Anatomy & Physiology

CREDIT HOURS
6

LEVEL
LOWER

EXAM
CODE
506

CATALOG
NUMBER
BIOx210

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www.excelsior.edu/contentguides
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Before You Choose This UExcel Exam

Uses for the Examination

• Excelsior College, the test developer, recommends granting six (6) semester hours of lower-level undergraduate credit to students who receive a letter grade of C or higher on this examination. The exam fulfills the anatomy and physiology core requirement for the Excelsior College nursing degrees.

• Other colleges and universities also recognize this exam as a basis for granting credit or advanced standing.

• Individual institutions set their own policies for the amount of credit awarded and the minimum acceptable grade.

Exam-takers who have applied to Excelsior College should ask their academic advisor where this exam fits within their degree program.

Exam-takers not enrolled in an Excelsior College degree program should check with the institution from which they wish to receive credit to determine whether credit will be granted and/or to find out the minimum grade required for credit. Those who intend to enroll at Excelsior College should ask an admissions counselor where this exam fits within their intended degree program.

Examination Length and Scoring

The examination consists of approximately 120 questions, most of which are multiple choice; for samples of all the item types on this exam, see the sample items in the back of this guide. Some items are unscored, pretest items. The pretest items are embedded throughout the exam and are indistinguishable from the scored items. You will have three (3) hours to complete the examination. Your score will be reported as a letter grade.

UExcel Exam Resources

Excelsior College Bookstore

The Excelsior College Bookstore offers recommended textbooks and other resources to help you prepare for UExcel exams.

The bookstore is available online at (login required):
www.excelsior.edu/bookstore

UExcel Practice Exams

The official UExcel practice exams are highly recommended as part of your study plan. Once you register for your UExcel exam, you are eligible to purchase the corresponding practice exam, which can be taken using any computer with a supported Web browser. Each practice exam includes two forms that you may take within a 180-day period.
Excelsior College Library

Enrolled Excelsior College students can access millions of authoritative resources online through the Excelsior College Library. Created through our partnership with the Sheridan Libraries of The Johns Hopkins University, the library provides access to journal articles, books, websites, databases, reference services, and many other resources. Special library pages relate to the nursing degree exams and other selected exams. To access it, visit www.excelsior.edu/library (login is required).

Our library provides:

- 24/7 availability
- The world’s most current authoritative resources
- Help and support from staff librarians

Online Tutoring

Excelsior College offers online tutoring through SMARTTHINKING™ to connect with tutors who have been trained in a variety of academic subjects. To access SMARTTHINKING, go to www.excelsior.edu/smarthinking. Once there, you may download a copy of the SMARTTHINKING Student Handbook as a PDF.

Preparing for UExcel Exams

Take Charge of Your Own Learning

At Excelsior College, independent, self-directed study supported by resources we help you find is not a new concept. We have always stressed to exam takers that they are acting as their own teacher, and that they should spend as much time studying for an exam as they would spend in a classroom and on homework for a corresponding college course in the same subject area.

Begin by studying the content outline contained in this content guide, at its most detailed level. You will see exactly which topics are covered, and where chapters on those topics can be found in the Recommended Resources. You will see exactly where you might need to augment your knowledge or change your approach.

The content outline, along with the Learning Outcomes for this exam and recommended textbooks, will serve as your primary resources.

How Long Will It Take Me to Study?

A UExcel exam enables you to show that you’ve learned material comparable to one or more 15-week college-level courses. As an independent learner, you should study and review as much as you would for a college course. For a 3-credit course in a subject they don’t know, most students would be expected to study nine hours per week for 15 weeks, for a total of 135 hours.

Study Tips

Become an active user of the resource materials. Aim for understanding rather than memorization. The more active you are when you study, the more likely you will be to retain, understand, and apply the information.

The following techniques are generally considered to be active learning:

- preview or survey each chapter
- highlight or underline text you believe is important
- write questions or comments in the margins
- practice re-stating content in your own words
- relate what you are reading to the chapter title, section headings, and other organizing elements of the textbook
- find ways to engage your eyes, your ears, and your muscles, as well as your brain, in your studies
- study with a partner or a small group (if you are an enrolled student, search for partners on MyExcelsior Community)
- prepare your review notes as flashcards or create recordings that you can use while commuting or exercising

When you feel confident that you understand a content area, review what you have learned. Take a second look at the material to evaluate your understanding. If you have a study partner, the two of you can review by explaining the content to each other or writing test questions for each other to answer. Review questions from textbook chapters may be helpful for partner or individual study, as well.

Using UExcel Practice Exams

We recommend taking the first form of the practice exam when you begin studying, to see how much you already know. After taking the first practice exam,
check your performance on each question and find out why your answer was right or wrong. This feedback will help you improve your knowledge of the subject and identify areas of weakness that you should address before taking the exam. Take the second form of the practice exam after you have finished studying. Analyze your results to identify the areas that you still need to review.

Although there is no guarantee, our research suggests that students who do well on the practice exams are more likely to pass the actual exam than those who do not do well (or do not take advantage of this opportunity).

Preparing for This Exam

Prior Knowledge
A familiarity with basic terms of biology and with concepts such as basic cell structure and function is assumed.

Using the Content Outline
Each content area in the outline includes (1) the recommended minimum hours of study to devote to that content area and (2) the most important sections of the recommended resources for that area. These annotations are not intended to be comprehensive. You may need to refer to other chapters in the recommended textbooks. Chapter numbers and titles may differ in other editions.

This content outline contains examples of the types of information you should study. Although these examples are numerous, do not assume that everything on the exam will come from these examples. Conversely, do not expect that every detail you study will appear on the exam. Any exam is only a broad sample of all the questions that could be asked about the subject matter.

Using the Sample Questions and Rationales
Each content guide provides sample questions to illustrate those typically found on the exam. These questions are intended to give you an idea of the level of knowledge expected and the way questions are typically phrased. The sample questions do not sample the entire content of the exam and are not intended to serve as an entire practice test.

About Test Preparation Services
Preparation for UExcel® exams and Excelsior College® Examinations, though based on independent study, is supported by Excelsior College with a comprehensive set of exam learning resources and services designed to help you succeed. These learning resources are prepared by Excelsior College so you can be assured that they are current and cover the content you are expected to master for the exams. These resources, and your desire to learn, are usually all that you will need to succeed.

