Montgomery County Community College
BIO 132
Human Anatomy and Physiology II
4-3-3

COURSE DESCRIPTION:
A continuation of BIO 131 with study of the normal structure and function of the human body, with pathological applications where relevant. Systems covered include cardiovascular, lymphatic, respiratory, digestive, urinary, endocrine and reproductive systems. This course is subject to a course fee. Refer to http://mc3.edu/adm-fin-aid/paying/tuition/course-fees for current rates.

REQUISITES:
Previous Course Requirements
- BIO 131 Human Anatomy and Physiology I with a minimum grade of "C" within 5 years.

Concurrent Course Requirements
None

LEARNING OUTCOMES Upon successful completion of this course, the student will be able to:	LEARNING ACTIVITIES	EVALUATION METHODS
1. Use of standard anatomical terminology and directional terms in describing each system and its organs.	Lecture Discussion	Quizzes Lecture Exams Departmental Final
2. List and identify the organs of each system covered together with their relevant histology.	Lecture Discussion Laboratory Exercises (details below)	Quizzes Lecture Examinations Departmental Final
3. Describe the physiology of each organ and its interrelatedness to its system and the greater body integration.	Lecture Discussion	Quizzes Lecture Examinations Departmental Final
4. Explain the role of negative feedback in reviewing and comparing the roles of each system in the maintenance of steady state.	Lecture Discussion	Quizzes Lecture Examinations Departmental Final
5. Define and outline the functions of each system as they relate to system-wide integration.	Lecture Discussion	Quizzes Lecture Examinations Departmental Final

LEARNING OUTCOMES	LEARNING ACTIVITIES	EVALUATION METHODS
6. Illustrate an understanding of physiologic processes by diagraming them whenever appropriate	Lecture Discussion	Quizzes Lecture Examinations Departmental Final
7. Assess, evaluate and interpret physiologic data and formulate appropriate conclusions.	Lecture Discussion Laboratory Exercises (details below)	Quizzes Lecture Examinations Departmental Final Laboratory Exercises (details below)
8. Demonstrate the use of appropriate dissecting skills and laboratory safety in laboratory dissections throughout the semester.	Lecture Discussion Laboratory Exercises (details below)	Laboratory Activities with Models and Dissection Specimens

At the conclusion of each semester/session, assessment of the learning outcomes will be completed by course faculty using the listed evaluation method(s). Aggregated results will be submitted to the Associate Vice President of Academic Affairs. The benchmark for each learning outcome is that *70% of students will meet or exceed outcome criteria*.

SEQUENCE OF TOPICS:
These outlines are intended to serve as guidelines for the minimum course content to be covered in BIO 132. Please feel free to expand upon any topics as you wish. The sequence in which systems are covered is entirely up to your own discretion. Along with straightforward memorization of material, understanding of physiological processes and concepts, application of knowledge and critical thinking are to be stressed. Appropriate, relevant laboratory experiences will be employed to supplement and/or reinforce the lecture material. Dissection of preserved animal material is required.

Topics will be discussed and assessed at or above the depth of the current text book

I. ENDOCRINE SYSTEM

- A. Functional Comparison of Endocrine and Nervous Systems
- B. Definition of Hormone and Chemical Classification of Hormones: Amines, Peptides and Proteins, Steroids, Circulating hormones, Local Hormones, Paracrines and Autocrines, Eicosanoids.
- C. Structural and Functional Comparison of Endocrine and Exocrine Systems
- D. Control of Hormone Secretion: Negative Feedback, Stimuli by Other Hormones, Humoral Stimuli, Neural Stimuli
- E. Mechanism of Hormone Action
  1. Plasma membrane receptors: concept of signal transduction, second messengers, protein kinases, cAMP, G-proteins.

2. Steroid hormones: intracellular receptors and the activation of gene expression

F. Biological Effects of Eicosanoids (including prostaglandins)

G. Endocrine Glands:

For each gland: anatomy, location and histology

For each hormone: target(s), function, regulation, consequences of hyper- and hyposecretion in child or adult (where applicable), syndrome names, etc., plus any items listed

