following structures:
 - a. Capsule (lined externally by a mesothelium)
 - b. White Pulp
 - i. Lymphatic Nodules (mainly B lymphocytes)
 1. Germinal Center
 2. Corona
 3. Central Artery
 - ii. Periarteriolar Lymphatic Sheath of T lymphocytes
(surrounds a central artery but has no germinal center)
 - c. Trabeculum
 - d. Trabecular Artery
 - e. Red Pulp
 - i. Splenic Cords (of Billroth)
 1. red blood cells
 - ii. Splenic Sinuses
 1. basement membrane
 2. endothelial cells
9. Identify (point to and name) blood vessels coursing through the spleen, and discuss the open and the closed theories of circulation through the spleen.
10. When viewing photomicrographs of thymus, identify (point to) the following structures: capsule, lobules, cortex, medulla, Hassall's corpuscles, epithelial reticular cells, lymphocytes, and blood vessels.

Relevant Topics:

Diffuse Lymphatic Tissue
 Lymphatic Nodules
 Palatine Tonsil
 Pharyngeal Tonsil
 Lingual Tonsil
 Lymph Nodes
 Lymph Node Organization
 Sinuses Overview
 Subcapsular Sinuses
 Trabecular Sinuses
 Medullary Sinuses
 Afferent Vessels
 Efferent Vessels
 Reticular Fibers

Spleen

- Spleen Organization
- White Pulp Overview
 - White Pulp Nodules
 - Central Artery
- Red Pulp Overview
 - Red Pulp
 - Red Pulp: Splenic Cords
 - Red Pulp: Splenic Sinuses
- Vascularization

Thymus

- Thymus Organization (1 and 2)
 - Cortex
 - Medulla

Helpful Hints:

- Lymphatic nodules can be found alone, in aggregates (in the ileum as Peyer's patches, in tonsils, or in the appendix), and located in organs such as lymph nodes and spleen. There are no lymphatic nodules in the thymus.
- Palatine tonsils are typically referred to as "the tonsils" in clinical settings and are easily viewed when a patient opens the mouth and says "ahhh." They are located on the posterior lateral walls of the oropharynx between the palatoglossal and palatopharyngeal arches to be studied in gross anatomy.
- Pharyngeal tonsils are difficult to see without the use of a mirror because they are located in the posterior wall of the nasopharynx. They are called "adenoids" when they become enlarged during infections.
- Lingual tonsils are located in the submucosa at the base of the tongue and can easily be seen when using a tongue depressor.
- It is not necessary to identify paracortical sinuses in photomicrographs of lymph nodes although it is necessary to know these connect the trabecular and medullary sinuses. Also, be aware that high endothelial venules (for lymphocyte recognition and segregation) are located in the paracortex although these need not be identified in photomicrographs.
- Reticular fibers are prevalent and provide structure in lymph nodes as in other organs such as liver and kidney which do not typically expand and contract.
- Learn the blood flow through the spleen as follows: splenic artery, trabecular arteries, central arteries, penicilli (red pulp artery, sheathed artery, and terminal capillaries), splenic sinuses or splenic cords, veins of the pulp, trabecular veins, and

splenic vein. Only the larger vessels, sinuses, and cords need to be identified in photomicrographs.

- Sections of thymus viewed on photomicrographs in the HT program are from young individuals. The thymus involutes and is infiltrated with adipose tissue after puberty, and the number of Hassall's corpuscles (found only in the medulla) increases with age.
- T lymphocytes enter the thymus to become immunocompetent as they move from the cortex to the medulla. The blood thymus barrier consists of continuous capillaries, with a thick basal lamina, surrounded by type 1 epithelial reticular cells.

LAB 7: Eye and Ear (Week 4)

Dr. Stanley

Reading assignment

HT CHAPTER: SPECIAL SENSES

Learning Objectives:

In photomicrographs on the HT program and in textbooks, the student will be able to identify (point to):

1. Each of the following components of the eye:
 - a. Cornea
 - b. Lens
 - c. Vitreous Body
 - d. Retina
 - e. Intraretinal Space (fetus only, refer to lecture)
 - f. Optic Nerve
 - g. Iris (adult only)
 - h. Anterior Chamber (adult only)
 - i. Posterior Chamber (adult only)
2. The following parts of the lens:
 - a. Lens Fibers
 - i. Nuclei (in fetal eye)
 - b. Anterior Cuboidal Epithelium (compare in fetus and adult)
 - c. Lens Capsule (adult only)
3. The following parts of the cornea:
 - a. Endothelium
 - b. Descemet's Membrane
 - c. Stroma
 - d. Bowman's Membrane
 - e. Corneal Epithelium (simple cuboidal)
4. The following components of the iris: pigmented epithelial cells, sphincter pupillae muscle (circular smooth muscle), and connective tissue (pigment cells and fibroblasts).
5. The iridocorneal angle while describing its components, where it is located, and the significance of the trabecular meshwork and canal of Schlemm.
6. The source of aqueous humor.
7. Each of the structures involved in accommodation for near vision while describing their microanatomy.
8. The following layers of the retina in photomicrographs of adult eye (pigment layer is visible in fetal eye), and describe the pathway light

takes from the vitreous body through each of these layers and the function of each layer in conveying a response to light:

- a. Pigment Epithelium
 - b. Layer of Rods and Cones Receptors
 - c. Outer Limiting Membrane (formed by what cells?)
 - d. Outer Nuclear Layer (nuclei of what cells?)
 - e. Outer Plexiform Layer (synapses between what cells?)
 - f. Inner Nuclear Layer (nuclei of what cells?)
 - g. Inner Plexiform Layer (synapses between what cells?)
 - h. Ganglion Cell Layer
 - i. Nerve Fiber Layer (from what cells? forms what?)
 - j. Inner Limiting Membrane (formed by what cells?)
9. The sclera and the choroid, and describe their histological composition, functions, and locations relative to the retina, cornea, and iris.
10. The optic disk, optic nerve, and the lamina cribrosa; and state the name of the two vessels that course through the optic nerve.
11. The cochlea including the modiolus, spiral ganglion (what type of neurons?), vestibular membrane, basilar membrane, scala vestibule, scala media, and scala tympani. A description of the fluids contain within the last three structures should be stated, and the names of which of these three communicate with the round window and the oval window should be given. The function of the helicotrema should be associated with the appropriate structures.
12. The organ of Corti including: inner and outer hair cells, inner and outer phalangeal cells, inner and outer pillar cells, the inner tunnel, and stereocilia.
13. Each of the following structures of the inner ear, and state their functions:
- a. Stria Vascularis (produces what fluid?)
 - b. Spiral Ligament (anchors what?)
 - c. Osseous Spiral Lamina (part of what larger bony structure?)
 - d. Limbus Spiralis (produces what?)
 - e. Tectorial Membrane (what relationship to hair cells?)
 - f. Internal Spiral Sulcus
 - g. Afferent nerve fibers (dendrites) of spiral ganglion neurons (receive afferent input from what cells?)
14. A crista ampullaris and receptor epithelium, and describe the location of cristae within the inner ear, the fluid surrounding the cristae, the cupula, the type of movement detected, and the innervation of the cristae.