There are test-preparation companies that will offer to help you study for our examinations. Some may imply a relationship with Excelsior College and/or make claims that their products and services are all that you need to prepare for our examinations.

Excelsior College is not affiliated with any test preparation firm and does not endorse the products or services of these companies. No test preparation vendor is authorized to provide admissions counseling or academic advising services, or to collect any payments, on behalf of Excelsior College. Excelsior College does not send authorized representatives to a student’s home nor does it review the materials provided by test preparation companies for content or compatibility with Excelsior College examinations.

To help you become a well-informed consumer, we suggest that before you make any purchase decision regarding study materials provided by organizations other than Excelsior College, you consider the points outlined on our website at www.excelsior.edu/testprep.
Recommended Resources for the UExcel Exam in Anatomy & Physiology

The resources and materials listed below were used by the examination development committee to verify all the questions on the exam. Excelsior College recommends you use these resources as the most appropriate information when ordering textbooks from the college’s bookstore (see page 1 of this content guide). You should allow ample time to obtain resources and to study sufficiently before taking the exam, so plan appropriately and systematically.

A word about textbook editions: Textbook editions listed in the UExcel content guides may not be the same as those listed in the bookstore. Textbook editions may not exactly match up in terms of table of contents and organization, depending upon the edition. However, our team of exam developers checks exam content against every new textbook edition to verify that all subject areas tested in the exam are still adequately available in the study materials. If needed, exam developers will list supplemental resources to ensure that all topics in the exam are still sufficiently covered. Public libraries may have the textbooks you need, or may be able to obtain them for you through interlibrary loan to reduce textbook costs. You may also consider financial aid, if you qualify, to further help defray the steep cost of textbooks. A section on OER has been included in this guide to help you locate additional resources to augment your study.

Textbooks

The following textbook was used by the examination development committee to verify all questions on the exam. These study materials may be purchased from the Excelsior College Bookstore.

www.excelsior.edu/bookstore


NOTE: The textbook edition offered at the Excelsior College Bookstore is packaged with the following supplements:

- Atlas of the Human Body

Reducing Textbook Costs

Many students know it is less expensive to buy a used textbook, and buying a previous edition is also an option. The Excelsior College bookstore includes a buyback feature and a used book marketplace, as well as the ability to rent digital versions of textbooks for as long as students need them. Students are encouraged to explore these and the many other opportunities available online to help defray textbook costs.

Practice Exam

Practice Exam is available after you register for this exam.

A Word About Open Educational Resources

Open educational resources (OER) are educational materials available for study at no cost on the Web. Some OER are available for anyone to access any time. Others, such as Massive Open Online Courses (MOOCs), require sign-up and are only available during certain windows. Please note that some MOOC providers offer certificates of completion or other products or services for a fee. No MOOC or other OER is a complete substitute for the content guide and officially Recommended Resources listed here in this content guide. However, by definition, MOOCs are essentially free of charge and include access to a main body of learning materials that may help you in your learning.

Being an independent learner preparing for credit by exam, you may not need any of the fee-based options that are offered elsewhere online. But if you are looking for a coherent academic course for self-study, lectures on specific topics, or audio or visual materials that fit your learning style better than print materials alone, a MOOC or other type of OER may be your answer. Keep in mind that none of these OER were designed by Excelsior, nor are they guaranteed to match the exam content outlines completely. They are simply another tool available in your study kit.
We highly encourage using the Recommended Resources. In the content outline, you will see that the topics in the exam are referenced to specific portions of recommended textbooks. Using OER alone will not ensure you’ve completely covered the content in the exam, or it may not cover some topics in sufficient-enough depth without the use of the formal, recommended textbooks.

If the OER course you choose does not include a textbook for reference and you do not have significant practical theory-based experience in the field of study, use a college textbook to ensure adequate preparation for the exam, and use the exam’s content outline as a guide.

Combined with comparable college textbooks, OER provides you with a variety of choices in knowledge sources and learning experiences, to enhance your understanding of the subject matter.

Choosing Open Educational Resources

Most sites for university-based OER can be searched through www.ocwconsortium.org and/or www.oercommons.org.

Sites that specialize in Web courses designed by college professors under contract with the website sponsor, rather than in Web versions of existing college courses, include:

- www.education-portal.com
- www.opencourselibrary.org (abbreviated as OCL)

We have included specific courses that cover material for one or more UExcel® exams from the sites in the listings above. It’s worth checking these sites frequently to see if new courses have been added that may be more appropriate or may cover an exam topic not currently listed.

In addition, sites like Khan Academy (www.khanacademy.com) and iTunes U feature relatively brief lessons on very specific topics rather than full courses. Full courses are also available on iTunes U (http://www.apple.com/education/ipad/itunes-u/). We have chosen a few courses and collections for this listing.

Other Online Resources

This section of the OER Guide is provided to allow learners to independently search for resources. Send an e-mail to OER@excelsior.edu if you have questions about a resource’s credibility.

Open Online Textbooks

- Boundless open textbooks https://www.boundless.com/open-textbooks/
- Flatworld Knowledge http://catalog.flatworldknowledge.com/#our-catalog

College Readiness

- Khan Academy http://www.khanacademy.org/
- Hippocampus http://www.hippocampus.org/

Study Aids

- Education Portal http://education-portal.com/
- Khan Academy http://www.khanacademy.org/
- Annenberg Learner http://www.learner.org/
- OpenCourseWare http://ocwconsortium.org/en/courses/search
- OER Commons http://www.oercommons.org/
- Open Course Library http://www.opencourselibrary.org/
Content Outline

General Description of the Examination

The UExcel Anatomy and Physiology examination is based on material typically taught in an eight-credit, two-semester lower-level course sequence in anatomy and physiology.

The examination measures knowledge and understanding of the integrative mechanisms that contribute to the functioning of the human body. Topics include an overview of the human body, the chemical basis of life, dynamics of support and motion, integration and regulatory mechanisms, maintenance of the human body, the urinary system, fluid and electrolyte balance, and reproduction and development.

Those beginning to study for this exam should be familiar with basic terms of biology and with concepts such as basic cell structure and function.