1. Hypothalamus
   a. link between nervous and endocrine systems
   b. function of somatostatin, growth hormone releasing hormone (RH), prolactin RH, prolactin inhibiting factor/dopamine, thyrotropin RH, corticotropin RH, gonadotropin RH
   c. hypothalamic-hypophyseal axis; including tract and portal circulation
2. Neurohypophysis
   a. relationship to hypothalamus
   b. oxytocin and antidiuretic hormones
3. Adenohypophysis
   a. growth hormone
   b. melanocyte stimulating hormone
   c. prolactin
   d. thyroid stimulating hormone
   e. adrenocorticotropic hormone
   f. follicle stimulating hormone
   g. luteinizing hormone, interstitial cell stimulating hormone
4. Thyroid hormones
   a. T3 and T4; synthesis, storage, transport, and effects; include thyroglobulin and thyroxine binding globulin, effect on metabolic rate
   b. calcitonin and its relationship to PTH
5. Parathyroid hormone
6. Adrenal medulla hormones
   a. epinephrine and norepinephrine
   b. relationship to sympathetic nervous system
7. Adrenal cortical hormones
   a. mineralocorticoids: aldosterone
   b. glucocorticoids: cortisol; uses of pharmacological levels (brief)
   c. adrenal sex hormones
8. Pancreatic hormones
   a. endocrine and exocrine pancreas
   b. glucagon
   c. insulin; plus mechanism of action
   d. somatostatin
   e. regulation of blood glucose by insulin and glucagon
   f. diabetes mellitus: IDDM and NIDDM
   g. hypoglycemia
9. Gonadal hormones: estrogen, progesterone, testosterone
10. Pineal gland: melatonin

11. Thymus: thymosin and thymopoietin

H. Stress and the General Adaptive Syndrome: Alarm, Resistance and Exhaustion; Include Endocrinology of Acute Versus Chronic Stress

LAB: Histology using endocrine and reproductive tissue slides

II. REPRODUCTIVE SYSTEM

A. Goal of Reproduction
   1. Gamete formation: concept of meiosis, haploid and diploid
   2. Fertilization

B. Male Reproductive System
   1. Gross anatomy and function of: scrotum, tunica albuginea, tunica vaginalis, testis, rete testis, epididymis, vas/ductus deferens, spermatic cord, urethra, seminal vesicles, prostate, bulbourethral glands, dartos and cremaster muscles and their role in temperature regulation.
   2. Descent of the testis; cryptorchidism
   3. Histology of testis: seminiferous tubules, spermatogonia, spermatocytes, spermatids, Sertoli cells, sperm, cells of Leydig
   4. Anatomy, function and ejaculatory pathway of mature sperm
   5. Anatomy of the penis: corpus spongiosum, corpus cavernosum, glans penis, root, bulb, shaft and glans penis
   6. Hormonal control of male reproduction: role GnRH, FSH, LH, androgen binding protein, testosterone, DHT and 5- alpha reductase
   7. Functions and effects of testosterone
   8. Physiology of erection, emission and ejaculation; include the role of parasympathetic and sympathetic nervous system

C. Female Reproductive System
   1. Gross anatomy: fallopian/uterine tubes, uterus, cervix, vagina, mons pubis, labia majora and minora, vestibule, Bartholin's glands, clitoris
   2. Histology of uterus: perimetrium, myometrium, endometrium, including stratum basalis and stratum functionalis
   3. Histology of the ovary: tunica albuginea, germinal epithelium, primordial follicles, primary follicles, secondary follicles, Graafian follicle, corpus hemorrhagicum, corpus luteum, corpus albicans
   4. Anatomy of developing and mature oocyte/follicle: granulosa cells, theca, zona pellucida, corona radiata, antrum; plus overview of meiotic events
   5. Events of puberty, menarche, and menopause
   6. Sources and functions of estrogen and progesterone
   7. Physiology of the hormonal, ovarian and uterine cycles
      a. correlation of events of the ovarian and menstrual events
      b. follicular phase: hormonal effects on follicles and corresponding uterine changes (proliferative phase)
      c. ovulatory phase: hormonal events
      d. luteal phase: function of the corpus luteum and corresponding uterine events (secretory phase) negative feedback regulation of FSH and LH
      e. menstruation

LAB: Histology using male and female reproductive histology slides

III. PREGNANCY, DEVELOPMENT AND PARTURITION

A. Role of Hormones including Progesterone, hCG, Relaxin
B. Fertilization: capacitation, acrosome reaction, blocks to polyspermy, completion of meiosis and formation of the zygote, role of HCG
C. Overview of the embryonic period cleavage, implantation, gastrulation, morphogenesis, germ layers
D. Embryonic membranes & placentation
E. Parturition
    1. Cervical dilation, expulsion, placental delivery
    2. Hormonal control, positive feedback
B. Lactation
    1. Breast anatomy and development; including hormonal control
    2. Milk production and secretion: role of prolactin, oxytocin, and suckling
C. Placental Blood Supply and Fetal Circulation
    1. Umbilical arteries, Umbilical vein, Ductus Venosus
    2. Foramen Ovale, Ductus Arteriosus
D. Cardiovascular Changes at Birth

