

## Objectives for Senses

1. State the basic types of receptors according to location or according to type of stimulus (energy). Give examples of each.
2. Know the distribution of  $K^+$  and  $Na^+$ , charges inside and outside the cell and resting action potential. Review what happens during an action potential.
3. Describe how sensory perception works. Describe what a receptor potential is and how receptors transmit information of modality, location, intensity and duration. Be sure to include adaptation listing a receptor that is tonic and one that is phasic.
4. Describe what is meant by 2 point discrimination. Can you discriminate better if the receptive field is larger? What areas of the skin are able to localize the best?
5. Describe the various receptors in the skin (hair root plexus, free nerve endings, meissner's corpuscles and pacinian corpuscles). Know the locations of each of these.
6. List and describe the 3 types of pain sensations (cutaneous, deep somatic pain and visceral). Describe the fast and slow sensations of cutaneous pain. List the type of nerve (A, B, or C), nerve tract and part of the brain that the nerve impulses go to. Which part of the brain localizes pain? What is the function of bradykinin?
7. Describe referred pain. What theory explains referred pain?
8. What are the endogenous opioids? Where are they found and what is their function?
9. Describe the formation of tears and their normal function. Describe and give the function of tarsal glands.
10. Give the function of the following parts of the eye:
 

palpebrae	iris	pupil
sclera	cornea	conjunctiva
vitreous humor	aqueous humor	anterior cavity
retina	choroid	ciliary body
fovea	lens	blind spot
canal of Schlemm or scleral venous sinus		
11. State the source and fate of aqueous humor. What is glaucoma?
12. Understand how light rays are bent, and trace, in correct sequence, the structures or openings through which light waves must pass to reach the retina. Know the difference between convex and concave lenses.
13. Describe the process of accommodation (close vision) and presbyopia.
14. Define astigmatism, myopia and hyperopia. Understand how corrective lenses change the path of light to the retina. Explain 20/20 or 20/100 vision.
15. Describe how pupils constrict or dilate for near or far vision or for high or low light.

16. Describe what rods and cones are used for. Know which is more prevalent, their distribution in the retina and the amount of convergence between the receptor and the optic nerve. Be able to explain the duplicity theory of vision.
17. Describe the process by which light is detected and converted to a nerve impulse. What is rhodopsin, retinal and opsin. What is dark adaptation?
18. How do cones see different colors, and what colors do they see? Describe the condition color blindness.
19. Trace the transmission of the nerve impulse from the retina, through the optic nerve, the optic chiasma, the optic tracts, the thalamus, to the visual area of the cerebral cortex. Know which tracts cross at the optic chiasma and which ones do not.
20. Understand the physics of sound waves. Show how loudness and pitch of the sound waves are distinguished.
21. Describe and give the function of the following ear parts.
- |                   |                         |                   |
|-------------------|-------------------------|-------------------|
| auricle           | external auditory canal | ceruminous glands |
| tympanic membrane | malleus                 | incus             |
| stapes            | oval window             | round window      |
| eustachian tube   | cochlea                 | utricle           |
| sacculle          | semi-circular canals    |                   |
22. Understand the anatomical and functional relationships of the following structures. Remember that you will have to label these structures on the lecture exam.
- |                    |                     |                |
|--------------------|---------------------|----------------|
| scala vestibuli    | scala media         | scala tympani  |
| basilar membrane   | vestibular membrane | helicotrema    |
| perilymph          | endolymph           | organ of corti |
| tectorial membrane |                     |                |
23. Trace the transmission of sound waves from the external environment to the stimulation of the cochlear branch of the vestibulocochlear nerve. How do we detect different pitches and how does the brain know how loud the sound was?
24. Define nerve deafness and conduction deafness. Give examples of both of these.
25. Name, locate and describe the structure and function of the receptors for head position (static equilibrium). Differentiate between horizontal and vertical acceleration.
26. Name, locate and describe the structure and function of the receptors for rotation (dynamic equilibrium).
27. Describe how movement (acceleration and rotation) is detected by these receptors and how this is converted into nerve impulses. What part of the brain receives these nerve impulses?
28. Describe and locate the receptors for the sense of smell. What nerve carries the afferent impulses?
29. Describe and locate the receptors for the sense of taste. What nerves carry the afferent impulses?

## Study Guide for Cardiovascular System

1. Know where the heart is found. Be able list the tissues found in the serous membrane that surrounds the heart. Be familiar with the following:
 

mediastinum	base of heart	apex of heart
parietal pericardium	visceral pericardium	pericardial cavity
myocardium	endocardium	
  
2. Know the following structures of the heart. Be able to trace blood from the vena cava to the aorta.
 

R & L atria	R & L ventricles	pulmonary artery
pulmonary vein	atrioventricular valve	semilunar valve
tricuspid valve	bicuspid valve	fibrous skeleton
interventricular septum	interatrial septum	
  
3. Know the tissues found in heart valves. How do valves work? What is the function of the papillary muscles and cordae tendineae?
  