Learning Outcomes

After you have successfully worked your way through the recommended study materials, you should be able to demonstrate the following learning outcomes:

1. Describe the fundamental concepts of anatomy and physiology, and the organizational scheme and standard terminology of the body.
2. Describe the major chemical constituents of the body, the chemical reactions, and the equilibrium state.
3. Describe the supporting tissue, skeletal system, muscle tissue, and tissue physiology.
4. Describe the nervous system, endocrine system, histological and functional classification of general and special sensory receptors, and structure and function of each special sense organ.
5. Describe the circulatory, respiratory, digestive, and urinary systems and the mechanisms of metabolism.
6. Describe the fluid compartments and acid-base balance.
7. Describe the function of the human reproductive system and its principal components, and explain prenatal development and the process of labor and delivery.
Content Outline

The content outline describes the various areas of the test, similar to the way a syllabus outlines a course. To fully prepare requires self-direction and discipline. Study involves careful reading, reflection, and systematic review.

The major content areas on the Anatomy & Physiology examination, the percent of the examination, and the hours to devote to each content area are listed below.

<table>
<thead>
<tr>
<th>Content Area</th>
<th>Percent of the Examination</th>
<th>Hours of Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. The Human Body: An Overview</td>
<td>5%</td>
<td>13</td>
</tr>
<tr>
<td>II. Chemical Basis of Life</td>
<td>5%</td>
<td>13</td>
</tr>
<tr>
<td>III. Dynamics of Support and Motion</td>
<td>12%</td>
<td>32</td>
</tr>
<tr>
<td>IV. Integration and Regulatory Mechanisms</td>
<td>23%</td>
<td>62</td>
</tr>
<tr>
<td>V. Maintenance of the Human Body</td>
<td>33%</td>
<td>89</td>
</tr>
<tr>
<td>VI. Urinary System</td>
<td>10%</td>
<td>27</td>
</tr>
<tr>
<td>VII. Fluid and Electrolyte Balance</td>
<td>5%</td>
<td>13</td>
</tr>
<tr>
<td>VIII. Reproduction and Development</td>
<td>7%</td>
<td>19</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100%</strong></td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:** Occasionally, examples will be listed for a content topic to help clarify that topic. However, the content of the examination is not limited to the specific examples given.

I. The Human Body: An Overview

**5 PERCENT OF EXAM | 13 HOURS OF STUDY**

*Martini (2015)*

Ch. 1, An Introduction to Anatomy and Physiology

Ch. 3, The Cellular Level of Organization

A. Basic anatomical terminology
   1. Body cavities and regions

   2. Anatomical position, planes, and directional terms

B. General organization of the body
   1. Cell structure and function as revealed by electron microscopy (including cell membrane receptor sites)
   2. Fundamental body tissues
      a. Epithelial
      b. Connective
      c. Muscle
      d. Nervous
   3. Organs: definition and examples
   4. Systems: definition and examples

C. Skin (Integument)
   1. Epidermis
   2. Dermis (receptors, glands, hair follicles, nails)
D. Maintenance of the internal environment
   1. Homeostasis
   2. Cellular fluid dynamics
      a. Osmosis
      b. Filtration
      c. Diffusion
      d. Active transport
      e. Endocytosis and exocytosis

II. Chemical Basis of Life

   5 PERCENT OF EXAM | 13 HOURS OF STUDY

Martini

Ch. 2, The Chemical Level of Organization

A. Atomic structure
   1. Elements and isotopes
   2. Atomic weights

B. Chemical bonds
   1. Ionic bonds
   2. Covalent bonds
   3. Hydrogen bonds

C. Types of reactions
   1. Decomposition
   2. Synthesis
   3. Reversible reactions
   4. Enzymes and chemical reactions

D. Inorganic compounds
   1. Water and its properties
   2. Aqueous solutions
   3. Colloids and suspensions
   4. Hydrogen ions in body fluids
   5. Inorganic acids and bases
   6. Salts
   7. Buffers and pH control

E. Organic compounds
   1. Carbohydrates
      a. Monosaccharides

III. Dynamics of Support and Motion

   12 PERCENT OF EXAM | 32 HOURS OF STUDY

Martini

Ch. 4, The Tissue Level of Organization
Ch. 5, The Integumentary System
Ch. 6, Osseous Tissue and Bone Structure
Ch. 7, The Axial Skeleton
Ch. 8, The Appendicular Skeleton
Ch. 9, Joints
Ch. 10, Muscle Tissue
Ch. 11, The Muscular System

A. Supporting tissue
   1. Anatomy
      a. Gross anatomy
         1) Bone
            (a) Types: long, short, flat, irregular, sesamoid
(b) Markings (processes):
elevations (for example: 
ridge or crest, tubercle, 
tuberosity, malleolus, 
trochanter, spine, head, 
condyles), depressions 
(for example: pit or fovea, 
fossa, groove or sulcus), 
openings (for example: 
foramen, canal or meatus, 
fissure)

2) Cartilage: hyaline, white 
fibrous, elastic

b. Microscopic anatomy

1) Bone (osseous tissue):
osteoblasts, osteocytes, 
osteoclasts, periosteum, 
Sharpey's fibers, osteon 
(Haversian) system, lacunae, 
canalculi, Haversian canal, 
lamellae, Volkmann's 
canal, interstitial lamellae, 
endosteum, bone marrow 
(yellow and red), organic and 
inorganic constituents

2) Cartilage: cells in intercellular 
matrix, chondrogenic 
layer (chondroblasts and 
chondrocytes), perichondrium

2. Development and growth

a. Intramembranous ossification

b. Intracartilaginous or endochondral 
ossification

c. Hormonal influences: for 
example: growth hormone 
(GH) (somatotropin), thyroxine, 
adrenocorticotropic hormone, 
parathyroid hormone, calcitonin, 
estrogen, testosterone

d. Other chemical influences: 
vitamins and minerals

B. Skeletal system

1. Divisions

a. Axial: skull (cranial and facial 
bones), hyoid, vertebral column, 
sternum, ribs

b. Appendicular (girdles and 
extremities)

1) Upper limb: pectoral girdle 
(clavicles, scapulae), humerus, 
radius, ulna, carpals, 
metacarpals, phalanges

2) Lower limb: pelvic girdle (hip 
bones), femur, patella, fibula, 
tibia, tarsals, metatarsals, 
phalanges

2. Articulations

a. Types

1) Synarthrosis (immovable): 
for example: sutures

2) Amphiarthrosis (slightly 
moveable): for example: 
symphysis pubis, 
intervertebral disks

3) Diarthrosis (fully moveable): 
gliding, hinge joint (ginglymus), 
condyloid joint, saddle joint, 
pivot joint, ball-and-socket joint

b. Movements: flexion, extension, 
adduction, abduction, 
circumduction, rotation

C. Muscle Tissue

1. Types and characteristics

a. Skeletal (striated, voluntary)

b. Smooth (nonstriated, involuntary)

c. Cardiac (striated, involuntary)

2. Gross anatomy

a. Attachment: origins, insertions 
(for example: by tendons and 
aponeuroses)

b. Levers: first class, second class, 
third class (fulcrum, effort, 
resistance)

c. Location and function of major 
muscles (Textbooks identify these 
muscles.)