Relevant Topics:

Introduction

Fetal Eye Overview

Fetal Eye: Retina and Lens

Adult Eye

Introduction

- Cornea
- Iris and Lens
- Iridocorneal Angle
- Ciliary Processes
- Retina
- Optic Nerve

Inner Ear

- Cochlea Introduction
- Cochlea Overview (1 and 2)
- Organ of Corti
- Spiral Ganglion
- Crista Ampullaris

Helpful Hints:

- When viewing photomicrographs of the cornea, remember that with regard to light traveling through the eye, the greatest refraction (bending) of light occurs as the rays of light travel from the air into the cornea.
- Refer to figures 22-4 and 22-17 of Gartner and Hiatt and figures 19-1 and 19-3 of Burns and Cave when studying the various components of the eye and ear, respectively. Relating the anatomy of the eye and the inner ear to the microanatomy of individual components of each facilitates comprehension of structure and function.
- In the HT program and in Gartner and Hiatt, the term “cochlear nerve” is used to describe the afferent (dendritic) branches of the bipolar spiral ganglion neurons. In the neuroscience course and in gross anatomy, the term “cochlear nerve” is used to refer to the efferent (axonal) branches of these bipolar neurons, collectively forming a nerve visible without the aid of a microscope and which can be seen entering the brainstem.
- Although there are no photomicrographs of maculae within the saccule and utricle, be aware that the maculae of both contain small stones called “otoliths” and that the macula of the saccule detects linear, vertical acceleration; whereas, the macula of the utricle detects linear, horizontal acceleration.

LAB 8: Respiratory System (Week 4)

Dr. Stanley

Reading Assignment

HT CHAPTER: RESPIRATORY SYSTEM

Learning Objectives:

The student will be able to:

1. Make a list of structures of the respiratory system categorizing each structure as part of the conducting or respiratory portion of the respiratory system and writing down distinguishing characteristics of each structure as seen in photomicrographs on the HT program and in textbooks. Define the transition point at which the conducting changes to the respiratory portion.
2. Identify (point to and name) the type of epithelium that lines the nasal passages in photomicrographs, and identify (point to and name) associated structures responsible for warming the air or producing mucus.
3. Compare and contrast the following, and distinguish between each pair in photomicrographs:
 - a. The trachea and bronchi while describing characteristics of the mucosa, lamina propria, submucosa, and adventitia.
 - b. Bronchi and bronchioles.
 - c. Alveolar ducts and alveolar sacs.
 - d. Pneumocytes type I and type II.
4. In photomicrographs of trachea, identify (point to) submucosal seromucous glands, and distinguish between those with and without serous demilunes, those that are purely serous or purely mucous, and the ducts of these glands.
5. Identify (name and point to) the division of the respiratory system where:
 - a. The trachealis muscle is located.
 - b. The goblet cells end but cilia remain, and describe the function and mode of operation of goblet cells and cilia.
 - c. Clara cells are located.
 - d. A smooth muscle cell layer is last seen beneath the epithelium.
 - e. Pneumocytes type I and II are located.
 - f. Knobs of smooth muscle are present.
6. Identify (point to) visceral pleura, and describe its composition.
7. Describe the respiratory membrane where gaseous exchange occurs, and identify (point to and name) its components as seen in LM and EM photomicrographs.

8. Identify (point to and name) cells that produce surfactant, and describe the function of surfactant.
9. Identify (point to) elastic fibers in photomicrographs of lung tissue stained for elastin.
10. Describe the function, contents, and the locations of alveolar macrophages, and identify (point to) these cells in photomicrographs.

Relevant Topics:

Introduction (1 and 2)
Olfactory Mucosa
Trachea
 Survey View (1 and 2)
 Epithelium
 Seromucous Glands
Bronchi
Bronchioles
Terminal Bronchioles
Respiratory Bronchioles
Alveolar Ducts
Alveolar Sacs
Alveoli
 Survey View
 Capillaries
 Type II Pneumocytes
 Smooth Muscle
Elastic Fibers
Visceral Pleura
Intra-Alveolar Macrophages

Helpful Hints:

- Intrapulmonary bronchi have lung tissue located around them in contrast to extrapulmonary bronchi which do not.
- Pseudostratified ciliated columnar epithelium (PSCC), containing goblet cells, is sometimes called “respiratory epithelium” but is confined to the larger structures of the conducting portion of the respiratory system.
- Photomicrographs of the larynx and epiglottis are not provided. However, an understanding of the function of these two structures provides the means for remembering their histology. The epiglottis is lined by stratified squamous wet epithelium on the anterior (digestive) surface and by PSCC on the posterior (respiratory) surface and has a core of elastic cartilage. In the larynx, the true vocal fold is lined by stratified squamous wet epithelium and contains a core of elastic connective tissue referred to as the “vocal ligament”

which is connected to skeletal muscle, the “vocalis muscle,” for creating sounds associated with speech. The false vocal fold, located superior to the true vocal fold, is lined by PSCC.

LAB 9: Endocrine System (Week 5)

Dr. Childs

Reading Assignment

HT CHAPTER: ENDOCRINE SYSTEM

Learning Objectives:

The student will be able to:

1. List the names of the encapsulated endocrine glands, and identify (point to and name) these glands and pancreatic islets in photomicrographs on the HT program and in textbooks.
2. Identify (point to) sinusoidal capillaries in photomicrographs of each endocrine gland studied, and write a list of chemical factors that these capillaries carry away from and bring to each endocrine gland. Be sure to state specifically where these factors originate.
3. Identify (point to) and describe the following regions of the pituitary gland in photomicrographs: pars distalis, pars intermedia, and pars nervosa. The names of hormones associated with each region should be given, and each region should be categorized as either adenohypophysis or neurohypophysis. Figures 13-2 of Gartner and Hiatt and 18-1 of Burns and Cave should be used to correlate the location of these regions with the general anatomy and the blood supply of the pituitary gland and with structures not shown in photomicrographs such as the pars tuberalis and the median eminence.
4. Locate (point to) acidophils, basophils, and chromophobes in photomicrographs of the pars distalis of the pituitary while stating which of the following functional types apply to each: mammotrophs (prolactin), somatotrophs (GH, somatotropin), corticotrophs (ACTH), gonadotrophs (FSH and LH), thyrotrophs (TSH), or degranulated chromophils.
5. Locate (point to) basophils and colloid-containing cysts in the pars intermedia, and state what hormone is produced by the basophils.
6. Make a list of endocrine glands and their specific regions where colloid is seen in photomicrographs, and state the possible function of colloid in each of these glands.
7. Identify (point to) axons, pituicytes, and Herring bodies (visible in textbook only) in photomicrographs of the pars nervosa of the pituitary gland, and state the function of each including an explanation of where the associated hormones are produced and how they reach the pars nervosa.
8. Identify (point to) lobules, pinealocytes, astroglia, and corpora arenacea in photomicrographs of pineal gland, and describe the function of the pineal gland.