4. Where are the blood vessels that bring nutrients to the myocardium? Know the following:
 

R & L coronary arteries	coronary sulcus	cardiac veins
Coronary sinus		
  
5. What is the function of the intercalated discs of cardiac tissue?
  
6. Define autorythmic cells. List cells that are autorythmic.
  
7. Follow the wave of depolarization from the atria to the ventricles. Be familiar with the following:
 

sinoatrial node	atrioventricular node	AV node delay
fibrous skeleton	AV bundle (bundle of his)	
R & L bundle branches	purkinje fibers	
  
8. How does the SA node generate a heart beat? Be able to draw the action potential of the SA node. Be familiar with the following:
 

pacemaker potential	sodium	calcium	potassium
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9. Be able to draw the action potential of a cardiac muscle cell. List the ions that are involved with this depolarization. What keeps cardiac cells from going into tetanus? Be sure to be able to tell the difference between an action potential of cardiac muscle cells and a SA node.
  
10. Describe what an electrocardiogram records. Describe what is happening during the P, QRS, and T waves and the P-Q and S-T segments.
  
11. Describe the changes that occur to the ECG with a heart attack, AV node block, PVC and fibrillation.
  
12. List the stages of the cardiac cycle, including when the valves open and close.
 

atrial systole	ventricular filling
ventricular systole	ventricular diastole



## Blood Vessels and Pressure

1. Know the definition of the 3 types of blood vessels. Do all arteries carry oxygenated blood? Can nutrients diffuse in and out of all blood vessels?
2. Know the 3 layers found in the wall of blood vessels and the tissue types found there. Be familiar with the following:
 

tunica intima (interna)	tunica media	tunica externa (adventitia)
internal & external elastic lamina	vasa vasorum	elastic arteries
3. Be familiar with the following and be able to give examples where appropriate:
 

conducting (elastic) arteries	distributing (muscular) arteries	arterioles
thoroughfare channel	continuous capillaries	sphincters
fenestrae	sinusoids	valves in veins
4. Describe how O<sub>2</sub>, glucose and steroids leave the blood stream.
5. Know that arteries have more smooth muscle and a thicker wall than veins, but a smaller overall diameter. Know that 54% of the blood is in the veins and that the capillaries have the highest cross-sectional area.
6. Be able to describe the usual route that blood takes through the body. Describe a portal blood system. How is this different from the usual route? List the 2 portal systems found in the body. Why do we have these 2 portal systems?
7. What are anastomoses? Be familiar with the different types of anastomoses: arteriovenous, arterial and venous.

### Start of test #3

8. Define blood pressure. List the approximate blood pressure of aorta, arteries, arterioles, capillaries, veins and right atrium.
9. Be able to describe HOW to measure blood pressure and why you can or can not hear blood flowing through the artery. We did this in lab.
10. Describe how the following alter blood pressure:
 

cardiac output	peripheral resistance	blood viscosity
vessel length	vessel diameter	
11. Why does the pressure drop in the arterioles and capillaries?
12. Know the relative speed of blood (fast, slow, in between) in arteries, capillaries and veins.
13. What is autoregulation of blood pressure? Describe how this works. Describe how the sympathetic system regulates peripheral resistance.
14. Be able to describe how arterioles alter blood pressure. Review how the sympathetic system regulates blood pressure. Include the following in your answer:
 

vasoconstriction	vasodilation
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## Study Guide for Blood

1. Know the average blood volume of men and women. List the 3 types of formed elements and their function. Define hematocrit and give a normal value.
2. Differentiate between plasma and serum. List the percentage of water, proteins and solutes in plasma. Discuss the function of the three types of protein found in plasma. Know where these proteins are made.
3. Describe the shape, color and function of erythrocytes.
4. For erythropoiesis, describe and locate pluripotent stem cells, erythroblasts, and reticulocytes. Which cells have a nucleus and can make hemoglobin?
5. Describe how the rate of erythropoiesis is elevated when oxygen delivery is low. What is the function of erythropoietin? How is the kidney involved with this process?
6. List the average life span of a RBC. Describe how old RBC are removed from the blood and recycled.
7. Discuss some dietary factors that cause anemia. Include factors that increase or decrease iron absorption, Vitamin B<sub>12</sub> and intrinsic factor.
8. Describe how and where platelets are made (pluripotent stem cells, megakaryoblast, megakaryocytes). Give the average life span of a platelet.
9. Define hemostasis (not homeostasis). List and briefly describe the three mechanisms of hemostasis (vascular spasm, platelet plug formation, clot formation).
10. Describe the process of platelet plug formation. Know the function of the following:
 

collagen	platelet adhesion	platelet release
serotonin (vasoconstriction)	thromboxan A <sub>2</sub> (prostaglandin)	ADP
11. Describe the process of clot formation. Be able to explain the intrinsic and extrinsic pathways (including the order of factor activation), and when each is used. Be sure to explain the role of:
 

prothrombin activator	prothrombin	thrombin
fibrinogen	fibrin	Ca <sup>+2</sup>
vitamin K	tissue thromboplastin	
platelet-derived growth factor - PDGF		
12. Describe the process of fibrinolysis and list the enzyme necessary for this process.
13. Describe why people with heart problems take aspirin.
14. Describe in detail how EDTA, citrate and heparin act as anticoagulants.