IV. DIGESTIVE SYSTEM

A. Location of Digestive Organs on Models and Dissection Specimen
B. General Histology of the Alimentary Canal/GI Tract: Mucosa, Submucosa, Muscularis, and Serosa; Including Sub-Specializations in Various GI Regions
C. Role of the Parasympathetic ANS and the Vagus Nerve
D. Organization of Peritonea with Extensions and Reflections including omenta, mesenteries, mesocolon, falciform ligament; Definitions of Ascites and Peritonitis
E. Organs of the Buccal Cavity: Function and Anatomy
    1. Cheek and lips; review muscles of mastication
    2. Hard and soft palate; review bones
    3. Tongue; including papillae, taste buds, and gustation
    4. Fauces
F. Teeth
    1. Primary and secondary dentitions
    2. Location, structure and function of incisors, cuspids, bicuspids, and molars
    3. Tooth anatomy: crown, root, enamel, dentin, root canal, pulp, pulp cavity, cementum, periodontal ligament; include gingiva
G. Salivary Glands
    1. Histology and functions
    2. Composition and functions of saliva
    3. Location and nature of the major glands and their ducts: parotid, submandibular and sublingual glands
    4. Control by the autonomic nervous system: sympathetic and parasympathetic (via cranial nerves V, VII, XI, X)
H. Pharynx
    1. Functions
    2. Anatomy and divisions: nasopharynx, oropharynx and laryngopharynx; include the seven openings

3. General characteristics and groups of pharyngeal muscles
4. Tonsils

I. Physiology of Deglutition

J. Esophagus
1. Location and gross anatomy
2. Microscopic anatomy, including: esophageal glands and modified 4 layer structure
3. Gastroesophageal sphincter
4. Definitions of GERD, hiatal hernia

K. Stomach
1. Gross anatomy: cardiac region, fundus, body, rugae, pyloric region and canal, pyloric sphincter, greater and lesser curvatures
2. Histology and functions: standard 4 layer structure plus oblique muscular layer, mucosa (including, mucous cells, parietal cells, chief cells, enteroendocrine cells)
3. Composition of gastric juice: production and functions of HCl, pepsinogen (concept of zymogen), intrinsic factor
4. Alkaline tide
5. Definitions of: gastritis, gastric (peptic) ulcers, gastric carcinoma

L. Stomach Digestive Processes
1. Events of the cephalic phase: role of vagus (X) nerve
2. Events of the gastric phase
   a. role of cholinergic stimulation
   b. role of hormones (gastrin and histamine); include effects of anti-ulcer antihistamines, proton pump inhibitors, antibiotics
   c. gastric mixing actions
3. Events of the intestinal phase
   a. excitatory phase: role of enteric gastrin
   b. inhibitory phase: role of the enterogastric reflex and the enterogastrones CCK, Secretin, GIP
4. Events of the absorptive and post-absorptive states; include the major hormones involved

M. Emesis: Control by the Medulla Oblongata and Consequences of Prolonged Vomiting

N. Pancreas
1. Location and anatomy: exocrine cells, pancreatic duct, hepatopancreatic ampulla (of Vader), hepatopancreatic sphincter (of Oddi), relation to the common bile duct
2. Pancreatic secretions
   a. production and function of bicarbonate ion
   b. digestive enzymes: amylase, lipase, nucleases and proteases (trypsinogen, chymotrypsinogen, proelastase, rocarboxypeptidase), cholesterol esterases
   c. activation of protease zymogens; role of enterokinase
3. Regulation of pancreatic secretions by the parasympathetic nervous system, secretin and cholecystokinin
4. Brief overview of pancreatitis and the use of serum amylase and lipase as diagnostic tests

O. Liver/Biliary System
1. Overview of liver functions

2. Location and gross anatomy: lobes, ligaments, omenta, blood vessels, hepatic ducts, cystic duct, common bile duct
3. Histology of hepatic lobules: central veins, portal veins, hepatic veins, hepatic arteries, (portal triad), sinusoids, bile canaliculi, hepatocytes, Kupffer cells
4. Liver physiology: function and flow of blood and bile in the liver lobule and duct system; include the role of CCK and secretin
5. Bile: composition, function of bile salts, bilirubin, cholesterol
6. Brief overviews of cirrhosis, infectious and serum hepatitides, cholelithiasis, cholecystitis, and jaundice

P. Small Intestine
1. Location and gross anatomy: duodenum, jejunum, ileum, ileocecal valve
2. Histology (4 layer structure plus the following modifications); correlate anatomy and function of: plicae circulares, villi, microvilli, epithelium, goblet cells, lacteal, capillary net, intestinal glands, enteroendocrine cells, Peyer's patches, Brunner's glands
3. Small intestine movements: segmentation and peristalsis
4. Digestion and brushborder enzymes
   a. proteins: dipeptidases
   b. carbohydrates: sucrase, maltase, lactase, dextrase, glucoamylase
   c. nucleic acids: nucleotidase
   d. lipids: include micelles, chylomicron formation, and transport to the lacteal
5 Absorption: trans epithelial transport via active and passive processes; include all in #4 above and vitamins, electrolytes, and water
6. Definitions of lactase insufficiency, Crohn’s disease and other related disorders