9. Distinguish between chief cells and oxyphils in photomicrographs of the parathyroid gland, and describe which cell type produces parathyroid hormone, the function and mechanism of action of parathyroid hormone (what bone cell it stimulates), and the location of the parathyroid glands in the human body.

10. Identify (point to) thyroid follicles in photomicrographs of the thyroid gland, and describe their epithelium, contents, and function. Be sure to include an explanation of how thyroid hormone is produced, stored, and secreted.
11. In photomicrographs of the thyroid gland, identify (point to and name) the cells that produce calcitonin, and describe their location as well as the function and mechanism of action of calcitonin.
12. Distinguish between the cortex and the medulla of the adrenal gland in photomicrographs, and state the embryonic origin of each.
13. Identify (point to) each of the following in photomicrographs of adrenal gland, list the products they produce (noting the functional classification of each product), and describe their morphology and specific location within the cortex (i.e., outermost, middle, or deepest region) or medulla:
 - a. Zona glomerulosa
 - b. Zona fasciculata
 - c. Zona reticularis
 - d. Chromaffin cells
 - e. Ganglion cells (for the purpose of this course, these are considered to be “sympathetic” not parasympathetic as the HT program states)
14. Identify (name and point to) the endocrine portion of the pancreas in photomicrographs, and describe how the endocrine structures differ in appearance from the exocrine structures.
15. Identify (name) the specific types of endocrine cells within the Islets of Langerhans and each cell’s endocrine product, and state why these cell types cannot be visibly distinguished from each other in the photomicrographs on the HT program.

Relevant Topics:

Pituitary

Organization

Pars Distalis

Acidophils

Basophils

Chromophobes

Capillaries

Colloid

Pars Intermedia
Pars Nervosa
Pineal Gland
Parathyroid Gland
 Organization
 Chief Cells
 Oxyphil Cells
Thyroid
 Organization
 Follicles
 Parafollicular Cells
 Capillaries
Adrenal Gland
 Organization
 Zona Glomerulosa
 Zona Fasciculata
 Zona Reticularis
 Medulla
 Capillaries
Islets of Langerhans

Helpful Hints:

- Be aware that the numerous sinusoidal capillaries throughout endocrine glands serve as functional ducts for transport of hormones out of the glands and serve as channels for import of releasing and inhibitory factors that act on the cells of the endocrine glands.
- Releasing hormones (sometimes called releasing factors) produced by the hypothalamus affect the various endocrine glands. The names of these releasing hormones usually indicate which endocrine gland cells they will act upon.
- Synonymous names are given for different regions of the pituitary gland. For instance, the adenohypophysis is also called the anterior pituitary, and the neurohypophysis is also called the posterior pituitary. To prevent confusion, use the list on page 302 of Gartner and Hiatt when studying the pituitary.
- When identifying endocrine cells using the Quiz Time portion of the HT program, be sure to look at the cells and tissue surrounding the individual cell at the tip of the pointer. Endocrine cells can have similar appearances, such as oxyphils and acidophils, and the only way to distinguish between them is to first identify what organ is viewed in the photomicrograph.
- Acidophils and basophils of the pituitary are collectively referred to as “chromophils” given their affinity for eosinophilic or basophilic dyes, respectively. Degranulated acidophils and basophils do not retain this affinity and therefore are referred to as “chromophobes” and have no color.
- In order to understand the endocrine system, it is important to know the function of the various hormones produced by the cells of the endocrine glands. Therefore, when cells are visualized in lab, immediately think of what hormone they produce and the function of the hormone.

- The presence of fat in the parathyroid gland is a useful characteristic for distinguishing this gland from other glands such as the adenohypophysis which has a similar appearance but no fat.
- Although single cell endocrine glands (DNES or APUD cells) are not covered in this chapter of the HT program, these cells will be studied with the digestive system. Cardiac cells that produce ANF (ANP) are best viewed in figure 8-22 of Gartner and Hiatt.

LAB 10: Histology of the Heart and Heart Development (Week 5)

Drs. Burns & Stanley

Reading Assignment

HT CHAPTER: CARDIOVASCULAR SYSTEM (HEART)

OPTIONAL HEART MODELS AND LANGMAN CHAPTER 11: ILLUSTRATIONS ON PAGES 230 - 267

Learning Objectives:

The student will be able to:

1. Identify (point to and name) the three layers of the heart wall and describe characteristic features of each layer.
2. Name the specific layer of the endocardium that contains Purkinje fibers and distinguish Purkinje fibers from normal cardiac muscle cells in photomicrographs.
3. Compare and contrast epicardium and endocardium as seen in photomicrographs.
4. Describe the normal development of the heart and great vessels while pointing to structures illustrated in the Langman textbook. Subsequently, do the same for abnormal development. The lecture guide/handout describing the normal and abnormal development of the heart and great vessels should be referred to during this activity.
5. **OPTIONAL:** Use the series of models depicting the development of the heart to identify (point to and name) 3D structures while describing the normal developmental process. Note that this is an optional activity, i.e., NO models or images of these models will be used for test questions. Many of the named structures in the lecture handout can be identified (pointed to) in the series of models.

Relevant Topics, Histology of the Heart:

Heart Introduction

Endocardium & Myocardium

Epicardium & Myocardium

HT REVIEW Topics:

HT CARDIOVASCULAR SYSTEM CHAPTER

Elastic Arteries

Large Veins

Valves

HT MUSCLE CHAPTER

- Cardiac Muscle
- Longitudinal Section
- Cross Section
- Intercalated Disks
- Purkinje Fibers

Relevant Topics, Heart Development

Langman Illustrations and Heart models in lab)

Relevant Topics, HEART DEVELOPMENT (Langman Illustrations, Optional Heart Models):

- Endothelial Heart Tubes
- Bulbus Cordis
 - Conus Cordis
 - Truncus Arteriosus
 - Proximal Part Aorta
 - Proximal Part Pulmonary Trunk
 - Trabeculated Part of Right Ventricle
 - Truncocoanal Ridges
 - Semilunar Valves
 - Spiral Aorticopulmonary Septum
 - Aorta
 - Pulmonary Trunk
 - Membranous Part Interventricular Septum
- Ventricle
 - Bulboventricular flange and sulcus
 - Primary Interventricular Foramen
 - Trabeculated Part of Left Ventricle
 - Trabeculae Carneae
 - Papillary Muscles
 - Interventricular Foramen
 - Interventricular Septum
 - Muscular Portion of Interventricular Septum
 - Interventricular Sulcus
 - Endocardial Cushions
 - Antero-superior
 - Postero-inferior
 - Membranous Part Interventricular Septum
- Atrioventricular Canal
 - Atrioventricular Valves
- Atrium
 - Primitive Right and Left Atria
 - Crista Terminalis
 - Septum Primum
 - Ostium Primum
 - Ostium Secundum
 - Valve of Oval Foramen
 - Septum Secundum
 - Oval Foramen
 - Crista Dividens