15. Know a typical WBC count. Describe the function of the various types of white blood cells. Know which cells are granulocytes and which are agranulocytes. Also know the color of the granules, the overall size of cell, and the shape of the nucleus for each. Know which cells are more prevalent. List where they are made.

neutrophils

eosinophils

basophils

monocytes

lymphocytes

16. Know what each of the following make: hemopoiesis, erythropoiesis, leukopoiesis, and thrombopoiesis.

## Study Guide for Lymph & Immune System

1. Describe the functions of the lymph system. What is typically in lymph?
2. Know the pathway of lymph flow. Include the parts of the body that drain into the right subclavian vein vs. the thoracic duct. How much lymph travels through this system each day? Describe the anatomy of lymphatic capillaries.
3. What is meant by lymphatic tissue? What cells are found in it and where is it located?
4. Describe the function of the lymph organs: lymph node, spleen (red pulp & white pulp), thymus gland and tonsils. Where are lymph nodes found? What cells are found in lymph organs?
5. Be familiar with Natural killer cells. Be able to describe what they attack and how they work.
6. Describe the body's nonspecific defense. Be familiar with phagocytic cells including fixed phagocytes. Know the following:  
macrophages of CT      hepatic and alveolar macrophages      microglia cells
7. Describe the inflammation response including what causes the redness, heat, swelling and pain. Describe the function of histamine, chemotaxis, neutrophils, and monocytes. Define diapedesis.
8. Describe what happens to cause a fever and what happens as it breaks. What is the benefit of fever? What makes the pyrogen and what is the function of a pyrogen?
9. Describe the general characteristics of specific immunity including humoral immunity and cellular immunity, antigens, specificity, and memory.
10. Describe the differentiation process for T cells and B cells. Know where these cells are stored in the body.
11. Be familiar with antigen-presenting cells (APC). What cells can be APCs? What is the function of APCs? Know what the major histocompatibility complex (MHC) proteins are and how they are important for T cell activation.
12. Describe the functions of T cells including what T cells do best. Explain how these cells are activated. Include the following:  
killer T cells                      helper T cells                      suppressor T cells                      memory T cells
13. Describe the functions of B cells. Include the following:  
antigen recognition                      plasma cells                      antibody binding  
B memory cells



## Objectives for Digestion

- Describe what is meant by digestion. How is this different than metabolism? What are the functions of the digestive system? Where does the mechanical and chemical digestion occur?
- Know which organs are part of the digestive tract and which are accessory organs.
- Be familiar with the four layers that make up the digestive system.
 

mucosa	lamina propria	muscularis mucosa
submucosa	submucosal plexus	myenteric plexus
	lymph nodes	
muscularis externa	circular & longitudinal muscles	
serosa		
- Review the serous membranes covering the digestive system. Include the following:
 

parietal peritoneum	visceral peritoneum	mesenteries
lesser omentum	greater omentum	
- Know what the term retroperitoneal means. List the organs that are retroperitoneal.
- Be able to follow food through the digestive system. Describe what processes occur in each organ. Know what type of tissue lines each organ. Be familiar with the following:
 

Mouth - stratified squamous		
hard palate	soft palate	uvula
Tongue - skeletal muscle		
papillae	taste buds	attached to hyoid
Teeth		
alveoli	gingivae	periodontal ligament
crown	roots	enamel
dentin	pulp cavity	apical foramen
cementum	incisors	canines
premolars & molars	deciduous teeth	permanent teeth
mastication		
parotid glands	submandibular glands	sublingual glands
salivary amylase	saliva	lingual lipase
deglutition		
Esophagus - stratified squamous, skeletal or smooth muscle		
peristalsis	cardiac sphincter	
- Describe the function of the parasympathetic and sympathetic nervous system as it relates to digestion.

8. Know the following parts of the: Stomach
- |                   |                       |                 |
|-------------------|-----------------------|-----------------|
| cardiac portion   | body                  | fundus          |
| pylorus           | 3 muscle layers       | chyme           |
| pyloric sphincter | rugae                 | gastric pits    |
| gastric glands    | chief cells           | parietal cells  |
| mucous cells      | enteroendocrine cells | simple columnar |
- Small intestines
- |                                  |                 |                |
|----------------------------------|-----------------|----------------|
| duodenum                         | jejunum         | ileum          |
| circular folds/plicae circulares | villi           | columnar cells |
| microvilli                       | brush border    | lacteals       |
| intestinal crypts                | duodenal glands | Peyer's patch  |
| segmentation                     | peristalsis     |                |
- Large Intestines - simple columnar
- |            |              |                   |
|------------|--------------|-------------------|
| cecum      | appendix     | ascending section |
| transverse | descending   | sigmoid           |
| haustra    | diverticulum | diarrhea          |
| rectum     | defecation   | defecation reflex |
9. List the characteristics of smooth muscle. Be able to compare smooth muscle to both skeletal and cardiac muscle. Describe pacemaker potentials and the effect of the autonomic nervous system on smooth muscle.
10. Know the following anatomy about the liver:
- |  |                  |                    |
|--|------------------|--------------------|
| portal blood system                            | R & L lobes      | falciform ligament |
| lesser omentum                                 | hepatic artery   | hepatic portal v.  |
| liver sinusoids                                | central vein     | hepatic vein       |
| Kupffer cells                                  | bile canaliculi  | bile ductule       |
| hepatic triad                                  | hepatic duct     | gallbladder        |
| cystic duct                                    | common bile duct | duodenal papilla   |
| hepatopancreatic sphincter (sphincter of Oddi) |                  |                    |
11. Describe the function of liver in digestion. List the components of bile and where they are made. List where it is stored. Be able to trace bilirubin from the spleen to the bile.
12. Describe the enterohepatic circulation of bile acids and urobilinogen. Be able to trace the path of bile acids from the liver, to the small intestines and back to the liver to be reused within the same meal. List how urobilinogen is removed from the body.
13. Know the following about the pancreas:
- |              |                   |                    |
|--------------|-------------------|--------------------|
| location     | exocrine function | endocrine function |
| acinar cells | pancreatic duct   | islets             |
| alpha cells  | beta cells        |                    |