Q. Large Intestine
1. Location and gross anatomy: cecum, appendix; ascending, transverse and descending colon; anal canal, haustra, taenia coli, epiploic appendages
2. Histology: modified four layer structure; including epithelial and smooth muscle modifications
3. Large intestine movements: mixing, peristalsis and mass movements
4. Functions of the large intestine: water, electrolyte and vitamin absorption; normal flora, feces formation, defecation reflex
5. Definitions of diarrhea, inflammatory bowel disorders, diverticulitis, constipation and colorectal cancer

LAB: Dissection Specimen – Internal Dissection

V. NUTRITION AND METABOLISM

A. Nutrition
1. Macronutrients and micronutrients; balanced diet and essential nutrients
2. Energy: definition of Calorie, basal metabolic rate, energy balance, obesity, malnutrition

3. Types, sources, uses, and caloric values of:
    a. carbohydrates; importance to the nervous system
    b. lipids
    c. proteins: incomplete & complete proteins, nitrogen balance
4. Micronutrients
    a. vitamins
        1) identify fat soluble A, D, E, K
        2) water soluble: functions and effects of deficit or excess (where applicable) of C, and B complex
    b. minerals
5. Define: Malnutrition, Kwashiorkor

B. Metabolism
1. Overall scheme of metabolism (some review from BIO 131): oxidation, reduction, catabolism, anabolism, metabolic pathway, allosteric enzyme, anaerobic respiration, aerobic respiration, coenzymes, and concept of interconversion metabolic pathway intermediates
2. Anaerobic respiration: glycolysis
    a. definition, cellular location, names of starting reactants and end products
    b. 3 phases: activation, cleavage, and oxidation/ATP formation
    c. energy yield (NADH and ATP)
3. Aerobic respiration
    a. importance of Coenzyme A (CoA) to various metabolic pathways
    b. citric acid (Krebs) cycle
        1) definition, cellular location (anatomy of a mitochondrion), know citric acid, alpha ketoglutaric acid and oxaloacetic acid intermediates
        2) major events: decarboxylation (CO_2 production), oxidation/reduction (dehydrogenase) reactions (formation of NADH), substrate level phosphorylation
        3) fate of NADH
    c. electron transport chain (ETC) and oxidative phosphorylation/chemiosmotic theory
        1) concept of the ETC: role of cytochrome oxidase, the function of oxygen, metabolic water, effects of cyanide
        2) building the hydrogen ion gradient
        3) using potential energy of the gradient to power ATP synthetase
    d. overall ATP yield per molecule of glucose
4. Consequences of limiting oxygen: lactic acid fermentation
    a. metabolic reason it occurs
    b. physiological consequences: events in skeletal muscle and liver
5. Protein metabolism
    a. deamination and urea formation
    b. transamination: formation of non-essential amino acid; serum levels in disease states (e.g. liver)

6. Fat metabolism
    a. catabolism
        1) concept of beta oxidation and importance of CoA
        2) metabolic reason for ketone body formation
        3) consequences of high rate of fatty acid oxidation: ketoacidosis/ketogenesis
        4) potential pathways and routes for acetyl groups
    b. anabolism: lipogenesis
    c. Roles of chylomicron, VLDL, LDL, HDL, Lipid Profile
7. Carbohydrate metabolism, including gluconeogenesis, glycogenesis and glycogenolysis

VI. BLOOD

A. Functions of the Blood - Transport; Fight Infection; Homeostasis, Including Body Temp, pH, Hemostatic Regulation

B. Characteristics of Blood - pH; Volume; Viscosity; Definitions of Hematocrit, Hemoglobin, Complete Blood Count; Microscopic Identification of All Cell Types

C. Erythrocytes
1. Characteristics: including morphology, life span, functions, cell structure, rouleaux formation, counts
2. Hemoglobin
    a. chemical structure - alpha and beta chains, heme group
    b. types: HbA, HbF, HbS
    c. role in transport of O_2, CO_2, H^+, CO
3. Erythropoiesis - include locations, pathway from hemocytoblast to erythrocyte, dietary needs, and regulation through erythropoietin
4. Removal from circulation and breakdown of Hb - bile pigments
5. Disorders - polycythemias and various anemias

D. Leukocytes
1. Characteristics: including counts, functions, morphology, diapedesis, and chemotaxis
2. Types - for each type state whether a granulocyte or agranulocyte, function, cell morphology and structure, % of all WBC, life span, and causes of an increase in number
3. Counts - CBC, differential - definition, significance, typical values
4. Leukopoiesis - locations, pathways starting with hemocytoblast, and role of CSF
5. Disorders - leukemia, leukopenia, leukocytosis