D. Muscle physiology

1. Contractions: muscle twitch, tetanus 
(complete vs. incomplete), summation 
(temporal, spatial)

2. Mechanism of contraction
a. Electrical and mechanical aspects
   (for example: stimuli [subthreshold, threshold], action potential, latent period, period of contraction, relaxation, all-or-none principle, graded strength principle, absolute and relative refractory period, tonus, motor unit, excitation-contraction coupling, calcium effect, summation [temporal, spatial])

b. Chemical and thermal aspects
   (for example: sliding filament theory [actin, myosin, regulating proteins], energy sources [ATP-creatine phosphate-glycogen], heat formation, oxygen debt, fatigue)

3. Exercise physiology: isometric and isotonic contractions, white and red fibers, strength vs. endurance

IV. Integration and Regulatory Mechanisms

23 PERCENT OF EXAM | 62 HOURS OF STUDY

Martini

Ch. 12, Neural Tissue
Ch. 13, The Spinal Cord, Spinal Nerves, and Spinal Reflexes
Ch. 14, The Brain and Cranial Nerves
Ch. 15, Sensory Pathways and the Somatic Nervous System
Ch. 16, The Autonomic Nervous System and Higher-Order Functions
Ch. 17, The Special Senses
Ch. 18, The Endocrine System

A. Nervous system
   1. Cell types
      a. Neuron: cell body, dendrites, axon, neurofibrils, myelin sheath, nodes of Ranvier, telodendria
         1) Structural classification: unipolar, bipolar, multipolar
         2) Functional classification: afferent (sensory), efferent (motor), association (interneuron)

b. Supportive cells
   1) CNS: neuroglia or glial cells
      (astrocytes, oligodendrocytes, microglia, ependymal cells)
   2) PNS: Schwann cells


3. Synapse: excitation (EPSP), inhibition (IPSP), convergence, divergence, calcium modulation, neurotransmitters, MAO, specificity of receptors (adrenergic, cholinergic), fatigue

4. Reflexes (knee jerk, stretch, withdrawal)

5. Development and growth
   a. Ectoderm: neural (medullary) plate, neural tube (brain and spinal cord)
   b. Brain: forebrain, midbrain, hindbrain

6. Divisions
   a. Central nervous system
      1) Brain: gray and white matter
         (a) Forebrain (prosencephalon): telencephalon (lateral ventricles, cerebral cortex, basal nuclei, rhinencephalon), diencephalon (third ventricle, epithalamus, thalamus, metathalamus, hypothalamus)
         (b) Midbrain (mesencephalon): cerebral aqueduct, cerebral peduncles, corpora quadrigemina
         (c) Hindbrain (rhombencephalon): fourth ventricle, metencephalon (cerebellum, pons), myelencephalon (medulla oblongata)
      2) Spinal cord: gray and white matter
(a) Ascending tracts (sensory) (for example: posterior columns, spinothalamic pathways, spinocerebellar pathways)

(b) Descending tracts (motor) (for example: pyramidal pathways [corticospinal tracts], extrapyramidal pathways [rubrospinal and reticulospinal])

3) Meninges: dura mater, arachnoid, pia mater

4) Cerebrospinal fluid (formation, flow, reabsorption, function)

b. Peripheral nervous system

1) Cranial nerves (12 pairs): name, number, type, function

2) Spinal nerves

(a) Thirty-one pairs (8 cervical, 12 thoracic, 5 lumbar, 5 sacral, 1 coccygeal): dorsal root, ventral root

(b) Plexi: cervical, brachial, lumbar, sacral

c. Autonomic nervous system (visceral efferent system)

1) Sympathetic division (thoracolumbar)

2) Parasympathetic division (craniosacral)

3) Anatomical and functional aspects

(a) Preganglionic (white rami root) and postganglionic (gray rami root) fibers (for example: adrenergics, cholinergics)

(b) Autonomic plexus

B. Senses

1. General senses

   a. Simple classification (interoceptors, exteroceptors, and proprioceptors)

   b. Detailed classification

2. Special senses

   a. Visual

      1) Anatomy of eye (for example: layers of eyeball, extraocular muscles)

      2) Physiology of vision and errors of refraction (CNII)

   b. Auditory

      1) Anatomy of ear: external ear, middle ear, inner ear

      2) Physiology of hearing (mechanics, organ of Corti) (CNVIII)

   c. Olfactory: olfactory nerves, olfactory membrane, conchae (CNI)

   d. Gustatory: tongue, taste buds (papillae of tongue), classes of taste (CNXI, XII)

   e. Balance and equilibrium

      1) Anatomy of semicircular canals (utricle and saccule)

      2) Physiology of balance (static vs. dynamic equilibrium) (CNVIII)

C. Endocrine system

1. Hormones
a. Amino acid derivatives
b. Peptide hormones
c. Proteins
d. Steroids

2. Mechanisms of hormonal action: first and second messengers
   a. Plasma membrane: adenyl cyclase mechanisms, c-AMP
   b. Cytosol: nuclear membrane receptor mechanism

3. Endocrine glands: structure and function
   a. Pituitary (hypophysis cerebri)
      1) Neurohypophysis (pars nervosa): ADH, oxytocin
      2) Adenohypophysis (pars distalis): ACTH, GH, TSH, FSH, LH (ICSH)
      3) Relationship to hypothalamus (hypothalamic-hypophyseal portal system and tract)
   b. Thyroid: thyroxine (T₄), triiodothyronine (T₃), calcitonin
   c. Parathyroid: parathormone (PTH)
   d. Adrenal (suprarenal)
      1) Medulla: epinephrine, norepinephrine, relationship to the sympathetic division of the autonomic nervous system
      2) Cortex: glucocorticoids, mineralocorticoids, sex hormones
   e. Pancreas: islets of Langerhans, insulin, glucagon
   f. Gonads
      1) Ovaries: estrogens and progesterone
      2) Testes: androgens (testosterone)
   g. Thymus
   h. Pineal gland: melatonin
   i. Placenta: estrogens, progesterone, human chorionic gonadotropin (hCG)