## Chemical Digestion & Control of Metabolism

1. Be able to describe where and how carbohydrates, fats and proteins are digested. Know the enzymes that are necessary for digestion and where they are made. List any activating factors that are necessary. Include the following:
 

Carbohydrates		
salivary amylase	pancreatic amylase	maltase
sucrase	lactase	
Proteins		
denaturing protein	zymogens	pepsinogen & pepsin
trypsinogen & trypsin	chymotrypsin	carboxypeptidase
brush border enzymes	enterokinase	amino acid absorption
Lipids		
Lingual lipase	emulsifier	bile salts & phospholipid
Micelles	pancreatic lipase	fatty acid absorption
Reforming triglycerides	chylomicrons	lacteals
lipoproteins	lipoprotein lipase	cholesterol
liver	VLDL, LDL, HDL	
  
2. Be able to describe the control over digestion. Include the effects of the parasympathetic & sympathetic nervous system. List the 3 phases of gastric digestion. Describe what is happening during each phase.
  
3. Describe how the production of pepsin is regulated. What stimulates gastrin release and is it more or less active at low pH? List factors that slow down digestion. Describe the process to slow down pepsin release when the food has left the stomach.
  
4. Describe the action of the following hormones:
 

gastric inhibitory peptide	cholecystokinin	secretin
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5. Review metabolism from previous classes. Include the following:
 

oxidation-reduction reactions	phosphorylation
NAD <sup>+</sup> , NADH, FAD, FADH <sub>2</sub>	glycolysis
pyruvate	lactic acid
acetyl CoA	citric acid cycle
electron transport chain	glycogenesis
glycogenolysis	gluconeogenesis
lipolysis	lipogenesis
  
6. List the cells that make insulin. Describe the functions of insulin. List the factor that stimulates insulin release. List which organs are insulin dependent for glucose uptake and which organs are not dependent on insulin. Know which processes are stimulated by insulin (glycolysis, glycogenesis, protein synthesis, and lipogenesis)
  
7. List the cells that make glucagon. Describe the function of glucagon. Name the factor that stimulates glucagon release. Know the processes that are stimulated by glucagon (glycogenolysis, gluconeogenesis, and lipolysis).

8. Describe the role of the liver in regulating metabolism. Be familiar with how it regulates the following:
- |                              |            |                |
|------------------------------|------------|----------------|
| Carbohydrates                | Lipids     | Proteins       |
| Synthesis of Plasma Proteins | Bile Salts | detoxification |
| Phagocytosis of bacteria     |            |                |
9. Describe the similarities and differences between type I diabetes mellitus (IDDM) and type II diabetes mellitus (NIDDM). Include the average age of onset and typical treatments. Know which type of diabetes is more common. Describe the complications of diabetes.
10. State the body's relative preference for using various types of molecules as a source of energy. Describe how and which hormones regulate fuel utilization.
11. Describe the neural process that stimulates hunger. What part of the brain regulates appetite? What substance in blood do these cells monitor?
12. Define absorptive and postabsorptive state. When do each of these occur and what process (glucose uptake, lipid storage, protein synthesis (only a partial list) etc) occur during each of these? What hormones are dominant during each of these states? What happens with prolonged starvation?

## Respiration

1. Define the terms pulmonary ventilation, external respiration, internal respiration and cellular respiration.
2. Know the following parts of the nose.
 

external nares	nasal septum	septal cartilage
vomer	ethmoid bone	paranasal sinuses
nasolacrimal ducts	nasal conchae	posterior nares
3. Know what tissue lines the nose and trachea. Describe the function of mucus and cilia.
4. Be able to locate the 3 portions of the pharynx: nasopharynx, oropharynx, and laryngopharynx. Know whether air or food goes through each part and the tissue that lines each part. Know any openings into each portion and the location of the tonsils.
5. Be able to describe the function of the larynx. Be familiar with the following:
 

laryngeal prominence	hyoid bone	thyroid cartilage
cricoid cartilage	epiglottis	arytenoid cartil
cuneiform cartilage	corniculate cartilage	false vocal folds
true vocal folds		
6. Describe the process of swallowing.
7. Know the parts of the lungs.
 