E. Platelets/Thrombocytes
1. Characteristics - cell structure, life span, counts
2. Function
3. Thrombopoiesis - locations, pathway starting at hemocytoblast

F. Plasma
1. Composition and appearance
2. Proteins - include relative abundance, site of production, and functions of albumins, globulins, and fibrinogen
3. Nutrients - amino acids, monosaccharides, lipoproteins (chylomicrons, HDL, LDL, VLDL)
4. Electrolytes - most abundant cations and anions

5. Non-protein nitrogenous substances - include sources and destination and role in kidney disease

G. Hemostasis
1. Vascular spasm
2. Platelet plug formation - include role of PG's, ADP, serotonin. Include events triggering, adhesion and release reaction
3. Coagulation
   a. common pathway, intrinsic and extrinsic mechanisms - include what triggers each, overview of pathways, end points, clotting factors, definition of serum
   b. clot retraction - include time involved and actomyosin
   c. fibrinolysis - include time involved and role of tPA and plasmin
4. Factors preventing coagulation - include roles of heparin, anti-thrombin III, smooth intact endothelium, fast-moving blood
5. Hemostatic disorders - hemophilia, thrombocytopenia, impaired liver function, and vitamin K deficiency

H. Blood Types
1. Definitions of agglutinins and agglutinogens
2. ABO group - include types, frequencies, agglutinogens and agglutinins
3. Rh group - include types, frequencies, agglutinogens and agglutinins
4. Transfusions
   a. type/cross match
   b. transfusion reaction
5. Erythroblastosis fetalis (hemolytic disease of newborn). Rh group of mother and fetus, reaction, and use of RhoGAM

LAB: Hematology lab – differential with prepared blood slides, and blood type determinations using artificial blood

VII. THE HEART

A. Characteristics
1. Location
2. Orientation within mediastinum - base, apex, great vessels
3. Pericardium - include serous and fibrous layers; visceral and parietal layers of serous; pericardial cavity; fluid; and functions

B. Wall of Heart (Include Epi-, Myo-, and Endo- Cardia)

C. Internal Anatomy
1. Define artery and vein functionally
2. Chambers (4) - compare atria to ventricles in terms of structure and function
3. Septum - interatrial, fossa ovalis, interventricular
4. Valves - (4) - include names, function, direction of opening, and role of chordae tendineae

D. External Features
1. Auricles
2. Great vessels
3. Grooves (sulci) - atrioventricular (coronary), anterior and posterior interventricular with associate vessels

E. Path of Blood Flow through Heart - Include All Chambers, Valves, and Vessels. Distinguish between Pulmonary and Systemic Circulations, Location of Oxygenated and Deoxygenated Blood
F. Fibrous Skeleton of Heart
G. Coronary Circulation
    1. Include R & L coronary, anterior and posterior interventricular, marginal, and circumflex arteries, anastomoses, and coronary sinus
    2. Angina pectoris and myocardial infarction - cause, symptoms, Rx
H. Cardiac Muscle Tissue
    1. Histology - review - intercalated discs, striations, gap junctions
    2. Energy sources - aerobic
    3. Functional syncytium - definition
    4. Contraction physiology - include depolarization, role of Ca^{++}, fast & slow calcium channels, all-or-none, long refractory period, and automaticity
I. Cardiac Cycle - For Each Step Include Amount of Time Involved, Pressure Changes and Position of Valves
    1. Mid to late diastole
        a. ventricular filling
        b. atrial systole
    2. Ventricular systole
        a. isovolumetric contraction phase
        b. ventricular ejection phase
    3. Early diastole
        a. isovolumetric relaxation phase
        b. ventricular filling
J. Heart Sounds - Lub, Dup, Split, Murmurs
K. Cardiac Conduction System
    1. Automaticity - self-exciting cells
    2. S-A node - location, inherent rhythm
    3. A-V node - location, inherent rhythm, impulse delay, electrical bridge
    4. A-V bundle - location, inherent rhythm
    5. Purkinje fibers - location, inherent rhythm
L. ECG - Include P, QRS, and T Waves, P-R and Q-T Intervals, Amount of Time Involved, and Correlating Events in Cardiac Cycle
M. Regulation of Heart Rate
    1. ANS - includes roles of sympathetic and parasympathetic stimulation and cardioacceleratory and inhibitory centers in medulla
    2. Influence of other factors: electrolytes (Ca^{++},$K^{+,}$ Na^{+}), hormones, age, sex, temperature
    3. Input from baroreceptors (pressoreceptors) in carotid sinus, R atrium, aortic arch; and Bainbridge (atrial) reflex
    4. Define tachy- and bradycardia
N. Hemodynamics
    1. CO = SV x HR; end-systolic and end-diastolic volumes, and mathematical relationships between each
    2. Cardiac reserve
    3. Frank-Starling law of the heart

