Biology 211
Exam 3 Study Questions

Chapter 23: The Digestive System

1. What organs make up the alimentary canal? What are the accessory digestive organs?
2. What is peristalsis & where does it occur? What is segmentation & where does it occur?
3. Histology: 4 layers of the alimentary canal & tissue organization in each (what type of tissue is each layer primarily composed of, & are there any there any other specialized tissues within each layer) – include the 3 sublayers of the mucosa.
4. Where are the submucosal & myenteric nerve plexuses & what do they regulate?
5. What are the 3 extrinsic salivary glands & where is each located?
6. What are the primary components of saliva? What division of the nervous system controls salivation?
7. Definitions: crown, gingiva, root, enamel, cementum, dentin, pulp, root canal, odontoblast. periodontitis.
8. Stomach gross anatomy: cardiac region, fundic region, pyloric region (location of each).
9. What is the function of the gastric glands? What type of product do they secrete?
10. Functions of mucous neck cells, parietal cells, chief cells, enteroendocrine cells.
11. What are the 3 phases of gastric secretion?
12. Small Intestine gross anatomy: duodenum, ileum, jejunum, plicae circulares, villi, lacteals, intestinal crypts, Peyer's patches (brief definition & location for each).
13. Function in digestion for: esophagus, stomach, small intestine, liver, gallbladder, pancreas, large intestine.
14. What is the composition & function of bile & pancreatic juice?
15. What are the primary digestive enzymes for: carbohydrates, lipids, & proteins?

Chapter 24: Nutrition, Metabolism & Body Temperature Regulation

16. Definitions: nutrients, major nutrients, essential nutrients.
17. What are the major dietary sources and basic functions of carbohydrates, proteins and lipids?
18. Definitions: vitamins fat soluble and water-soluble vitamins, antioxidants, minerals.
19. What are coenzymes & which of the above molecules can function as coenzymes?
20. What are the seven minerals most required by the body?
21. Definitions: metabolism, anabolism, catabolism.
22. Definitions: oxidation, reduction, dehydrogenases, oxidases,.
23. What are the two most important coenzymes for energy production during cellular respiration?
24. What is the difference between substrate-level phosphorylation and oxidative phosphorylation in ATP synthesis, and where does each occur. Which is carried out by a chemiosmotic process & how?

25. Carbohydrate metabolism: define the major pathways & where each occurs (cytoplasm or mitochondria).
26. What is the end result of glycolysis (how many total pyruvic acids, NADH molecules, and ATP molecules) of 1 glucose molecule?
27. If oxygen is present, pyruvic acid produced by glycolysis is converted to acetyl-CoA and enters the Krebs cycle (also referred to as the TCA (tricarboxylic acid) cycle or the citric acid cycle). What happens to this pyruvic acid when an adequate supply of oxygen is not available (during heavy exercise)?
28. What is the end result of the Krebs cycle in terms of ATP molecules, NADH molecules and $FADH_2$ molecules produced per acetyl CoA.
29. What is the function of oxygen in aerobic cellular respiration?
30. What is the function of the electrochemical proton (H^+) gradient produced by chemiosmosis during the electron transport system? What is the enzyme responsible for ATP synthesis in mitochondria?
31. What is the net gain of ATP molecules synthesized as a result of the complete breakdown of 1 glucose molecule in aerobic cellular respiration?
32. Definitions: glycogenesis, glycogenolysis, gluconeogenesis.
33. Glycerol is a component of, and breakdown product of, triglycerides in cells. How is glycerol used by cells to produce energy through aerobic cellular respiration (how does it enter the pathway)?
34. Definitions: beta-oxidation, lipogenesis, lipolysis, ketogenesis, ketosis.
35. What are the 2 major pathways for removal of amino groups from amino acids for their use as an energy source? What type of molecule is the result of the process?
36. Definitions: absorptive state, postabsorptive state.
37. What are the major sources of blood glucose?
38. How is cholesterol transported in the bloodstream? What factors lead to increased plasma cholesterol levels?
39. Definitions: metabolic rate, basal metabolic rate, total metabolic rate.
40. How does the hypothalamus regulate body temperature (what are the physiological effects of the heat-loss and heat-promoting centers)?
41. How is heat loss achieved/regulated?