apex	base	hilum	costal surface
cardiac notch			
8. Know that the right lung has 3 lobes and the left has 2. Know the relationship between the lobes and secondary bronchi. What is a bronchopulmonary segment? Can air move from 1 bronchopulmonary segment to another one?
9. Know the following anatomy:
 

trachea	c-shaped cartilage rings
R & L primary bronchi	secondary bronchi
tertiary bronchi	bronchioles
respiratory bronchioles	alveoli
10. Know the tissue types found lining or found in each of the following. Know what parts of the respiratory tree have cartilage and which have smooth muscle.
 

trachea	bronchioles	alveoli
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11. What is the function of great alveolar cells and macrophages in the lungs?
12. Be able to list the layers that make up the respiratory membrane. Know what type of cells line the lungs and capillaries.
13. Know the following which are found around the lungs:
 

visceral pleura	parietal plura	pleural cavity
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## Physiology of Respiration & Gas Exchange

1. Be able to describe the pressure changes during ventilation. You do NOT need to know exact pressures but you do need to know whether the pressure in each space has gone up or down during ventilation. Know that the pleural cavity has a negative pressure. Know the difference between passive and forced expiration. Be able to identify the following:
 

parietal pleura	visceral pleura	pleural cavity
atmospheric pressure	alveolar pressure	pleural pressure
phrenic nerve	inspiratory muscles	expiratory muscles
2. Define elasticity, compliance, surface tension and surfactant. Discuss what contributes to these, and how they are important for breathing.
3. Know how to measure lung volumes. Know approximate volumes for each.
 

tidal volume	respiration rate
vital capacity	inspiratory reserve volume
residual volume	expiratory reserve capacity
total lung volume	forced expiratory volume
4. Be able to describe each of the following:
 

asthma	emphysema
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5. Describe how the medulla and pons regulate breathing rate. Describe the function of the following:
 

rhythmicity area	dorsal respiratory group	I neurons
ventral respiratory group	E neurons	pneumotaxic area
6. Describe what forces act on gasses as they move between the lungs and capillaries.
7. Describe the relationship between volume and pressure in the lungs. List the  $PO_2$  and  $PCO_2$  in the air we breathe. (Close will count).
8. Be able to trace  $O_2$  and  $CO_2$  from the lungs to the cells and back to the lungs. Know where the  $PO_2$  and  $PCO_2$  are highest and lowest. KNOW the value of  $PO_2$  and  $PCO_2$  in ARTERIAL blood.
9. Describe how  $O_2$  is carried in the blood. Be able to draw the  $O_2$ -hemoglobin dissociation curve. Know the % saturation of hemoglobin in arterial blood and in the capillaries (veins) under normal conditions. Describe how the dissociation of  $O_2$  changes with pH,  $PO_2$  and temperature. Describe how fetal hemoglobin differs from adult hemoglobin.
10. Describe the 3 ways  $CO_2$  is carried in blood. Be able to describe the reactions converting  $CO_2$  to bicarbonate and  $H^+$ . Know the name of the enzyme that is necessary for this reaction.
11. Describe other factors that alter breathing rate including:
 

cerebral cortex	stretch receptors	chemosensitive area
carotid bodies	aortic bodies	

12. What is the chemical that directly stimulates the I neurons of the dorsal respiratory group?
13. Be able to explain how hypercapnia (high CO<sub>2</sub>) and hypocapnia (low CO<sub>2</sub>) can alter blood pH. Know what causes hypercapnia and hypocapnia (eg. Hypoventilation, hyperventilation).

## Study Guide for Urinary System

1. List several functions of the kidneys. Do not list making urine!!!
2. Know the location of the kidneys. What does retroperitoneal mean? Know the following:
 

renal capsule	adipose layer	renal fascia
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3. Know the following anatomy:
 

renal hilus	cortex	renal columns
medulla	renal pyramids	renal papilla
renal pelvis	minor calyx	major calyx
renal pelvis		
4. Know how much blood flows to the kidneys. Know the following vessels (arteries and veins):
 

renal	segmental	interlobar
arcuate	interlobular	afferent arteriole
efferent arteriole	vasa recta	peritubular capillaries
5. Know the parts of a nephron.
 

glomerular capillaries	Bowman's capsule	proximal tubules
loop of Henle	distal convoluted tubules	collecting duct
6. Differentiate between cortical nephrons and juxtamedullary nephrons.
7. Describe how the filtrate is made in the glomerulus. Discuss the importance of fenestrated capillaries, basement membrane, and podocytes.
8. Be able to list the pressures involved with glomerular filtration rate (GFR). Know the GFR for men and women. Describe autoregulation of GFR. Describe how sympathetic stimulation decreases GFR.
9. Describe how Na is reabsorbed across the proximal convoluted tubules. List what percentage of salt and water are reabsorbed at the tubules. List the osmolality of the filtrate at the beginning and end of the tubules.
10. Know the tissue type that lines the glomerular capsule, proximal tubule, ascending nephron loop (thick), descending nephron loop (thin), and distal tubule.
11. Describe the countercurrent multiplier process by which the loop of Henle works. List where Na and Cl are pumped out of the loop and where water moves by osmosis. Be able to list relative osmolality for portions of the loop of Henle, extracellular fluid and the vasa recta. What is the function of the vasa recta? Discuss the function of urea.
12. Describe the reabsorption of water from the collecting duct. Describe the affect of anti-diuretic hormone (ADH) on the production of aquaporins in the collecting duct. List where ADH is made, secreted from and what controls its secretion.
13. How concentrated can the urine become? Why do desert animal have a long loop of Henle? Be sure to read the Evolutionary Insight, The Kidney and Life on Dry Land.