O. Cardiac Disorders - Causes, Symptoms, Treatments, Physiology of: Valvular Disorders, Including MVP, Incompetent and Stenotic Valves; Fibrillation; Conduction Disorders Including Ectopic Beat and Heart Block (1°, 2°, 3°), and Congestive Heart Failure

LAB: Heart Dissection

VIII. BLOOD VESSELS

A. Characteristics - Functional Definition and Relative Pressures within Each

B. Arteries
1. Wall - tunica intima, media, and adventitia; histology; vaso vasorum
2. Types: elastic and muscular - locations and structure
3. Arterioles - structure
4. Pulse
5. Pressure points

C. Capillaries
1. Characteristics - structure, significance, abundance
2. Types - continuous, fenestrated, sinusoids
3. Capillary beds - include vascular shunts, true capillaries, pre-capillary sphincters
4. Fluid movements - include opposing roles of hydrostatic and osmotic pressures, movements at arteriole and at venule end, and net loss of fluid
5. Edema

D. Veins
1. Characteristics - wide lumen, low pressure, blood reservoir
2. Wall - 3 tunics
3. Venules
4. Valves
5. Venous circulation
6. Sinuses - dural sinus, coronary sinus

E. Anastomoses

F. Blood Pressure
1. Definition and values (include Pulse Pressure and Mean Arterial Blood Pressure)
2. Factors influencing - include CO and heart action, blood volume, peripheral resistance (viscosity, vessel diameter and length)
3. Systemic pressure gradient
4. Regulation - include role of ANS, vasomotor center of medulla, baroreceptors in carotid and aortic sinuses, renal regulation, sympathetic hormones, atrial natriuretic factor, angiotensin II, chemoreceptors, and pH

G. Vascular Disorders
1. Circulatory shock - include types and causes, symptoms, and acute vs. chronic compensatory mechanisms
2. Atherosclerosis, arteriosclerosis, aneurysm, CVA, phlebitis, and hypertension - causes, treatment

H. Circulatory pathways - locate on a diagram or model and state where they supply blood to/drain blood from, the vessels listed below:
ARTERIES:
aorta-ascending and descending, aortic arch, coronary arteries, brachiocephalic, common carotids, subclavians, vertebrals, basilar,

internal carotids, external carotids, Circle of Willis/associated vessels, pulmonary, axillaries, brachials, radials, ulnars, celiac, hepatic, superior and inferior mesenterics, renals, gonadals, common iliacs, internal and external iliacs, femorals, popliteals, anterior and posterior tibials
VEINS:
superior and inferior vena cava, brachiocephalic, subclavian, internal and external jugular, basilic, brachial, cephalic, median cubital, axillary, azygous, hepatic portal, hepatic, renal, sphlenic, superior mesenteric, femoral, popliteal, internal and external iliac, common iliac, great and small saphenous

G. Fetal Blood Circulation (see under III)

LAB: Vascular models

IX. LYMPHATIC SYSTEM

A. Functions
B. Lymphatic Vessels (Compare wherever possible to vascular vessels)
   1. Capillaries
   2. Lymphatic vessels (lymphatics)
   3. Trunks: lumbar trunks (R&L), intestinal (single, unpaired) bronchomediastinal (R&L), subclavian (R&L), jugular (R&L)
   4. Collecting ducts: R lymphatic duct, thoracic duct and cisterna chyli
C. Circulation of lymph - include factors responsible for formation and flow of lymph
D. Lymph Nodes
   1. Structure - include stroma and parenchyma
   2. Locations - arranged in clusters along lymph pathways - note areas of great abundance and their significance
   3. Functions
E. Lymph nodules including tonsils, MALT and GALT
F. Disorders: lymphangitis, lymphadenitis, lymphedema
G. Lymphatic organs - anatomy and function of the following:
   1. Thymus
   2. Spleen
   3. Tonsils
   4. Peyer's patches

X. BODY DEFENSES

A. Non-Specific Defenses
   1. Mechanical barriers
   2. Chemical defenses
   3. Interferon (IFN) (alpha and beta)
   4. Inflammation
   5. Fever
   6. Complement
   7. Monocyte-Macrophage/Reticuloendothelial System
   8. NK Cells
B. Immunity - Specific Defense
   1. Antigens; definition, examples, antigenic determinant sites, haptens
   2. Immunoglobulins (Ig)
   a. structure - include heavy and light chains, constant and variable portions

b. classes - function and characteristics of each: IgG, IgA, IgM, IgD, IgE
c. function: complement activation, neurtralization, agglutination, precipitation,