4. Other secretory tissue
   a. Gastrointestinal mucosa (enteroendocrine cells): gastrin, secretin, cholecystokinin (CCK)
   b. Kidney (for example: renin, erythropoietin)

5. Hypothalamus
   a. Releasing factors and inhibiting factors
   b. Posterior pituitary hormones (ADH, oxytocin)

V. Maintenance of the Human Body

Martini

Ch. 19, Blood
Ch. 20, The Heart
Ch. 21, Blood Vessels and Circulation
Ch. 22, The Lymphatic System and Immunity
Ch. 23, The Respiratory System
Ch. 24, The Digestive System
Ch. 25, Metabolism and Energetics

A. Circulatory system

1. Blood
   a. Characteristics: color, specific gravity, pH, temperature
   b. Formed elements: characteristics, life cycle, number, function
      1) Erythrocytes (red blood cells)
      2) Leukocytes (white blood cells)
      3) Thrombocytes (platelets)
   c. Nonformed elements (plasma): components and characteristics
      1) Water
      2) Proteins (albumin, globulin, fibrinogen)
      3) Salts
      4) Gases
      5) Nutrients
6) Enzymes and hormones

7) Waste products

d. Blood typing (agglutinins, agglutinogens)
   1) ABO groups
   2) Rh factor

e. Hemostasis: vessel constriction, platelet plugging, coagulation (intrinsic and extrinsic)

2. The heart: a dual pressure pump

a. Structure
   1) Layers: pericardium, endocardium, myocardium, epicardium
   2) Chambers: atria, ventricles
   3) Valves: tricuspid, bicuspid (mitral), aortic and pulmonic semilunar
   4) Pulmonary vs. systemic circulation (for example: superior vena cava, pulmonary trunk, aorta)
   5) Coronary circulation: coronary arteries, cardiac veins, coronary sinus
   6) Conduction system
      (a) Intrinsic (S-A node, A-V node, Bundle of His, left and right bundle branches, Purkinje fibers)
      (b) Extrinsic (vagal and cardiac nerve modulation)

b. Function
   1) Properties of cardiac muscle: automaticity, intercellular conductivity (gap junctions)
   2) Origin of heartbeat and conduction pathway
   3) Cardiac cycle: phases (systole, diastole), pressure and volume changes, heart sounds, ECG
   4) Control of cardiac output
      (a) Nervous control: vagus and cardiac nerve
      (b) Autoregulation
      (c) Role of receptors: baroreceptors (Bainbridge reflex, aortic sinus reflex, carotid sinus reflex)
      (d) Other factors affecting frequency and strength of heart action (for example: blood pressure, emotional excitement, blood temperature, physical factors [size, age, gender])

3. Vascular system

   a. Divisions: systemic, pulmonary
   b. Vessels: histology and function
      1) Arteries: layers, elastic arteries, muscular arteries, vasa vasorum
      2) Veins: layers, valves, vasa vasorum
      3) Capillaries: distribution
   c. Location of major vessels (Textbooks identify these vessels.)
   d. Special circuits
      1) Hepatic portal system
      2) Coronary
      3) Cerebral (circle of Willis)
      4) Renal
      5) Fetal
      6) Hypothalamic and hypophyseal portal systems

4. Cardiovascular physiology

   a. Pressure dynamics: blood distribution to body organs and organ needs
   b. Regulation and maintenance of blood pressure
      1) Cardiac output (stroke volume times heart rate)
      2) Resistance to blood flow: vasodilation, vasoconstriction, blood viscosity
3) Role of chemoreceptors and baroreceptors
4) Effect of nervous stimulation
c. Capillary exchange
   1) Fluid exchange: a result of the balance between
      (a) Hydrostatic pressure
      (b) Osmotic (oncotic) pressure
   2) Diffusion (nutrients, gases)
5. Lymphatic system
   a. Anatomical organization: lymph capillaries, right lymphatic duct, thoracic duct, lymph nodes
   b. Lymph fluid: origin, composition, flow, function
   c. Structure of lymph vessels and organs: spleen, thymus, tonsillar tissue, pharyngeal tissue (adenoid)
6. Immune responses
   a. Nonspecific resistance to disease
   b. Specific resistance to disease
      1) Antigens and antibodies
      2) Cellular and humoral immunity
         (a) T lymphocytes (helper, cytotoxic, suppressor, memory)
         (b) B lymphocytes (active and memory)
         (c) Types of immunity: active and passive
b. Diffusion of gases: pressure (intraalveolar and intrapleural)
   1) Boyle’s Law
   2) Charles’ Law
   3) Dalton’s Law
   4) Henry’s Law
c. Mechanisms of ventilation
   1) Inspiration
   2) Expiration
   3) Lung volumes and capacities (for example: tidal volume, inspiratory reserve, expiratory reserve, residual volume, vital capacity)
d. Gas exchange and transport
   1) Oxygen, carbon dioxide
   2) Hemoglobin dissociation curve
e. Control ventilation
   1) Nervous control
      (a) Medulla oblongata (inspiration, expiration)
      (b) Pons varolii (apneustic area and pneumotaxic area)
      (c) Lungs (Hering-Breuer reflex)
   2) Chemical control: pH, carbon dioxide (PCO₂), hypoxia (PO₂)
   3) Other controls: temperature change, pressure change, voluntary (cerebrum)
B. Respiratory system
1. Anatomy
   a. Respiratory tract (conducting and respiratory portions — changes in histology)
   b. Respiratory muscles: diaphragm and intercostals
   c. Pleura (visceral and parietal layers)
2. Physiology
   a. Compliance
C. Digestive system
1. Anatomy and functions of the alimentary canal
   a. Microscopic anatomy: serosa, muscular layers, submucosa, mucosa, lymph nodes (Peyer’s patches)
   b. Gross anatomy
1) Alimentary tract: mouth, pharynx, esophagus, cardiac (esophageal) sphincter, stomach, pyloric sphincter, small intestine (duodenum, jejunum, ileum), ileocecal valve, large intestine (caecum, vermiform appendix, ascending colon, transverse colon, descending colon, sigmoid colon, rectum, anal canal)

2) Accessory organs: tongue, teeth, salivary glands, pancreas, liver, gallbladder