## Urinary System Cont. and Acid Balance

1. Describe how and where glucose is reabsorbed. What is a symport system? Describe what is meant by transport maximum. Why do diabetics sometimes have glucosuria?
2. Describe what is meant by secretion by the nephrons. List substances that are secreted.
3. List the 3 nitrogenous waste products that are found in urine and their source.
4. Describe the action of aldosterone on the kidneys. List where aldosterone is made and what triggers its release. Give the relative amounts of Na and K in the urine with and without aldosterone. Where is atrial natriuretic hormone made and what is its function?
5. Define the juxtaglomerular apparatus. Describe what triggers renin release. List the reactions that occur when renin makes angiotensin II. Where is ACE found and what does it do?
6. Describe 3 actions of angiotensin II. Be able to start with a fall in blood pressure and trace the actions of angiotensin II and aldosterone to increase blood pressure.
7. Be able to list the 4 categories of hypertension medicines and briefly how each works.  
ACE inhibitor                      diuretic                                      Ca channel blocker                       $\beta$ -blocker
8. Know the following anatomy of the ureters, bladder and urethra:  

ureters: mucosal layer (transitional)	muscular layer	fibrous - adventitia
bladder: mucosal layer (transitional)		submucosa
detrusor muscle	internal sphincter	adventitia
urethra: mucous membrane	muscle layer	external sphincter
9. Know how much urine the bladder can hold and when it feels full. List the minimum and typical urine productions. Describe the process of micturation.
10. Know the percentage of fluid found in each of the following compartments:  
intracellular                      extracellular                                      interstitial                                      plasma & lymph
11. Explain 4 ways that water is lost from the body.
12. List the ions found in the extracellular and intracellular fluid. Be able to define hypokalemia and hyperkalemia.
13. Describe how the ammonia and phosphate buffer systems work.
14. Be able to define, recognize and give examples of:  
respiratory acidosis                      respiratory alkalosis                                      metabolic acidosis  
metabolic alkalosis  
You should be able to list blood pH and  $PCO_2$  for each of these!!!
15. Describe how each of the above situations is compensated. Be able to discuss what happens to bicarbonate,  $PCO_2$ , pH, ammonia,  $H_2PO_4$  etc.



## Acid-Base Problems

The following table lists the expected changes for the 4 basic conditions.

Condition	pH	pCO <sub>2</sub>	Bicarbonate
Normal Values	7.35-7.45	39-41 mmHg	24 mEq/L
Respiratory acidosis	low	high	high
Respiratory alkalosis	high	low	low
Metabolic acidosis	low	normal	low
Metabolic alkalosis	high	normal	high

The following table lists the changes for the 4 basic conditions after they have been compensated for. Remember that you compensate a respiratory problem with metabolic changes, and you compensate a metabolic problem with respiratory changes.

Condition	pH	pCO <sub>2</sub>	Bicarbonate
Metabolic acidosis with Respiratory alkalosis	normal to low Urine will be acidic	low	low
Metabolic alkalosis with Respiratory acidosis	normal to high Urine will be basic, high bicarbonate	high	high
Respiratory acidosis with Metabolic alkalosis	normal to low Urine will be acidic, high bicarbonate	high	high
Respiratory alkalosis with Metabolic acidosis	normal to high Urine will be basic	low	low

The following are examples of acid base problems.

1. A patient is on vacation and has been neglecting to take insulin properly. She is hyperventilating. Her blood pH is 7.31, her  $p\text{CO}_2$  is 38 mmHg and her bicarbonate level is 22 mEq/L. Explain each value, stating whether it is normal, high or low. State the specific acid/base imbalance that exists. What is the cause of the hyperventilation? Would her urine be basic or acidic?
2. A patient has severe emphysema. His blood pH is 7.3, his  $p\text{CO}_2$  is 42 mmHg and his bicarbonate is 26 mEq/L. State the primary acid/base condition and the compensating condition. Explain the causes of the values for pH,  $p\text{CO}_2$  and bicarbonate. Do you expect his urine to be acidic or basic? Will his breathing rate be normal?
3. A woman has had the flu and has vomited for 4 days. Her pH is 7.5, her  $p\text{CO}_2$  is 42 mmHg and her bicarbonate is 26 mEq/L. State the primary acid/base condition and the compensating condition. Explain the causes of the values for pH,  $p\text{CO}_2$  and bicarbonate. Do you expect her urine to be acidic or basic? Will her breathing rate be normal?
4. A student was studying for his MCAT and was very anxious. He came to the emergency room with a pH of 7.71,  $p\text{CO}_2$  of 15 and bicarbonate of 19.0. State the primary acid/base condition and the compensating condition. Explain the causes of the values for pH,  $p\text{CO}_2$  and bicarbonate. Do you expect his urine to be acidic or basic?