C. Lymphocytes: T-cells: helper / $T_{H,}$ cytotoxic T_c, T regulator T_{REG} and B-cells / plasma cells

D. Cytokines including: interferons, interleukins (main types IL1, IL2, IL4, IL5, tumor necrosis factor, colony-stimulating factors, lymphtoxins, perforins, defensins

E. Immune response with roles of: MHC I & II, antigen-presenting cells, T_H cells, cytokines
1. Steps in presentation of T-dependent antigens: antigen processing and presentation, T_H activation / costimulation, B-cell activation and clonal selection.
2. AMI / antibody-mediated immunity. Include roles of B-lymphs, clones, plasma and memory cells, 1° and 2° (booster) responses
3. CMI / cell mediated immunity. Include roles of T-lymphs, clones, subpopulations of helper, suppressor, cytotoxic, delayed hypersensitivity, and memory cells in T cell recall responseF.

F. Types of Immunity
1. Active immunity
   a. naturally acquired active
   b. artificially acquired passive
2. Passive immunity
   a. naturally acquired passive
   b. artificially acquired passive

G. Disorders
1. Autoimmune (include lupus, multiple sclerosis, rheumatoid arthritis, Grave's disease, fetal hemolytic disease)
2. Hypersensitivity - delayed and immediate
3. Immune Deficiency Diseases: SCID and AIDS
4. Fetal Hemolytic Disease

LAB: Lymphatic histology slides

XI. RESPIRATORY SYSTEM

A. Functions
1. Exchange of O_2 and CO_2. Include definition of: external respiration, internal respiration, cellular respiration
2. Homeostasis of blood pH

B. Anatomy
1. Structure and function of: nose, nasal cavity, nasal conchae, paranasal sinuses, pharynx (with subdivisions and openings), larynx, trachea, bronchial tree, lungs. Describe hierarchy of lung structure in terms of alveoli, terminal respiratory units, lobules, bronchopulmonary segments, lobes
2. Describe pleurae: include visceral pleura, pleural cavity, surface tension, subatmospheric pressure (negative pressure), parietal pleura; and pleurisy
3. Alveoli

a. histology (include type I cells - simple squamous cells; type II cells - surfactant producing cells; dust cells - macrophages; and lamina propria)
b. function

4. Respiratory musculature - role of diaphragm and intercostal muscles

C. Physiology

1. Pulmonary ventilation
   a. Boyle's Law, Dalton's Law, Henry's Law
   b. inspiration (active)
      1) forceful inspiration
   c. expiration (passive)
      1) forceful expiration (active)
2. Pleural cavity (include pressure and pneumothorax)
3. Role of surfactant - include IRDS (infant respiratory distress syndrome) or hyaline membrane disease
4. Respiratory volumes - include TV, IRV, ERV, VC, RV, FEV, FEV_1, TLC, ADS, MRV, AVR, and mathematical relationships between each
5. ANS innervation of smooth muscle in the respiratory tract, including neurotransmitters and receptors
6. Regulation of breathing
   a. regulation of rate
      1) medulla - respiratory center - roles of:
         a) DRG (dorsal respiratory group)
         b) VRG (ventral respiratory group)
      2) Pons - roles of:
         a) pneumotaxic area
         b) apneustic area
   b. chemosensitive areas
      1) medulla - sensitive to CO_2 and H^+
      2) peripheral chemoreceptors (carotid and aortic bodies)
         a) sensitive to oxygen if very low
         b) COPD patients
         c) Hering-Breuer reflex
         d) other factors
            (1) CNS stimulants/depressants
      2) temperature
      3) stretching of anal sphincter
7. Terms - define: apnea, eupnea, dyspnea, hyperpnea, cyanosis, hypoxia, hypercapnia, etc.
8. Mechanical aspects of gas exchange - include roles of: alveolar pores, respiratory membrane, Dalton's Law, partial pressures

LAB: Spirometry

9. Blood transport of gases - include Henry's Law
   a. oxygen
      1) hemoglobin (Hb)
         a) chemical structure
         b) saturation with oxygen
      2) dissociation curves

3) factors affecting dissociation
a) PO_2
b) PCO_2
c) temperature
d) pH (Bohr effect)
e) BPG (biphosphoglyceric acid)
4) types of Hb - HbA, HbF, HbS
5) hyperbaric oxygen
b. CO (carbon monoxide)
c. CO_2 - % carried in plasma, RBC, as HCO_3- (include Cl- shift and role of CO_2 in regulation and homeostasis of blood pH)
d. N_2 - include nitrogen narcosis and decompression sickness
e. Complimentary effects of Haldane and Bohr effects
10. Respiratory disorders
a. COPD (emphysema, chronic bronchitis)
b. asthma