Chapter 25: The Urinary System

42. What is glomerular filtration rate? Distinguish between filtrate, plasma & urine.
43. Describe the mechanisms of regulation of glomerular filtration (intrinsic controls, sympathetic nervous system controls & renin-angiotensin mechanism). What is meant by the myogenic mechanism & tubuloglomerular mechanism?
44. Detail the release of aldosterone by the renin-angiotensin mechanism. What is the function of aldosterone, which endocrine gland releases it & what cells does it act on?
45. Distinguish among passive transport and primary & secondary active transport mechanisms. Which molecules are primarily transported by each mechanism?
46. Which region of the renal tubules is most active in reabsorption of most solutes? What solutes are primarily absorbed by each region of the renal tubules?
47. What is meant by tubular secretion? What types of solutes are primarily secreted?
48. What factors favor formation of dilute & concentrated urine?

49. Define diuretic & give some examples.
50. List the general tissue composition of the mucosa & muscularis layers of the ureters, bladder & urethra.
51. Where are the detrusor muscle located?
52. What is the function & muscle type of the internal & external urethral sphincters?
53. What causes renal calculi & how can they be eliminated?
54. Define micturition, incontinence & urinary retention.

Biology 211
Answers to Study Questions for Exam 3

Chapter 23: The Digestive System

1. ***alimentary canal (GI tract***): mouth, most of the pharynx, esophagus, stomach, small intestine & large intestine; ***accessory digestive organs***: teeth, tongue, salivary glands, liver, gallbladder & pancreas
2. peristalsis: alternate waves of contraction & relaxation of muscles in walls of GI tract organs (esophagus, stomach)
3. **mucosa**: moist epithelial membrane that lines the lumen - ***3 sublayers***: *lining epithelium*: mostly simple columnar epithelium with goblet cells (stratified squamous epithelium in esophagus); *lamina propria*: loose areolar or reticular connective tissue; *muscularis mucosae*: smooth muscle cells that twitch for local movements & folds mucosa in small intestine; **submucosa**: dense connective tissue (with elastic fibers) containing blood & lymphatic vessels, lymph nodules & nerve fibers**; muscularis externa:** *inner circular layer & outer longitudinal layer* of smooth muscle (stomach has additional innermost oblique layer)**; serosa (***visceral peritoneum***):** outermost layer of areolar connective tissue covered with mesothelium (simple squamous epithelium) **-** in esophagus, replaced by adventitia (fibrous CT)
4. ***submucosal nerve plexus*** (in submucosa): controls glands & smooth muscle of mucosa; ***myenteric nerve plexus*** (located between circular & longitudinal muscle layers of muscularis externa): controls GI tract mobility (segmentation & peristalsis)
5. ***parotid glands***: paired glands anterior to ear between masseter muscle & skin; **submandibular glands**: walnut-sized glands that lie along medial aspect of mandible; **sublingual gland**: anterior to submandibular gland under tongue
6. **saliva**: mostly water; slightly acidic secretion containing electrolytes (sodium, chloride, bicarbonate… ions), salivary amylase (digestive enzyme), mucin, lysozyme, IgA & metabolic wastes (urea & uric acid); control of salivation: primarily controlled by parasympathetic division of ANS
7. *gingiva (gum)*: oral mucosa that surrounds tooth*; crown*: exposed part of tooth above gingival; *enamel*: acellular brittle material composed of hydroxyapatite crystals (mostly calcium salts); *root*: portion of tooth embedded in jawbone (teeth can have from 1 to 3 roots); *cementum*: calcified connective tissue covering outer surface of root; dentin: bonelike material under enamel forming bulk of tooth; *pulp*: connective tissue, blood vessels, & nerves in *pulp cavity*; *root canal*: where pulp cavity extends into root; *odontoblast*: cell forming the outer surface of dental pulp that produces the dentin of a tooth; ***periodontitis (periodontal disease)***: bacteria invade the bone surrounding a tooth, & immune system response further erodes bone & tooth
8. ***cardiac region***: region near the heart; surrounds cardiac orifice***; fundus***: dome-shaped region superolateral to cardiac region; ***pyloric region***: funnel-shaped region inferolateral to body & continuous with duodenum through ***pyloric sphincter*** (valve-like smooth muscle that controls stomach emptying)
9. ***gastric glands*** secrete ***gastric juice,*** a mix of secretions from *secretory cells of gastric glands*