## Endocrinology

1. Describe general differences between the nervous system and the endocrine system. Define the term hormone.
2. Be able to define hormones as protein, steroids or monoamines. Describe the differences between the slow acting hormones (steroids & thyroid) and fast acting hormones (protein & catecholamines). Why are the slow acting hormones so slow?
3. Describe what is meant by a second messenger. Which hormones use a second messenger? Describe how cyclic AMP and IP<sub>3</sub> are used as second messengers.
4. Know the origins of the neurohypophysis and the adenohypophysis. Is the posterior pituitary a true endocrine gland? Describe the process to release the hormones from the posterior pituitary.
5. Describe the function of antidiuretic hormone (review info from kidney) and oxytocin.
6. Describe the interaction between the hypothalamus and the anterior pituitary. Be familiar with the following:
 

thyroid-stimulating hormone	adrenocorticotropin hormone
follicle-stimulating hormone	luteinizing hormone
prolactin	growth hormone
thyroid releasing hormone	corticotropin releasing hormone
gonadotropin releasing hormone	growth hormone releasing hormone
prolactin releasing hormone	somatostatin
prolactin-inhibiting hormone	
7. Describe negative feedback regulation. Be able to discuss the regulation of the hormones we have studied.

### Beginning of Final Exam

1. Describe the functions of growth hormone. This includes both growth and metabolic effects. List factors that stimulate growth hormone release. Include the following:
 

dwarfism	gigantism	epiphyseal plates
acromegaly	somatomedians, IGF-I	protein synthesis
fatty acid usage	glucose usage	glucose-sparing effect
2. Describe the structure of the follicles in the thyroid. Know that the cells are cuboidal. Be able to briefly describe the process to make the iodothyronines. Know which hormone is more prevalent. Know the following:
 

thyroxine	triiodothyronine	thyroglobulin
colloid	iodine	
3. Describe the effects of T<sub>3</sub> and T<sub>4</sub> and how they are carried in the blood. Describe how T<sub>3</sub> and T<sub>4</sub> effect the following:
 

glucose uptake	oxygen utilization	protein synthesis
growth	fatty acid usage	heart rate

nervousness

4. Define basal metabolic rate. Describe how this is measured. List factors that increase or decrease BMR. Describe how body temperature and BMR are related.
5. Describe the following conditions: goiter, hyperthyroidism, hypothyroidism.
6. List the function of collagen fibers and inorganic compounds in bone. List the functions of osteoblasts and osteoclasts.
7. Review and be able to describe 4 different functions of calcium in the body.
8. Be familiar with the location of the parathyroid gland and the chief cells within it. Know the specific functions of parathyroid hormone.
9. Describe the function of calcitriol (vitamin D) and calcitonin. Know the specific organs that they act at. Know what regulates the secretion of each of these also. Know that calcitonin is made by the C (parafollicular) cells of the thyroid gland, and what it does.
10. Know the location and anatomy of the adrenal gland. Include the following:  
fibrous capsule                      cortex                      medulla
11. Know that the adrenal medulla makes catecholamines. Review the functions of epinephrine and norepinephrine. Include the effects on glycogenolysis and triglyceride usage.
12. List the 3 divisions of the adrenal cortex (glomerulosa, fasciculata & reticularis) and the types of hormones they produce (mineralcorticoids-aldosterone, glucocorticoids-cortisol, sex steroids-androgens and estrogens). Review the functions of aldosterone and its effects on the kidney and large intestines. How does it increase Na reabsorption?
13. Describe the functions of the glucocorticoids - cortisol. How does it alter gluconeogenesis? What is the effect of pharmacological doses of cortisol? What stimulates cortisol release? What are the side effects of prolonged high levels of cortisol (Cushing Syndrome)?
14. Describe the condition Addison disease (low mineral and glucocorticoids).
15. List the sex steroids that are made by the adrenal gland. Which of these are important for women and which are important for men?
16. What is meant by a paracrine secretion? List some chemicals that are in this category. What are the SAIDs and the NSAIDs?

## Female Reproduction

1. Know the anatomy covered in class. Be familiar with the following:
 

ovaries	uterine (fallopian) tubes	peritoneal cavity
fimbriae	infundibulum	ampulla
smooth muscle of tubes	columnar cells	
uterus	body	cervix
fundus	myometrium	smooth muscle
endometrium	columnar cells	uterine glands
vagina	stratified squamous	smooth muscle
  
2. Know the external genital organs and ligaments mentioned in class.
 

vulva	mons pubis	labia majora
labia minora	clitoris	prepuce
glans		
ovarian ligament	suspensory ligament	broad ligament
peritoneum	rectouterine pouch	vesicouterine pouch
round ligament		
  
3. List the function of estrogen in the body. Include effects on the osteoblasts, epiphyseal plates, secondary sex characteristics, and protein synthesis. List the effects on testosterone in women.
  
4. Describe the function of progesterone in the body. Note that these functions are different than estrogen's.
  
5. Define menarche (first period) and menopause (last period). What triggers these two events? At what ages do they occur in boys and girls?
  