2. Physiology of the digestive process
   a. Physical (mechanical) digestion: ingestion, mastication, deglutition, peristalsis, segmentation, pendular movement, defecation
   b. Chemical digestion: catalytic enzymes and hydrolysis of carbohydrates, lipids, proteins
   c. Control of digestion
      1) Nervous control: autonomic nervous system (parasympathetic and sympathetic), myenteric and submucosal plexus
      2) Hormonal control: gastrin, enterogastrone (GIP), secretin, cholecystokinin (CCK)
   d. Mechanisms of absorption: simple diffusion, facilitated diffusion, osmosis, active transport, endocytosis, physical factors (particle size, concentration of materials, lipid solubility, surface area)

D. Metabolism
   1. Nutrient metabolism of carbohydrates, proteins, and lipids
      a. Anabolism (glycogenesis, gluconeogenesis, lipogenesis, protein synthesis)
      b. Catabolism (glycogenolysis, glycolysis, lipolysis, protein degradation)
   2. Energy metabolism (aerobic and anaerobic): role of enzymes and phosphorylation, TCA (Krebs) cycle, oxidative phosphorylation, electron transport chain, role of NAD and FAD (Students are not responsible for the individual biochemical events of these processes.)

3. Daily calorie requirement, nutritional needs, body heat

4. Calorimetry: basal metabolic rate (BMR)

5. Vitamins and minerals

VI. Urinary System

10 PERCENT OF EXAM  |  27 HOURS OF STUDY

Martini

Ch. 26, The Urinary System

A. Gross anatomy: kidney (capsule, pelvis, calyces, medulla, cortex, renal columns, renal pyramids), ureters, bladder, urethra, blood supply

B. Microscopic anatomy: nephron (glomerulus, podocytes, renal [Bowman's] capsule, proximal convoluted tubule, loop of Henle [nephron loop], distal convoluted tubule), collecting duct

C. Nephron dynamics (homeostatic maintenance)
   1. Glomerular filtration (GFR, GFP)
      a. Hydrostatic pressure
      b. Osmotic pressure
      c. Fluid exchange
   2. Tubular reabsorption
   3. Tubular secretion
   4. Countercurrent multiplier/exchanger
   5. JGA (renin-angiotensinogen mechanism)

D. Control of renal function
   1. Hormonal: antidiuretic hormone (ADH or vasopressin), aldosterone
   2. Nervous: autonomic nerves

E. Micturition reflex and voluntary control
F. Urine composition
1. Physical characteristics: color, transparency, pH, specific gravity, quantity
2. Constituents
   a. Inorganic: chlorides; sulphates; phosphates of sodium, potassium, magnesium, and calcium; water; ammonium salts
   b. Organic: creatinine, urea, uric acid

VII. Fluid and Electrolyte Balance

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<th>5 PERCENT OF EXAM</th>
<th>13 HOURS OF STUDY</th>
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Martini
Ch. 27, Fluid, Electrolyte, and Acid-Base Balance

A. Fluid compartments: distribution of water and electrolytes in the body, movement of water, water intake and output, adjustment of excess fluid intake, regulation by hormones, stress situations, reserve body water, milliequivalents, important cations and anions
   1. Extracellular (interstitial fluid, plasma)
   2. Intracellular
B. Acid-base balance: normal pH range, pH regulation, sources of acid and base
   1. Blood buffers
   2. Respiratory regulation
   3. Renal regulation
   4. Acid-base disturbances (acidosis, alkalosis)

VIII. Reproduction and Development

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<th>7 PERCENT OF EXAM</th>
<th>19 HOURS OF STUDY</th>
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Martini
Ch. 28, The Reproductive System
Ch. 29, Development and Inheritance

A. Anatomy
   1. Primary reproductive organs

   a. Male: testes
   b. Female: ovaries

2. Accessory reproductive organs
   a. Male: epididymis, vas deferens (ductus deferens), seminal vesicles, ejaculatory ducts, prostate gland, bulbourethral (Cowper’s) glands, urethra, penis
   b. Female: fallopian tubes (oviducts), uterus, vagina, greater vestibular (Bartholin’s) glands, external genitalia

B. Physiology of reproductive system
1. Gametogenesis: reduction division
   a. Spermatogenesis
   b. Oogenesis
2. Hormonal control
   a. Female: oogenesis, menstrual cycle (FSH, LH, estrogen, progesterone)
   b. Male: spermatogenesis, gonadotropins (FSH, LH [ICSH]), testosterone
3. Nervous control
   a. Erection (parasympathetic)
   b. Ejaculation (sympathetic)
4. Fertilization and implantation
5. Pregnancy
   a. Hormonal control: corpus luteum (estrogen, progesterone), placenta (hCG)
   b. Development
      1) First trimester
      2) Second trimester
      3) Third trimester
6. Parturition: stages, hormonal control (oxytocin, relaxin)
7. Lactation: nervous and hormonal control, nutritional aspects
Sample Questions

The sample questions give you an idea of the level of knowledge expected in the exam and how questions are typically phrased. They are not representative of the entire content of the exam and are not intended to serve as a practice test.

Rationales for the questions can be found on pages 20–23 of this guide. In that section, the correct answer is identified and each answer is explained. The number in parentheses at the beginning of each rationale refers to the corresponding section of the content outline. For any questions you answer incorrectly, return to that section of the content outline for further study.

1. What is the name given to an imaginary plane that divides the body into right and left halves?
   1) coronal
   2) frontal
   3) sagittal
   4) transverse

2. Which statement best explains what happens when oxygen and hydrogen combine to form water (H₂O)?
   1) Hydrogen becomes weakly negative.
   2) Oxygen remains in an unstable state.
   3) Oxygen loses its high electronegativity.
   4) There is unequal sharing of electrons.

3. Which cordlike structure attaches muscle to bone?
   1) aponeurosis
   2) fascicle
   3) ligament
   4) tendon

4. Which property of cardiac muscle prevents tetanic contractions?
   1) sliding of actin and myosin
   2) branching muscle fibers
   3) long refractory period
   4) low extracellular calcium

5. Which component of the spinal reflex arc is responsible for delivering an efferent impulse to either a muscle or a gland?
   1) association neuron
   2) postganglion neuron
   3) motor neuron
   4) sensory neuron

6. Which is a function of the cerebellum?
   1) control of voluntary scanning movements of the eyes
   2) production of coordinated movement
   3) regulation of autonomic body functions
   4) regulation of emotions
7. What results from sectioning the corpus callosum?
   1) The brain ceases to function and death occurs.
   2) The capacity for abstract thought is lost.
   3) Information transfer between the cerebral hemispheres is lost.
   4) Control of autonomic functions is lost.