10. ***secretory cells of gastric glands***: **mucous neck cells**: in upper "neck" region; secrete acidic mucus**; parietal cells**: in middle region; secrete ***hydrochloric acid*** (HCl) and *intrinsic factor* (necessary for vitamin B_{12} absorption in small intestine); **chief cells**: in basal region; produce pepsinogen (precursor of enzyme pepsin, a protease); **enteroendocrine cells**: a variety of cell types that secrete hormones & hormone-like molecules (including gastrin, histamine, endorphins & somatostatin) - **G cells**: secrete gastrin
11. **gastric secretion:** ***phase 1: cephalic (reflex) phase:*** triggered by aroma, taste, sight, smell of food & results in stimulation of parasympathetic fibers & gastric glands; ***phase 2: gastric phase***: initiated when food enters stomach; stomach distension activates stretch receptors & peptides & rising pH activate chemoreceptors - stretch receptors feed back to medulla & vagus nerve to stimulate gastric juice secretion; chemical stimuli activate *G cells* to secrete ***gastrin***, which in turn stimulates HCl secretion from parietal cells; ***phase 3: intestinal phase***: low pH & partially digested foods in duodenum stimulate intestinal gastrin release to blood - the enterogastric reflex following duodenal filling inhibits gastric secretion
12. ***duodenum***: shortest region; continuous with pylorus of stomach; ***jejunum***: extends from duodenum to ileum; ***ileum***: continuous with large intestine through ileocecal valve**; *plicae circulares (circular folds)***: deep folds of mucosa & submucosa slowing chyme movement for absorption; ***villi***: fingerlike projections of mucosa composed of absorptive columnar cells with microvilli called enterocytes - in the core of each villus is a *capillary bed & lymphatic lacteal* for absorption; ***intestinal crypts (crypts of Lieberkuhn)***: tubular intestinal glands between villi; ***Peyer's patches***: lymphoid follicles in submucosa
13. **esophagus**: delivers bolus of food from laryngopharynx to cardiac region of stomach through cardiac sphincter; **stomach**: food entering stomach from esophagus is broken down by chemicals into a paste called chyme; major function is *digestion* (primarily proteolytic) of contents; **small Intestine**: major function is *completion of digestion & absorption of nutrients;* **large Intestine**: major function is to absorb water from indigestible foods & eliminate them from body as feces
14. **bile**: bile is a yellow-green alkaline solution consisting of bile salts, bile pigments, cholesterol, neutral fats, phospholipids & a variety of electrolytes***; bile salts***: cholesterol derivates that emulsify fats (suspend in water), aiding in digestion & absorption of fats; ***bilirubin***: bile pigment produced as a waste product of heme of hemoglobin during red blood cell breakdown; **pancreatic juice**: contains ***digestive enzymes: proteases*** *trypsin, chymotrypsin, carboxypeptidase;* ***amylase, lipases & nucleases*** for breakdown of macromolecules to aid in their absorption in small intestine
15. **carbohydrates**: amylase (salivary & pancreatic), lactase; **proteins**: proteases *(trypsin, chymotrypsin, carboxypeptidase)*; **lipids**: lipase