6. Describe the ovarian cycle. Be familiar with the following:
 

germ cells	mitosis	primary oocytes
follicular granulosa cells	atresia	
meiosis	secondary oocyte	graafian follicle
1 <sup>st</sup> & 2 <sup>nd</sup> polar body	ovulation	corpus luteum
  
7. Be able to describe the secretion of FSH, LH, estrogen and progesterone during a sexual cycle. Be able to graph the relative values. Know when LH values peak and what triggers LH release.
  
8. Describe the changes in the uterine wall during the uterine cycle. List which hormones cause these changes. Be familiar with the proliferative stage, secretory phase and menstrual stage.
  
9. Describe what happens with pregnancy. When does the embryo implant? List the function of human chorionic gonadotropin (HCG) and human chorionic somatomammotropin (HCS). List the hormones that the placenta secretes.

## Male Reproduction

1. Know that both male and female fetuses start with the same basic anatomy. With testosterone it becomes a male, without testosterone it is a female.
2. Know the anatomy covered in class including:
 

testis	scrotum	tunica albuginea
seminiferous tubules	rete testis	efferent ductules
sustentacular cells	interstitial cells of Leydig	dartos muscle
cremaster muscle	epididymis	
vas deferens	ampula	spermatic cord
seminal vesicle	ejaculatory duct	prostate
membranous urethra	spongy urethra	bulbourethral gland
penis	shaft	prepuce
corpra cavernosa	corpus spongiosum	
3. Describe how Viagra works. What is its effect on nitric oxide?
4. List the function of testosterone in the body. Include effects on the osteoblasts, epiphyseal plates, secondary sex characteristics, and protein synthesis.
5. Describe the function of testosterone, FSH, LH and inhibin. What is the side effect of high levels of testosterone in men?
6. Be familiar with the following terms:
 

spermatogenesis	seminiferous tubules	germinal cells
sustentacular (sertoli) cells	interstitial cells of Leydig	
7. Describe the process of spermatogenesis. Define the following terms:
 

primitive germ cells	spermatogonia	meiosis
primary spermatocytes	secondary spermatocytes	spermatids.

 Know how long this process takes. Describe why the testes are outside the body.
8. Describe the many functions of the sustentacular cells.
9. Name the 3 glands that contribute to the semen. What is the normal volume of ejaculate and a normal sperm count. What is the pH of semen and why?

## Study Guide for Comprehensive Final Exam HAPS Test - AP II

These are the topics that will be covered on the comprehensive portion of the final. This part of the final will be multiple choice and will be curved. There will be 58 questions and be worth 48 points.

Anatomy of an Eye

Detecting Balance

Cardiac Output

Heart Sounds

Blood Flow thru the heart

Types of Blood Vessels (arteries, veins, capillaries)

Regulation of Blood Pressure

Red Blood Cell Production - erythropoietin

Blood Types and compatibility

Blood clotting

Granulocytes vs. Agranulocytes

T cells vs. B cells

Inflammation Response

Lymphatic System

Processes of digestion (deglutition, mastication, peristalsis etc)

Bile Production

Digestive Enzymes and Hormones

Lung Volumes

Bicarbonate production, relationship to breathing

O<sub>2</sub> transport in blood

Nephron Anatomy & Function

Glomerular Filtration Rate (GFR) Regulation

Tubular Reabsorption (proximal tubules)

Antidiuretic Hormone

Aldosterone

Renin-angiotensin

Acid-Base Balance

Endocrinology - where specific hormones are made, chemical classification, hormone action

Sympathetic and Parasympathetic Nervous system

Male Reproductive Anatomy

Female Reproductive Anatomy

Female Reproductive Physiology

Study Guide for Comprehensive Final Exam **Not used with HAPS Test**

1. Describe the structure and function of the plasma membrane including the chemicals found there. Describe in detail how each of the following compounds enters the cell:  
sodium                      glucose                      proteins                      steroid hormones
2. Describe the function of the sodium-potassium ATP pump. List 3 different types of cells (or places in the body) that use this pump and explain why they need this pump.
3. How are you using your DNA today?
4. Describe all the components needed for the brain to sense and localize a stimulus.
5. List 4 cells in the body that require calcium. For each of these describe the function of calcium. Also describe the function of parathyroid hormone and vitamin D in maintaining calcium levels in the blood.
6. Describe how each of the following helps to decrease blood pressure:  
diuretic                      beta blocker                      calcium channel blocker  
ACE inhibitor
7. Explain to a person with diabetes why insulin can not be given as a pill.
8. Describe the function of NAD/NADH for glucose metabolism. What happens when we run out of NAD?
9. Describe the function and give an example of a second messenger. What types of hormones need a second messenger?
10. Describe how a negative-feedback mechanism works using thyroid hormone as an example. Include the 3 glands involved with thyroid hormone release. What happens TO THE SYSTEM if  
A) the person does not make thyroid hormone  
B) makes too much thyroid hormone  
C) makes too much TSH.  
**DO NOT EXPLAIN DISEASES, JUST CHANGES IN HORMONE SECRETION!!!!**