- Pulmonary Vein
 - Smooth Wall of Left Atrium
 - 4 Pulmonary Veins
- Sinus Venosus
 - Right Sinus Horn
 - Superior and Inferior Vena Cava
 - Sinus Venarum (Smooth Wall of Right Atrium)
 - Sinuatrial orifice
 - Right Venus Valve
 - Crista Terminalis
 - Valve of the inferior Vena cava
 - Valve of Coronary Sinus
 - Left Venous Valve
 - Septum Spurium
 - Crista Terminalis
 - Left Sinus Horn
 - Oblique Vein of Left Atrium
 - Coronary Sinus
- Common Cardinal Vein
 - Cardinal Veins
 - Anterior
 - Posterior
- Umbilical Vein
- Vitelline Vein
- Aortic Roots
 - Aortic Arches
 - I = Maxillary Artery
 - II = Hyoid + Stapedial Arteries
 - III = Common Carotid, Prox. Internal, External
 - IV = Arch of Aorta
 - V = Disappears
 - VI = Left & Prox. Right Pulmonaries, Ductus Arteriosus,
- Pericardium
 - Pericardial Cavity

Helpful Hints:

- Review cardiac muscle (LM and EM) in longitudinal and cross sections as well as intercalated disks and Purkinje fibers in the HT chapter titled “Muscle” which was covered in the MCB course. Figure 11-16 in Gartner and Hiatt shows the location of Purkinje fibers within the heart.
- Review elastic arteries, large veins, and valves which are found in the same HT chapter (Cardiovascular System) as the heart.
- Although no photomicrographs of heart valves (Semilunar and AV) are found in the textbook or HT program, study the written descriptions of their histology in the textbooks and in the lecture material.

- Use of the heart models in lab is optional; however, it is highly recommended students study these to gain a three dimensional understanding of the development of the heart. Studying the models can enhance comprehension and long term memory of the lecture material.
- While studying the normal development of the heart in lab, correlate material learned in lecture and in the textbook regarding defects of the heart and venous and arterial systems.

LAB 11 GI System, part A (Week 6)

Dr. Stanley

Reading Assignment

HT CHAPTER: **DIGESTIVE SYSTEM**

Learning Objectives

(NOTE: objectives 1 – 3 also apply to Lab 12):

The student will be able to:

1. Identify (point to and name) each of the following in photomicrographs on the HT program and in textbooks:
 - a. Oral cavity: lip and tongue
 - b. Alimentary canal: esophagus, stomach, small intestine, colon, appendix, and anal-rectal junction
 - c. Glands: pancreas, liver, gall bladder, parotid gland, submandibular gland, and sublingual gland
2. Identify (name and point to) the mucosa, submucosa, muscularis externa, and serosa (or adventia) when present in photomicrographs of structures of the oral cavity and alimentary canal listed in objective #1.
3. As objective #2 is performed, compose a list describing the following (or noting absence of the following) in each structure of the oral cavity and alimentary canal:
 - a. Components of the mucosa:
 - i. Epithelium (including specific cell type like goblet cells)
 - ii. Type of connective tissue of the lamina propria
 - iii. Blood vessels and lymphatics
 - iv. Type and name of muscle layers of the muscularis mucosa
 - b. Components of the submucosa:
 - i. Connective tissue type
 - ii. Blood vessels and lymphatics
 - iii. Name and type of glands (esophagus and duodenum)
 - iv. Name of the parasympathetic plexus
 - v. Boundaries
 - c. Components of the muscularis externa:
 - i. Type and name of muscle layers
 - ii. Name and location of the parasympathetic plexus
 - d. Components of the serosa:
 - i. Connective tissue type
 - ii. Name and classification of epithelial lining
4. Compare and contrast the two sides of the lip seen in photomicrographs, and identify (point to and name) the transition zone and the muscle which forms the deepest layer of the oral mucosa. The salient features of the transition zone and the type of muscle should be mentioned.

5. Compare, contrast, and identify (point to and name) the four types of papillae on the tongue in photomicrographs being sure to mention:
 - a. Their locations
 - b. Their morphology
 - c. Which have taste buds
 - d. Which is not prominent in humans
 - e. Which is associated with von Ebner's salivary glands
6. Identify (point to) the following features of the tongue:
 - a. Lingual tonsil (describe its location and organization)
 - b. Skeletal muscle (describe the orientation of fibers)
 - c. Taste buds (point to the taste pore)
 - d. Seromucous and mucous glands (state their functions)
7. Compare and contrast the upper, middle, and lower thirds of the esophagus, and identify (point to and name) these in photomicrographs.
8. Identify (point to), compare, and contrast the thick, longitudinally arranged smooth muscle of the muscularis mucosa of the esophagus with the muscularis mucosa of other structures of the alimentary canal.
9. Identify (name and point to) the following in photomicrographs of the stomach:
 - a. Rugae (describe their location, composition, and function)
 - b. Regions including (list the distinguishing features of each):
 - i. Cardiac (describe epithelial transition from esophagus)
 - ii. Fundic/body
 - iii. Pyloric
 - c. Layer delineating mucosa from submucosa (name this layer)
 - d. Thick muscularis externa (name layers and muscle type)
 - e. Gastric pits (ducts for gastric glands)
 - i. Compare and contrast these in different stomach regions
 - ii. Describe the epithelial cells
 - iii. Compare and contrast the mucus product of pit epithelial cells with the mucus produced by gastric gland neck cells
 - f. Gastric glands
 - i. Describe their morphological classification
 - ii. Compare and contrast these in different stomach regions
 - iii. Using figure 17-3 of Gartner and Hiatt as a reference, identify (point to and name) the 3 regions making up a gastric gland as seen in photomicrographs.
 - iv. Identify (point to and name) the regions of the gastric gland where the largest populations of the following cell types reside, and name the products of each cell type:
 1. Mucous neck cells
 2. Parietal cells (specifically point to these cells)
 3. Chief cells (specifically point to these cells)
 4. DNES cells (APUD cells)

(Note: 17-3 shows regenerative cells only in the pit but not the glandular area although they are present in both)
 - v. Identify (point to and name) the region of the gland where regenerative cells (VIM's) reside.

10. In photomicrographs, identify (point to and name) the region of the stomach where mucus-producing cells are the only cell type present (parietal and chief cells are absent), the lamina propria is easily seen, and the gastric pits are very deep; state the functional significance of the mucous cell population being predominant in this stomach region.

Relevant Topics:

- Introduction (1 and 2)
 - Oral Cavity
 - Introduction
 - Lip
 - Tongue
 - Introduction
 - Papillae
 - Filiform
 - Fungiform
 - Circumvalate
 - Foliate
 - Taste Buds
 - Lingual Tonsil
 - Tongue Muscle
 - Seromucous Glands
- Esophagus
 - Introduction
 - Mucosa
 - Submucosa and Muscularis
- Stomach
 - Introduction
 - Overview
 - Mucosa & Rugae
 - Submucosa
 - Muscularis & Serosa
 - Cardiac Region Mucosa
 - Fundic/Body Region
 - Introduction
 - Gastric Pits
 - Fundic Glands
 - Parietal Cells
 - Chief Cells
 - Pyloric Region Mucosa

Helpful Hints:

- It is not necessary to identify adventitia, the outermost layer of retroperitoneal structures such as the esophagus, duodenum (except where fixed to the stomach and jejunum), ascending and descending colon, posterior and inferior part of the rectum, and anal canal.
- Other names for the “red area” of the lip are “vermilion zone” and “vermilion border.”
- The circumvalate papillae are located below the line delineating the surface of the tongue (down in the valley); whereas, the other types of papillae extend above this line.