Chapter 24: Nutrition, Metabolism & Body Temperature Regulation

16. **nutrient**: substance in food that is used by the body to promote normal growth, maintenance & repair; ***major nutrients***: carbohydrates, lipids, proteins, vitamins, minerals & water; ***essential nutrients***: nutrients that cannot be synthesized by chemical reactions in the body, & must be obtained from the diet
17. see notes
18. **vitamins**: organic compounds needed in small amounts for growth & metabolism; **water-soluble vitamins**: absorbed along with water from GI tract (***vitamin C & the B vitamins)***; **fat-soluble vitamins**: bind to ingested lipids & absorbed along with their digestion products (***vitamins A, D, E & K)***; ***antioxidants***: vitamins (A, C, & E) that neutralize harmful free radicals in body; **minerals**: salts or salt components (cations & anions) used by other nutrients to carry out necessary cellular reactions
19. ***coenzymes*** assist an enzyme in its activity; most *vitamins* function as coenzymes
20. 7 minerals required in moderate amounts: calcium, phosphorus, potassium, sulfur, sodium, chloride & magnesium
21. **metabolism**: all chemical reactions occurring in the body & necessary to maintain life; **anabolism**: reactions that build up molecules (larger molecules are built from smaller molecules); **catabolism**: reactions that break down molecules (complex structures are broken down into simpler ones)
22. **oxidation**: the gain of oxygen or the loss of hydrogen (or electrons)**; reduction**: the loss of oxygen or the gain of hydrogen (or electrons); ***dehydrogenases***: enzymes that catalyze transfer of hydrogen; ***oxidases***: enzymes that catalyze transfer of oxygen
23. NAD^+ & FAD
24. ***substrate-level phosphorylation***: high-energy phosphate transferred directly from a substrate molecule to ADP; ***oxidative phosphorylation***: a *chemiosmotic* process where hydrogen ion transport across the mitochondrial membrane provides the energy required for ATP synthesis
25. ***glycolysis***: cytoplasm***; formation of Acetyl Coenzyme A***: en route to mitochondrion, completed in mitochondrial matrix; ***Krebs Cycle***: mitochondrial matrix; ***electron transport***: mitochondrial inner membrane (& matrix)
26. 2 ATP (net yield), 2 NADH, 2 pyruvic acids
27. if oxygen is in short supply, pyruvic acid is reduced to ***lactic acid*** (*anaerobic respiration or fermentation*)
28. ***Krebs Cycle***: 1 ATP, 3 NADH & 1 $FADH_2$ produced per acetyl coA (2 acetyl coA were produced from 1 glucose)
29. **oxygen** acts as an <u>*electron acceptor*</u>, & uses the transported electron with available hydrogen atoms to form ***water***
30. the ***hydrogen ions*** sent back across the mitochondrial membrane (through an *ATP synthase* enzyme), release <u>energy</u> that is used by the enzyme **ATP synthase** to produce ATP from ADP & phosphate
31. 36-38, depending on the cell type
32. **glycogenesis**: glucose molecules are combined in long chains to form glycogen; **glycogenolysis**: glycogen *lysis* occurs, releasing glucose molecules from glycogen; **gluconeogenesis**: glycerol & amino acids are converted to glucose

33. *glycerol* enters the glycolytic pathway, & can be used to produce glucose, or converted to pyruvic acid & then acetyl coA to enter the Krebs cycle & electron transport for ATP production

34. ***beta oxidation***: fatty acids oxidized to acetic acid with production of NADH & $FADH_2$ (half as many acetic acids formed as carbon molecules in the fatty acid) - coenzyme A is added to each acetic acid to form acetyl coA; **lipogenesis**: triglyceride synthesis from acetyl coA & glycerol; **lipolysis**: breaking of stored fats into fatty acids & glycerol; ***ketogenesis***: 2 acetyl coA molecules are condensed to acetoacetic acid, which is then converted to beta-hydroxybutyric acid & acetone (ketone bodies); ketosis: a condition of abnormally high levels of ketone bodies in the blood (can lower blood pH – acidosis)

35. ***transamination***: transfer of amine group from amino acid to α–ketoglutaric (keto) acid to form *glutamic acid****;*** ***oxidative deamination***: amine group of glutamic acid is removed as *ammonia*

36. **absorptive state**: the time during & shortly after eating when nutrients are actively being absorbed from GI tract; **postabsorptive state**: between meals when blood sugar levels are falling

37. ***sources of glucose***: glycogenolysis in liver & skeletal muscle cells; lipolysis in adipose tissue & liver (released glycerol is converted to glucose); catabolism of cellular protein (deamination of amino acids to keto acids & conversion of keto acids to glucose)

38. ***low-density lipoproteins (LDLs)***: transport cholesterol to tissues (bad cholesterol)***;*** ***high-density lipoproteins (HDLs)***: transports excess cholesterol from tissues to liver for use in bile salts; high intake of dietary fats stimulates reabsorption of bile (& cholesterol) & some saturated fats are converted to cholesterol, & since aerobic exercise tends to raise HDL levels, lack of exercise may lead to higher LDL & lower HDL levels

39. **metabolic rate**: the overall rate at which metabolic reactions use energy; **basal metabolic rate:** the metabolic rate when the body is in a quiet, resting & fasting (postabsorptive) condition (~1200-1800 kcal/day in adults); *total metabolic rate*: rate of energy consumption for all ongoing daily activities in the body

40. ***hypothalamic thermoregulatory centers*** include heat-loss center & heat-promoting center; ***heat-promoting mechanisms***: hypothalamic heat-promoting center activated - vasoconstriction of cutaneous blood vessels (blood rerouted to internal organs), increase in metabolic rate, shivering (contraction of skeletal muscle), enhanced thyroxine release (increases metabolism & heat); ***heat-loss mechanisms***: hypothalamic heat-loss center activated - vasodilation of cutaneous blood vessels (heat lost through skin); enhanced sweating