8. Which ability would be impaired by damage to hair cells at the basal end of the cochlea?
   1) discriminating loudness
   2) discriminating the direction of sound
   3) hearing high-frequency sounds
   4) hearing low-frequency sounds

9. Which compensatory response is likely to occur when the blood calcium level is low?
   1) Fecal calcium will be higher than normal.
   2) Urine calcium will be higher than normal.
   3) Osteoclast activity will be greater than normal.
   4) Calcium deposition in bone will be greater than normal.

10. When does ejection of blood from the ventricles occur during an ECG trace?
    1) between the QRS and T waves
    2) right after the P wave
    3) between the T and P waves
    4) right after the T wave

11. During which phase of the cardiac cycle is the pressure in the aorta the highest?
    1) early atrial diastole
    2) atrial systole
    3) early ventricular diastole
    4) ventricular systole

12. In a normal heart, which of the following decreases cardiac output?
    1) increased stroke volume
    2) increased heart rate
    3) increased venous return to the heart
    4) increased parasympathetic stimulation of the heart

13. Which cells in the islets of Langerhans produce insulin?
    1) alpha cells
    2) beta cells
    3) delta cells
    4) F cells

14. Which statement best explains why stimulating the sympathetic nervous system will increase arterial blood pressure?
    1) Cardiac output will increase and total peripheral resistance will remain unchanged.
    2) Cardiac output will remain unchanged and total peripheral resistance will increase.
    3) Cardiac output will increase and stroke volume will decrease.
    4) Cardiac output and total peripheral resistance will both increase.

15. Which condition may result from the hypersecretion of gastric juices?
    1) acute pancreatitis
    2) cirrhosis
    3) peptic ulcers
    4) peritonitis

16. What is the effect of the Hering-Breuer reflex?
    1) It controls the basic rhythm of respiration.
    2) It constricts terminal bronchioles.
    3) It stimulates inspiration.
    4) It prevents overinflation of the lungs.

17. Which is the correct pathway of filtrate through the nephron?
    1) Bowman’s capsule, proximal convoluted tubule, loop of Henle, distal convoluted tubule
    2) Bowman’s capsule, loop of Henle, proximal convoluted tubule, collecting tubule
    3) Bowman’s capsule, collecting tubule, proximal convoluted tubule, loop of Henle
    4) collecting tubule, Bowman’s capsule, loop of Henle, distal convoluted tubule
18. During cellular respiration, a diminished supply of oxygen will result in the storage of hydrogen as which acid?
   1) acetic
   2) citric
   3) lactic
   4) pyruvic

19. Which hormone increases the reabsorption of sodium and the secretion of potassium by the kidney?
   1) aldosterone
   2) antidiuretic hormone (ADH)
   3) thyroxine
   4) cortisol

20. The renin-angiotensin mechanism regulates the production of which hormone?
   1) aldosterone
   2) cortisol
   3) glucagon
   4) insulin

21. An increase in renal bicarbonate reabsorption would tend to have which effect on body fluids?
   1) increased acidity
   2) increased pH
   3) decreased buffering capacity
   4) decreased osmolarity

22. Which would be the effect of afferent impulses from lactating breasts to the hypothalamus?
   1) Release of posterior pituitary hormones would increase.
   2) Lactiferous ducts would not develop.
   3) The milk let-down reflex would not occur.
   4) Prolactin levels would increase.

23. What is the main source of progesterone following degeneration of the corpus luteum during pregnancy?
   1) corpus albicans
   2) follicular epithelial cells
   3) placenta
   4) thecal cells
**SECTION FOUR**

**Rationales**

1.(IA2)

1) The coronal plane divides the body into ventral (anterior) and dorsal (posterior) planes.
2) The frontal plane is the same as the coronal plane.
3) The sagittal plane divides the body in half along the vertical (longitudinal) axis, thus dividing into right and left halves.
4) The transverse plane divides the body into superior and inferior halves.

2.(IIB)

1) Hydrogen becomes weakly positive.
2) Oxygen forms a stable atom in the water molecule.
3) Oxygen’s electronegativity remains the same within the water molecule.
4) Hydrogen and oxygen have different electronegativities, resulting in an unequal sharing of electrons.

3.(IIIC2)

1) An aponeurosis is a broad sheetlike tendon that connects muscle to other muscle or to bone.
2) A fascicle is a bundle of muscle or nerve cells surrounded by a connective tissue membrane.
3) A ligament is composed of dense regular collagen fibers with some elastin. A ligament connects bone to bone.
4) A tendon is a cordlike structure composed of dense regular collagen fibers. A tendon connects muscle to bone.

4.(IIDA1/2)

1) Actin and myosin interact to promote muscle contraction in all muscle tissue.
2) Branching muscle fibers allow for sequential and rhythmic contraction associated with cardiac muscle.
3) The refractory period is the period during which muscle contraction cannot be initiated.
4) Low extracellular calcium inhibits proper muscle contraction.

5.(IVA1/4)

1) Association neurons connect sensory and motor neurons.
2) Postganglionic neurons transmit impulses from preganglionic fibers to the target organ.
3) Motor neurons carry impulses from the central nervous system to a series of effectors, i.e., muscles or glands.
4) Sensory neurons transmit impulses from sense organs to the central nervous system.

6.(IVA6a)

1) Voluntary eye movements are controlled by the oculomotor and trochlear cranial nerves.
2) The cerebellum coordinates motor function with the cerebrum through three paired bundles of nerve fibers known as the cerebellar peduncle.
3) Regulation of autonomic body functions is done by the autonomic nervous system comprised of the sympathetic and the parasympathetic divisions.
4) Regulation of emotions is largely in the domain of the hypothalamus and limbic system.

*Correct answer
7.(IVA6)
1) Brain function depends upon adequate blood supply and not on the corpus callosum.
2) Abstract thought is controlled by higher centers in the cerebral cortex.
*3) The corpus callosum consists of commissural fibers carrying information between the right and left cerebral hemispheres.
4) Autonomic function is associated with brain stem activity.