- Seromucous glands of the tongue can be identified based on the fact that they are surrounded by skeletal muscle.
- The different muscle types within the muscularis externa of the esophagus can be remembered by associating voluntary, involuntary, or mixed functions with the appropriate third of the esophagus. Note that the esophagus has the most prominent muscularis mucosa of all of the other parts of the alimentary canal. Cardiac glands (mucous) typically found in the lamina propria of the esophagus at the gastro-esophageal junction are not visible in photomicrographs on the HT program or in the textbook.
- The lamina propria of the fundic/body region of the stomach is not easily seen because of the numerous, tightly packed gastric glands.

LAB 12 GI System, part B (Week 6)

Dr. Stanley

Reading Assignment

HT CHAPTER: DIGESTIVE SYSTEM

Learning Objectives

(continue to use objectives 1 – 3 given in Lab 11):

The student will be able to:

1. Identify (point to) and describe the following structures and cells in photomicrographs of the small intestine. Include a description of the function of each structure and cell, and classify each as part of the mucosa, submucosa, both mucosa and submucosa, or muscularis externa:
 - a. Plicae circulares (compare and contrast to rugae)
 - b. Simple columnar epithelium
 - i. Enterocytes (surface absorptive cells)
 - ii. Goblet cells (name their secretory product)
 - iii. Striated (brush) border (microvilli)
 - iv. Terminal web (microfilaments)
 - c. Villi (compare and contrast to plicae circulares)
 - i. Lamina propria
 - ii. Central lacteals (note their location)
 - iii. Smooth muscle cells
 - iv. Capillaries
 - d. Intestinal glands (Crypts of Lieberkuhn)
 - i. Paneth cells (note their location)
 - ii. Mitotic figures
 - iii. Enterocytes
 - iv. Goblet cells
 - e. Muscularis mucosa
 - f. Parasympathetic ganglia (name each plexus)
 - i. Multipolar neurons
 - ii. Glial cells
 - g. Brunner's glands (mucus, duodenum)
 - h. Peyer's patches (ileum)
 - i. Inner circular and outer longitudinal smooth muscle layers
2. Use the EM photomicrographs in Gartner and Hiatt together with the LM photomicrographs in the HT program to:
 - a. Compare and contrast the secretory granules of Paneth cells, DNES cells, stomach lining cells, mucous neck cells, and stomach chief cells.
 - b. Compare and contrast striated border microvilli with the much larger villi.

- c. Identify (point to) and explain the function of the tubulovesicular apparatus of parietal cells.
3. In photomicrographs, identify (point to and name) three structures that increase the surface area for absorption in the small intestine, and compare the relative sizes of these structures.
4. Draw a region of the small intestine showing villi and a plica circulares as seen in photomicrographs. All of the following labels should be put on the drawing (refer to Gartner and Hiatt figure 17-13 for the location of DNES and regenerative cells):
 - villus
 - lumen
 - intestinal gland
 - DNES cells
 - regenerative cells
 - Paneth cells
 - enterocytes
 - goblet cells
 - lymphocytes
 - central lacteal
 - mucosa
 - simple columnar epithelium
 - lamina propria
 - muscularis mucosa
 - striated (brush) border (microvilli)
 - submucosa
 - Meissner's plexus
 - plica circulares
5. Compare and contrast photomicrographs of the mucosa of the colon with photomicrographs of the mucosa of the small intestine and of the three regions of the stomach. As these photomicrographs are compared and contrasted, refer to figures 17-22, 17-13, and 17-3 of Gartner and Hiatt, and be particularly careful not to confuse the identification of the colon with the pyloric and cardiac regions of the stomach.
6. Identify (point to) taenia coli in photomicrographs of colon while stating their function and naming the specific layer of the wall of the colon in which they are located.
7. Compare and contrast the anal-rectal junction with the gastro-esophageal junction in photomicrographs.
8. Compare and contrast the appendix with the ileum in photomicrographs. Be sure to describe the arrangement of lymphatic tissue and to describe the contents and size of the lumen of the appendix.
9. Compare and contrast the pancreas with the parotid gland in photomicrographs being sure to:
 - a. Name the type of secretory acini present
 - b. Describe the secretory granules
 - c. List the contents of the secretory granules

- d. Identify (point to) centroacinar cells
 - e. Identify (point to) and describe the ducts
 - f. State if adipocytes are present or absent
10. In photomicrographs of salivary glands (parotid, submandibular, and sublingual) and pancreas, identify (point to) secretory acini and tubules, classifying them as either mucous or serous and locating (pointing to) associated myoepithelial cells. Also, state the estimated or known percentages of mucous and serous acini in each gland.
11. Identify (point to) and describe serous demilunes in photomicrographs, and name the glands in which they are found.
12. Compare and contrast serous cells with mucous cells as seen in both LM and EM photomicrographs of salivary glands and pancreas being sure to mention:
- a. The location of nuclei
 - b. Type of secretory granules and mode of secretion
 - c. Which type are stimulated by which division of the autonomic nervous system
 - d. Cytoplasmic staining properties
13. Compare and contrast the duct systems seen in photomicrographs of the parotid, submandibular, and sublingual salivary glands. Be sure to name each type of duct and state whether it is present or absent in each gland. Also, list the ducts in order from small to large diameter, and explain why striated ducts have a striated appearance.
14. Identify (point to) all of the following in photomicrographs of liver:
- a. Cords of hepatocytes (list the functions of hepatocytes)
 - b. Central vein (to the hepatic vein which joins the IVC)
 - c. Sinusoids (name the two vessels that empty into these and the one vessel that receives blood from these)
 - d. Portal triad (also called portal canal, portal tract, or portal area) composed of branches of the:
 - i. Hepatic artery (to sinusoids, oxygen to hepatocytes)
 - ii. Portal vein (to sinusoids for filtering of blood)
 - iii. Bile duct (classify the epithelium)
 - e. Boundaries of each of the following:
 - i. Classical lobule (describe blood flow and bile flow)
 - ii. Portal lobule (state the number of central veins)
 - iii. Hepatic acinus (describe the zones and oxygen content)
(Refer to figure 18-11 of Gartner and Hiatt)
 - f. Glisson's capsule
 - g. Kupffer cells (describe their function)
15. Identify (point to) blood in branches of the portal vein, sinusoids, and central vein of a classical hepatic lobule seen in photomicrographs of the liver, and state which organ the blood traveled from to the liver, why the blood filters through the liver, and where it goes when it leaves the liver.
16. Compare and contrast branches of the hepatic artery, portal vein, and bile duct in photomicrographs being sure to describe differences in the

luminal contents (not visible) of each and to state where these contents flow.