41. see # 40

Chapter 25: The Urinary System

* Please note: although there are no questions here regarding kidney & nephron anatomy, there will be several questions on the test on these topics

42. **glomerular filtration rate (GFR)**: total amount of filtrate formed per minute by kidneys; **plasma**: the fluid component of blood, including dissolved solutes &

macromolecules; **filtrate**: the fluid material including everything in blood plasma except large proteins that enters kidney tubules from glomerular capillaries; **urine**: mostly metabolic wastes & unneeded substances (filtrate without most water, nutrients & essential ions) that exits the collecting ducts

43. **renal autoregulation (intrinsic controls)**: kidney adjusts its own resistance to blood flow to maintain a nearly constant GFR despite fluctuations in systemic blood pressure; **sympathetic nervous system controls**: release of norepinephrine & epinephrine cause constriction of afferent arterioles & activation of the renin-angiotensin mechanism; **renin-angiotensin mechanism**: renin released by JG cells leads to activation of **angiotensin II**, which is a potent vasoconstrictor that raises mean arterial blood pressure & stimulates the adrenal cortex to release aldosterone, which causes renal tubules to reabsorb more sodium ions from filtrate; ***myogenic mechanism***: increase or decrease in systemic blood pressure causes afferent arterioles to constrict or relax, restricting or enhancing blood flow to glomerulus***;*** ***tubuloglomerular mechanism***: macula densa cells of juxtaglomerular apparatus in walls of distal tubules respond to filtrate flow by releasing or inhibiting release of chemicals that produce vasoconstriction of afferent arterioles
44. **renin-angiotensin mechanism**: renin released by JG cells converts angiotensinogen in plasma (made by liver) to angiotensin I, which is in turn converted to angiotensin II by angiotensin-converting enzyme (ACE)**; angiotensin II** stimulates the adrenal cortex to release aldosterone, which causes renal tubules to reabsorb more sodium ions from the filtrate
45. ***primary active transport***: sodium is actively transported out of the tubule cell by a sodium-potassium ion ATPase pump in the basolateral membrane; ***secondary active transport***: glucose, amino acids, lactate, vitamins & most cations are transported along with sodium
46. **PCT cells:**most active reabsorbers; **loop of Henle**: reabsorbs water, sodium, chloride & potassium ions (water can leave descending limb but not ascending limb); **DCT cells**:reclaim some water, sodium & chloride ions (reabsorption of sodium regulated by aldosterone)
47. **tubular secretion**: reverse reabsorption; substances move from blood of the peritubular capillaries through tubule cells into filtrate; hydrogen & potassium ions, ammonium ion, urea & some organic acids are secreted
48. **formation of dilute urine**: normal course of filtration; low antidiuretic hormone (ADH) levels & collecting ducts remain impermeable to water**; formation of concentrated urine**: increased release of **ADH** from posterior pituitary inhibits ***diuresis*** (urine output) by increasing reabsorption of water from collecting ducts
49. **diuretics**: chemicals that enhance urinary output through inhibition of water or sodium ion reabsorption or increased osmotic pressure in kidney tubules***; alcohol*** inhibits ADH release, while *caffeine* & *drugs* such as Lasix & Diuril inhibit sodium ion reabsorption
50. **ureters**: mucosa lined with transitional epithelium; muscularis with inner longitudinal & outer circular smooth muscle sheets; **urinary bladder**: mucosa lined with transitional epithelium; muscularis (*detrusor muscle*) with inner longitudinal, middle circular & outer longitudinal smooth muscle sheets; **urethra**: epithelium of mucosa changes from transitional to pseudostratified columnar to stratified squamous near

external urethral orifice - ***internal urethral sphincter***: near bladder; smooth muscle (involuntary control) & ***external urethral sphincter***: near urogenital diaphragm; skleletal muscle (voluntary control)

51. **detrusor muscle**: smooth muscle in the muscularis layer in the wall of the urinary bladder
52. see # 50
53. ***renal calculi (kidney stones)***: form from crystallization of salts in urine in renal pelvis; can obstruct ureters; shock wave lithotripsy (ultrasonic shock breaks up stones)
54. **micturition** (voiding or urination): act of emptying bladder; ***incontinence***: inability to control micturition; ***urinary retention***: bladder unable to expel urine