8.(IVB2b)
1) Loudness is dependent upon sound intensity. The greater the sound intensity, the greater the vibration of the basilar membrane which leads to increased transmission of nerve impulses to the brain.
2) Each ear receives the vibrating signal from slightly different positions. Discriminating the direction of sound is done by the temporal lobes of the brain.
*3) The basilar membrane is narrower and stiffer at the base of the cochlea where high-frequency (high-pitched) sounds produce maximum vibration and greater transmission of nerve impulses to the brain.
4) Low-frequency sounds cause maximum vibration at the apex of the cochlea where the basilar membrane is wider and more flexible.

9.(IVC)
1) Less calcium will be lost in the feces.
2) Less calcium will be excreted in the urine.
*3) Osteoclasts are bone-dissolving cells that release calcium into the bloodstream.
4) Bone will be broken down in an attempt to raise blood calcium levels.

10.(VA2)
*1) The QRS wave reflects the spread of the impulse throughout the ventricles, forcing blood into the aorta and pulmonary artery.
*2) The P wave represents the spread of an electrical impulse through the atria and their subsequent contraction.
3) The T wave represents repolarization of the electrical tissue and the P wave represents the beginning of the next cardiac cycle.
4) Right after the T wave, the heart is at rest.

11.(VA2a)
1) In early atrial diastole, the atria are filling with blood from the venous system.
2) Atrial systole involves contraction of the atria, forcing blood into the ventricles.
3) In early ventricular diastole, the ventricles are receiving blood from the atria.
*4) In ventricular systole, the ventricles are contracting and forcing blood into the aorta and pulmonary artery.

12.(VA2b)
1) An increased stroke volume increases the amount of blood ejected from the ventricle.
2) A more rapid heart rate increases the amount of blood forced out of the heart.
3) As more blood returns to the heart, more blood is subsequently ejected.
*4) The parasympathetic nervous system has an inhibitory effect on cardiac function.

13.(IVC3e)
1) Alpha cells produce glucagon which raises blood sugar.
*2) Beta cells produce insulin which lowers blood sugar.
3) Delta cells secrete somatostatin which inhibits the secretion of insulin and glucagon.
4) F-cells secrete hormones which regulate the release of pancreatic digestive enzymes.
14. (VA4b)
1) See 4).
2) See 4).
3) The sympathetic nervous system stimulation of the adrenal medulla releases epinephrine and norepinephrine which will cause an increase in cardiac output and an increase in stroke volume.
*4) The sympathetic nervous system stimulation of the adrenal medulla releases epinephrine and norepinephrine which will cause an increase in cardiac output and vasoconstriction in visceral blood vessels resulting in an increase in peripheral resistance.

15. (VC2)
1) Acute pancreatitis results from severe insults to the pancreas.
2) Cirrhosis is a hardening of the liver tissue.
*3) Gastric juices are rich in hydrochloric acid, which causes irritation in the gastric mucosa.
4) Peritonitis is an inflammation of the peritoneum and is usually the result of infection.

16. (VB2d)
1) The basic rhythm of respiration is regulated by the medullary rhythmicity center which is located in the medulla oblongata.
2) Constriction of terminal bronchioles is caused by histamine.
3) Inspiration is part of the medullary rhythmicity center in the medulla oblongata and is stimulated by high CO₂ levels, low O₂ levels, and falling pH levels.
*4) Stretch receptors are found within the bronchioles and lung tissue. When the receptors are stretched, nerve signals are sent via the vagus nerve to the apneustic center and medullary rhythmicity center and further inspiration is inhibited. Therefore, the Hering-Breuer reflex protects the lungs from overinflation damage.

17. (VI/B/C)
*1) This represents the path by which the blood filtrate passes on the way to the final production of urine.
2) The loop of Henle transports the filtrate from the proximal convoluted tubule to the distal convoluted tubule.
3) The collecting tubule represents the end of the filtration process.
4) The collecting tubule represents the end point of the pathway.

18. (VD2)
1) Acetic acid is formed when pyruvic acid is decarboxylated and joined with CoA to enter the mitochondria during aerobic oxidation when the oxygen supply is adequate.
2) During aerobic oxidation, citric acid is formed in the mitochondria when the acetyl group of acetic acid is joined with oxaloacetic acid.
*3) When oxygen is inadequate, pyruvic acid is reduced by two hydrogen ions to form lactic acid. Lactic acid can be transported to the liver to be reformed into glucose or pyruvic acid.
4) Pyruvic acid is the end product of anaerobic glycolysis.

19. (VID1)
*1) Aldosterone from the adrenal cortex increases the retention of sodium and triggers the loss of potassium.
2) ADH from the posterior pituitary triggers the retention of water by the kidneys.
3) Thyroxine from the thyroid gland regulates cell metabolism.
4) Cortisol from the adrenal cortex elevates blood sugar and reduces inflammation.

*correct answer
20. (VID&E)

1) A decrease in blood volume leads the nephron juxtaglomerular cells to release renin. Renin converts angiotensinogen to angiotensin I. Angiotensin I is converted to angiotensin II in the lung. Angiostatin II stimulates the adrenal cortex to release aldosterone.

2) Cortisol is stimulated by pituitary ACTH.

3) Glucagon is produced in the alpha cells of the islets of Langerhans and is stimulated by epinephrine.

4) Insulin is produced in the beta cells of the islets of Langerhans and is stimulated by high blood glucose levels.

21. (VIIB)

1) Since bicarbonate absorbs H+, acidity will be reduced. Increased acidity is caused by an increase in H+.

2) Increased pH is caused by a reduction of available H+. Bicarbonate absorbs H+, reducing the available H+ and causing pH to increase.

3) Bicarbonate is a component of the carbonic acid-bicarbonate buffer system. The more bicarbonate available, the greater the opportunity to absorb H+ and prevent a fall in pH.

4) Bicarbonate is a plasma solute. Any increase in solutes will increase osmolarity.

22. (VIIIIB7)

1) Prolactin has no connection with the posterior pituitary.

2) Prolactin triggers the development of lactiferous ducts.

3) The milk let-down reflex is a product of oxytocin release.

*4) Impulses from a suckling infant induce an increase in prolactin production and more milk production.

23. (VIIIIB5a)

1) A corpus albicans is a degenerated corpus luteum that has lost its capacity to produce progesterone.

2) Follicle cells are involved in producing estrogen and developing the secondary oocyte.

*3) The placenta is able to convert cholesterol to progesterone which is important to maintain the pregnancy after the corpus luteum degenerates.

4) Thecal cells surround the follicle and are involved in the secretion of steroids.

*correct answer
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