17. Identify (point to) the following in EMs of liver:
 - a. Bile canaliculi (describe their location and function)
 - b. Sinusoids (describe their epithelium and contents)
 - c. Space of Disse (describe the boundaries, refer to figure 14-6 of Burns and Cave)
 - d. Hepatocyte microvilli (describe where these project)
 - e. Kupffer cell (describe function)
 - f. Glycogen granules in hepatocytes (state the function of these inclusions and explain how they can be seen also in LMs)
18. Identify (point to) and describe mucosal folds in photomicrographs of the gall bladder, and compare and contrast the mucosa of the gall bladder with the mucosa of the small intestine.
19. State which components listed in objective #3 of GI lab part A are absent in the gall bladder.

Relevant Topics:

Small Intestine

Introduction

Overview

Mucosa and Plicae

Submucosa

Muscularis/Serosa

Villi

Overview

Absorptive Cells

Goblet Cells

Villus Core

Intestinal Glands

Introduction

Overview

Paneth Cells

Mitotic Figures

Duodenum & Brunner's Glands

Ileum & Peyer's Patches

Colon

Introduction

Overview

Mucosa

Submucosa

Muscularis

Anal-Rectal Junction

Appendix

Pancreas

Introduction

Overview & Acini

Centroacinar Cells

Intercalated Ducts

Interlobular Ducts

Liver

Introduction

Overview & Parenchyma

Portal Canals

Introduction

Bile Duct

Hepatic Artery

Portal Vein

Central Vein

Glycogen

Gall Bladder

Salivary Glands

Introduction

Parotid Gland

Submandibular Gland

Sublingual Gland

Helpful Hints:

- Photomicrographs of the pancreas are sometimes confused with those of the parotid gland as both glands have purely serous acini. Look for adipose in the parotid (not in the pancreas) and centroacinar cells and islets of Langerhans in the pancreas (not in the parotid gland).
- Notice how the number of goblet cells increases from the small intestine to the colon.
- Be aware that the villi of the small intestine sometimes appear circular and unattached to the rest of the mucosa when cut in cross section. Intestinal glands throughout the small and large intestines are referred to as “Crypts of Lieberkuhn.”
- Review the cellular contents of the lamina propria described in the HT chapter titled “Connective Tissue Proper” and in the connective tissue lab of the cell biology course, and review the endocrine portion of the pancreas in HT “Endocrine System” and the endocrine lab of this course.
- Unlike in the muscularis externa of the colon, taenia coli are not present in this layer of the rectum and appendix.
- Where lymphatic nodules are adjacent to the epithelium of the intestine, M cells (microfold) replace the columnar cells but need not be identified in photomicrographs. However, knowledge of the function and location of these cells is important.
- It is only necessary to identify Paneth cells in photomicrographs of the small intestine although these cells are also present in the mucosa of the rectum and the appendix.
- Although the term “salivon” is not used in the HT program, it is used by some authors and refers to the secretory acinus together with the intercalated and striated ducts.
- Form conceptual stories linking structure and function of different components of the digestive system together when viewing separate entities of the digestive system in photomicrographs. For example, when viewing a photomicrograph of duodenum, remember there are DNES cells in the Crypts of Lieberkuhn that produce the hormone secretin in

response to acid chyme entering the duodenum from the stomach. Secretin travels away from the duodenum in the blood to reach the pancreas where secretin stimulates the pancreatic centroacinar cells to secrete alkaline fluid (bicarbonate rich) into the pancreatic ducts which eventually hook up to the lumen of the duodenum into which the alkaline fluid is dumped and neutralizes the acid chyme thereby protecting the small intestine.

- Integrate knowledge of the portal circulation and other circulatory structures learned in gross anatomy with observation of the microcirculation of the liver in microscopic anatomy lab, keeping in mind the functional connection between the small intestine and the liver. For instance, the liver functions to filter (purify and process) nutrition-rich blood (which travels to the liver from the intestines via the portal vein) and then collects this filtered nutrition-rich blood in the central veins of the liver which empty into branches of the hepatic vein which empties into the inferior vena cava (IVC) which sends blood to the heart which pumps blood to the lungs which send blood back to the heart to be pumped throughout the body and thereby feed as well as oxygenate the body.
- The HT program refers to the short canals connecting bile canaliculi to the branch of the bile duct in the hepatic triad as “canals of Hering.” However, other authors refer to the branch of the bile duct in the portal triad as “canal of Hering.”

LAB 13 Urinary System (Week 6)

Dr. Stanley

Reading Assignment

HT CHAPTER: URINARY SYSTEM

Learning Objectives:

The student will be able to:

1. Identify (point to) each of the following structures in photomicrographs of kidney on the HT program and in textbooks, and use figure 19-1A of Gartner and Hiatt to describe where each structure is located in the kidney:
 - a. Medullary Rays
 - b. Renal Corpuscles
 - c. Proximal Tubule
 - d. Loop of Henle (thin descending and ascending limbs, loop)
 - e. Distal Tubule
 - f. Collecting Duct
 - g. Medullary Pyramid
2. Identify (point to and name) the four types of tubules found in medullary rays in photomicrographs, and explain why these rays are called “medullary” rays.
3. Trace the imaginary boundaries of a kidney lobule in photomicrographs, and name the structures contained in a lobule.
4. Identify (point to) and describe the following components of a renal corpuscle in photomicrographs. Identify these in EM’s and illustrations in Gartner and Hiatt (GH) where indicated:
 - a. Bowman’s Capsule
 - i. Parietal layer
 - ii. Visceral layer (podocytes)
 - b. Bowman’s (urinary) space
 - c. Vascular Pole
 - i. Afferent arteriole
 - ii. Efferent arteriole
 - d. Glomerulus (figures 19-4 and 19-9 GH)
 - i. Podocytes (figures 19-7, 19-8, and 19-10 GH)
 - ii. Fenestrated Capillaries (figures 19-6 and 19-10 GH)
 - iii. Mesangial cells (figures 19-5 and 19-6 GH)
 - e. Urinary Pole
 - i. Proximal convoluted tubule (describe the connection with Bowman’s space)