XII. KIDNEY/FLUID-ELECTROLYTE/ACID-BASE HOMEOSTASIS
URINARY ANATOMY AND PHYSIOLOGY

A. General Functions of the Kidney
B. Kidney Location
C. Anatomy of Kidney Including: Capsule, Pelvis, Hilum, Lobules, Pyramids, Columns, Cortex, Medulla, Ureter and Blood Supply From Renal Artery to Renal Vein
D. Diagram/Model of Urinary System with Major Organs; Locate on Pig Kidney
E. Nephron Structure and Function Including Juxtaglomerular and Cortical Nephrons, Glomerulus with Fenestrated Capillaries and Podocytes, Prox. Conv. Tubule, Loop Of Henle, Distal Conv. Tubule, Juxtaglomerular Apparatus, Collecting Duct
F. Nephron Physiology
1. Glomerular filtration including role of osmotic and hydrostatic pressures and calculation of effective filtration pressures; include Net Filtration Pressure (NFP) and Glomerular Filtration Rate (GFR)
2. Selective tubular reabsorption including role of tubules, specific solutes handled, role of tubular/transport maxima (receptor saturation), active and passive transport
3. Selective tubular secretion (excretion)
4. Role of countercurrent multiplier exchange mechanism in maintaining nephron osmolarity
G. Actions of ADH and Aldosterone on the Nephron; Review Diabetes Insipidus, Polyuria, Oliguria, Anuria, Diuresis
H. Homeostatic functions
1. Maintenance of blood volume
2. Blood pressure including renin/angiotensin system and role of juxtaglomerular apparatus
3. pH regulation including roles of Na^+/H^+ antiport, deamination and role of ammonia, mono and dibasic phosphate regulation, urine acidification and maintenance of carbonate/bicarbonate ratio
I. Structure and function of ureters, bladder, urethra

J. Micturition Reflex Including Voluntary, Involuntary and Neuronal Components
K. Describe Characteristics and Composition of Urine. Include Normal and Pathologically Significant Values from Urinalysis Lab
L. Define: Cystitis, Urethritis, Nephritis, Glomerulonephritis, Pyelitis, Ureteritis
LAB: Kidney dissection, urinalysis lab

XIII. FLUID, ELECTROLYTE HOMEOSTASIS/ACID-BASE HOMEOSTASIS

A. Define: Body Fluid/Fluid Balance, Compartments (Intracellular, Extracellular with Subdivisions), Third Spaces with Examples and Relative Distributions of Fluid in Each
B. Fluid Input-Output and Factors Influencing/Regulating
C. Define Nonelectrolyte, Electrolyte with Examples of Major Anions and Cations in Each Compartment; Milliequivalent System Including the Importance of Charge and Concentration When Discussing electrolytes
D. Roles and Functions of Specific Ions, Regulation and Their Imbalances Including Sodium, Chloride, Potassium, Calcium, Phosphate, Magnesium
E. Obligatory and Facultative Water Reabsorption
F. Causes and Effects of Overhydration, Water Intoxication
G. Starling's Law of Capillaries and Factors Contributing To Edema, Calculate Peff
H. Review Buffering and Account For Ion Disruptions Occurring In Response to Acidosis (Hypercalcemia, Hyperkalemia) and Alkalosis (Hypokalemia, Hypocalcemia)
Review Buffering Capacities of Hemoglobin, Phosphate, Biarbonate/Bicarbonate, Protein/Amino Acids. Review the Body's Tendency to Generate Acids
I. Clinical Signs and Symptoms, Findings; i.e., Arterial Blood Gas (ABG) Causes, Physiologic Effects Of Respiratory and Metabolic Acidosis and Alkalosis. Include Renal and Respiratory Compensation Mechanisms and Timeliness thereof.

LEARNING MATERIALS:
Required Textbook:
Marieb, E.N. & Hoehn, K. *Human Anatomy & Physiology*, Pearson Publishing.

Suggested (Not Required) Secondary Sources:
Marieb. *The A&P Coloring Book*.
Rust, Thomas. *A Guide to Anatomy and Physiology Lab*.

LABORATORY

Required Laboratory Manual:
Marieb, Elaine. *Human Anatomy & Physiology* (Custom Edition).

Laboratory Topics: Gross anatomy and histology of the endocrine, reproductive, cardiovascular, digestive, lymphatic, respiratory and urinary systems; spirometry and urinalysis. The dissection of preserved laboratory material is a requirement of the course.

Other learning materials may be required and made available directly to the student and/or via the College's Libraries and/or course management system.

COURSE APPROVAL:

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VPAA/Provost or designee Compliance Verification:		Date: 3/6/2017
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This course is consistent with Montgomery County Community College's mission. It was developed, approved and will be delivered in full compliance with the policies and procedures established by the College.