5. Identify (point to and name) and describe the components of the urinary membrane (also called filtration barrier) in the following photomicrographs and illustrations in Gartner and Hiatt: figures 19-5, 19-6, 19-7, 19-8, and 19-10 of Gartner and Hiatt. Be sure to mention the functional role of each component of the urinary membrane in filtration.
6. Identify (point to) the Juxtaglomerular apparatus in photomicrographs. Use figure 19-14 GH as a reference.
7. Identify (point to and name) the part of the distal convoluted tubule that has tightly packed cells in close association with the afferent arteriole, and describe the chain of events that occurs as these cells respond to low sodium concentration in the filtrate.
8. Use figures 19-4 and 19-14 of Gartner and Hiatt to compare and contrast afferent and efferent arterioles. Be sure to mention their relative wall sizes, which vessel is has smooth muscle cells called juxtaglomerular cells, and the arteriolar role in the regulation of blood pressure and flow in the glomerulus.
9. Classify specific kidney tubules in photomicrographs as permeable or impermeable to water, sodium, and chloride. The tubule that has a chloride pump and is impermeable to water should be named and the significance of this pump explained. Refer to figure 19-20A and information in the Gartner and Hiatt textbook.
10. In photomicrographs, identify (point to and name) the kidney tubules in humans where antidiuretic hormone (ADH) acts, and explain how ADH affects the cells of this tubule and what happens to the urine filtrate.
11. In photomicrographs, identify (point to and name) the kidney tubule where aldosterone acts, and explain how aldosterone affects the cells of this tubule and what happens to the urine filtrate.
12. Compare and contrast proximal, distal, and collecting tubules as well as capillaries and thin segments of the loop of Henle seen in photomicrographs. Be sure to mention cellular morphology (e.g. squamous, cuboidal, or columnar), staining properties, and characteristic features such as microvilli or basal infoldings.
13. In photomicrographs of kidney, identify (point to and name):
 - a. Tubules located within a medullary pyramid
 - b. The region of the renal pelvis into which the renal papilla of the pyramid empties the collecting ducts
 - c. The blood vessel that branches into afferent arterioles, and describe its relationship to a kidney lobule.
 - d. The location of the efferent arterioles that send blood to the vasa recta.
14. Compare and contrast the ureter and the urinary bladder in photomicrographs being sure to mention distinguishing characteristics of the layers of their walls including the muscularis externa of the ureter both distal and proximal to the bladder.

15. Identify (point to) and describe transitional epithelium in photomicrographs, and list the structures of the urinary system that are lined by this type of epithelium.

Relevant Topics:

Kidney
 Introduction
 Medullary Rays
 Renal Corpuscle
 Vascular Pole
 Urinary Pole
 Macula Densa
 Glomerular Capillaries
 Kidney Tubules
 Proximal Tubules
 Thin Segments
 Distal Tubules
 Collecting Tubules
 Medulla & Renal Papilla
 Cortex Vascularization (1 and 2)

Ureter
Bladder
Transitional Epithelium

Helpful Hints:

- The ascending thick limb of Henle's loop is also called the pars recta (straight part) of the distal tubule by some authors.
- As kidney tubules are studied in photomicrographs, keep in mind where they are located in the nephron. Figure 19-11 of Gartner and Hiatt shows this organization and should be referred to often. For example, when the distal tubule is viewed in photomicrographs, the tubules that lead to and from this part of the nephron should be recalled, i.e., the thin ascending segment of the loop of Henle and the cortical collecting tubule, respectively.
- It is unnecessary to distinguish between the convoluted and straight portions of the proximal and distal tubules.
- Interlobular arteries, afferent arterioles, glomerular capillaries, and cortical peritubular capillary network are identifiable in photomicrographs. Use figure 19-1 (on two pages) to learn the names and patterns of other blood vessels involved in renal circulation. Be aware that the arcuate arteries extend along the boundary between the cortex and the medulla of the kidney and are between the interlobar and

interlobular arteries. The small blood vessels visible in photomicrographs of the renal papillae are vasa recta.

- Adventitia could not be seen in HT photomicrographs of retroperitoneal structures of the alimentary canal, but adventitia can be seen in photomicrographs of the ureter. Note that the layers of the muscularis externa in the intestine are organized in reverse of the layers of the muscularis externa of the ureter.

LAB 14: Reproduction Female (Week 8)

Dr. Stanley

Reading Assignment

HT CHAPTER: FEMALE REPRODUCTIVE SYSTEM

Learning Objectives:

The student will be able to:

1. Distinguish between the cortex, medulla, and hilus in photomicrographs of the ovary; and identify (name) and describe the components of each of these regions.
2. Identify (point to and name) cells of the ovary in photomicrographs, and describe these cells as either endocrine or exocrine in function.
3. Compare and contrast primordial follicles, primary follicles (unilaminar and multilaminar), secondary follicles, mature (Graafian) follicles, and atretic follicles seen in photomicrographs of ovary. Be sure to mention hormones that affect the follicles and to point out and describe each of the following:
 - a. Primary oocyte
 - b. Follicular cells
 - c. Granulosa cells
 - d. Zona pellucida
 - e. Antrum
 - f. Liquor folliculi
 - g. Theca folliculi
 - h. Theca interna
 - i. Theca externa
 - j. Cumulus oophorus
 - k. Corona radiata
4. Identify (point to) the germinal epithelium in photomicrographs of ovary, and describe the function of this epithelium.
5. Identify (point to and name) the follicle where the zona pellucida first appears and the cells responsible for producing the zona pellucida.
6. Compare and contrast the corpus luteum and the mature follicle seen in photomicrographs. Be sure to describe and name the transformed granulosa cells and layers of the theca folliculi associated with the corpus luteum and to name the hormones they produce. Mention of what happens to the corpus luteum during pregnancy or when no pregnancy occurs should be included. The sizes of the corpus luteum and the mature follicle relative to the size of the ovary should be noted.
7. Distinguish between granulosa lutein cells and theca lutein cells in high magnification photomicrographs of the corpus luteum being sure

to mention staining properties, cell size, and location within the corpus luteum.

8. Compare and contrast the corpus luteum, the corpus albicans, and atretic follicles in photomicrographs of ovary. A description of the fate and relative size of each should be included, and definitions of the following terms should be given: luteum, albicans, and atretic.
9. Identify (point to) the infundibulum, ampulla, isthmus, and intramural regions of the oviduct in photomicrographs, and name the regions that fit each of the following descriptions:
 - a. Location where fertilization usually occurs
 - b. Closest to the ovary
 - c. Narrowest portion
 - d. Fingerlike projections (fimbriae)
 - e. Numerous mucosal folds
 - f. Located in the wall of the uterus
10. Describe the epithelium of the oviduct as seen in photomicrographs being sure to name the two types of cells present and to state their functions.
11. Identify (point to and name) and describe the three layers of the wall of the uterus.
12. Identify (point to and name) the two layers of the endometrium, and compare and contrast these two layers.
13. Distinguish between the proliferative (follicular) , secretory (luteal), and menstrual stages (phases) of the endometrium seen in photomicrographs being sure to mention:
 - a. Hormones associated with each stage
 - b. The usual days of the menstrual cycle for each stage
 - c. Whether the stage is before or after ovulation
 - d. The changes in the glandular epithelium (noting cellular inclusions and locations of the nuclei at different stages)
 - e. The contents of the glandular secretory product
 - f. The morphology of the uterine glands
 - g. Numerous red blood cells in the functional layer at the beginning of the menstrual phase
14. Identify (point to) smooth muscle cells in cross section and longitudinal section within the myometrium and describe what happens to these cells during pregnancy.
15. Identify (point to) the cervix in photomicrographs, and describe its function, histological features (stroma, glands, and epithelium), and location in the human body. A description and explanation of the cyclical changes in the secretory product of the cervix should be included.
16. Identify (point to) vagina in photomicrographs, and distinguish between the layers of the wall of the vagina while pointing out each layer's identifiable characteristics.
17. While using Langman textbook figures 3.1, 3.3, 3.4, 3.6, 4.15, 4.16, 4.17, 6.7, 6.8, 6.10, and 6.13 as a guide to the development and structure of the placenta, identify (point to) placenta in

photomicrographs, being sure to point out each of the following structures and to describe their function:

- a. Chorionic villi
 - i. Small tertiary villi
 - ii. Fetal blood vessels
 - iii. Syncytiotrophoblast cells
 1. syncytial knots
 - iv. Anchoring villi
- b. Maternal blood (in maternal spaces)
- c. Fetal blood
- d. Basal (decidual) plate
 - i. Decidual cells

Relevant Topics:

Introduction

Ovary

Overview

Cortex

Medulla

Ovary Follicles

Primordial

Primary

Secondary

Graafian

Atretic

Corpus Luteum

Overview (1 and 2)

Theca Lutein Cells

Granulosa Lutein Cells

Corpus Albicans

Oviduct

Introduction

Infundibulum Fimbriae

Ampulla

Isthmus

Intramural Portion

Oviduct Epithelium

Uterus

Introduction

Endometrium

Myometrium

Perimetrium

Endometrial Phases

Cervix

Vagina

Placenta (1 and 2)

Helpful Hints:

- As structures of the female reproductive system are observed in photomicrographs, link them together functionally. For example, when observing the cells of the ovary, recall photomicrographs of the endometrium and how hormones produced by cells of the ovary affect this layer of the uterus during the menstrual cycle.
- All of the oocytes observed in the various follicles in ovary are primary oocytes arrested in dictyotene of prophase one of meiosis ($2n, 4C$) until ovulation at which time the oocyte to be ovulated completes meiosis I ($1n, 2C$) and enters meiosis II which is completed ($1n, 1C$) only at fertilization.
- Although the proliferative and secretory phases of the endometrium can be further described as early or late, it is only necessary to identify these as proliferative (follicular) or secretory (luteal).
- Different sources use different terminology when referring to the layers of the endometrium. For the purposes of this lab, the layers will be referred to as the basal layer and the functional layer. Be aware that other sources use the terms stratum basale and stratum functionalis for these two layers and divide the stratum functionalis into stratum spongiosum (toward the basale) and stratum compactum (toward the lumen of the uterus).
- When studying photomicrographs of the vagina in lab, other areas in the body where stratified squamous wet epithelium is located should be reviewed.
- Although only tertiary villi are shown on the HT program, be aware of how the tertiary villi differ from primary and secondary villi.

Lab 15: Reproduction, Male (Week 8)

Dr. Stanley

Reading Assignment

HT CHAPTER: MALE REPRODUCTIVE SYSTEM

Learning Objectives:

The student will be able to:

1. Identify (name) each of the following structures of the male reproductive system when seen in photomicrographs, and point out distinguishing characteristics. Be sure to mention epithelium and wall structure.
 - a. Testis
 - b. Seminiferous tubules
 - c. Rete testis
 - d. Efferent ductules
 - e. Epididymus
 - f. Ductus deferens
 - g. Urethra
 - i. Prostatic
 - ii. Membranous
 - iii. Penile
 - h. Seminal vesicle
 - i. Prostate gland
 - j. Penis
2. Identify (point to and name) cells within the testis seen in photomicrographs while stating whether these cells are endocrine or exocrine in function. The location of the cells that produce testosterone should be emphasized.
3. Identify (point to and name) cells in meiosis or having gone through meiosis in the process of spermatogenesis in the seminiferous tubules; state each cell's DNA content (C) and number of chromosomes (n); and describe their relative location and morphology.
4. Identify (point to) Sertoli cells in photomicrographs, and describe their location, morphology, and functions.
5. Locate (point to) the tunica albuginea in photomicrographs of testis, and describe its function and modifications that extend into the testis. Be sure to mention the relationship of this connective tissue to the seminiferous tubules and the rete testis.
6. Identify (point to and name) in order the structures through which a newly formed sperm travels from the seminiferous tubules to exit through the urethra, and describe the epithelium and wall composition of each structure.
7. Identify (point to) both tall, ciliated cells and short, non-ciliated (absorptive) cells which together give an irregular appearance to the epithelium of the efferent ductules seen in photomicrographs. A connection in the functions

- of the absorptive cells and the Sertoli cells should be discussed. The direction the tall cell cilia beat should be described.
8. Compare and contrast stereocilia seen in photomicrographs of the epididymis with microvilli shown in textbooks.
 9. Designate each of the following characteristics as belonging to the prostate gland or the seminal vesicle as observed in photomicrographs, and describe the secretory products of the prostate gland and seminal vesicle.
 - a. Fibroelastic stroma with many smooth muscle cells
 - b. Mucosal folds
 - c. Tubuloalveolar glands with a saw tooth appearance
 - d. Lamellated concretions (corpora amylacea)
 - e. Smooth muscle surrounding the mucosa
 - f. Pseudostratified columnar epithelium
 - g. Simple columnar, simple cuboidal, and pseudostratified columnar epithelia
 10. Identify (point to) the following components of the penis, and describe the function of each:
 - a. Tunica albuginea
 - i. Septum
 - b. Corpora cavernosae
 - c. Corpus spongiosum (corpus cavernosum urethrae)
 - d. Penile urethra
 - i. Pseudostratified columnar epithelium
 - e. Erectile tissue
 - i. Vascular sinuses
 - ii. Fibrous trabeculae

Relevant Topics:

Introduction

Testis

Capsule

Lobules

Seminiferous Tubules

Overview

Spermatogonia

Primary Spermatocytes

Spermatids

Spermatozoa

Sertoli Cells

Interstitial Cells of Leydig

Rete Testis

Efferent Ductules

Epididymus

Ductus Deferens

Seminal Vesicle

Overview

Mucosal Folds

Epithelium

Prostate

- Overview
- Concretions
- Epithelium

Penis

- Overview
- Urethra
- Erectile Tissue

Helpful Hints:

- SpermIOgenesis refers to the process of maturation of spermatids to become sperm; whereas spermATOCYTOgenesis refers to the process of formation of new cells from spermatogonia. Collectively these two processes are referred to as spermATOgenesis.
- Primary spermatocytes in pachytene of prophase I of meiosis are easily visible in the epithelium of the seminiferous tubules. Use these cells as a landmark when identifying the seminiferous tubules. Other visible cells associated with meiosis in the seminiferous tubules include: spermatogonia, spermatids, and spermatozoa.
- Secondary spermatocytes (2C, 1n) cannot be seen in photomicrographs because they rapidly undergo the next cell division to become spermatids.
- Although it is necessary to understand the functional differences between Type A and Type B spermatogonia, it is unnecessary to try to distinguish between these two types in photomicrographs in lab.
- Stereocilia are characteristic of the epididymis, making this division of the duct system easy to identify.
- Be aware of the luminal contents of structures of the male reproductive system.
- The rete testis can be distinguished from erectile tissue of the penis by noting the differences in the epithelia of these two structures.