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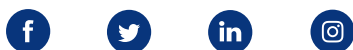
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Pathology Q&A

Walter L. Kemp, MD, PhD

Associate Professor

University of North Dakota School of Medicine and Health Sciences

Grand Forks, North Dakota

Travis Brown, MD

Family Physician

Midlothian, Texas

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333 Seventh Avenue, New York, NY 10001 USA
+1 800 782 3488, customerservice@thieme.com

Thieme Publishers Stuttgart
Rüdigerstrasse 14, 70469 Stuttgart, Germany
+49 [0]711 8931 421, customerservice@thieme.de

Thieme Publishers Delhi
A-12, Second Floor, Sector-2, Noida-201301
Uttar Pradesh, India
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About this Book

The questions in this book are designed to present a clinical scenario that requires a student to diagnose a pathologic condition. For many questions, the answer to the question is the pathologic diagnosis; however, for other questions, the diagnosed pathologic condition is assumed to be known to the student, and instead, the question stem asks for a specific feature of that condition. The organ-specific sections (e.g.,

Cardiovascular) can easily be used during the second year of medical school as a review of the material and to study for tests during the year. The mixed question sections would be best for USMLE review; however, the organ-specific sections can also easily be used for USMLE study. The images in the text are chosen to represent common or uncommon but characteristic pathologic findings.

To my wife, Kelly, for her unconditional love and never ending patience for my professional endeavors, including the support of my writing of another book when I had specifically told her not to let me write any more.

To Dr. Gary Dale, for being a good friend and a supportive and collegial mentor during our ten years working together in our home state of Montana, and for showing me the truth to the quote, "Stand up for what you believe in even if it means standing alone."

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Walter Kemp

Dedicated to my wife, to my daughter, Nola, and my son, Abraham, and to the most gifted clinician I have ever known, Dr. Andrey Manov, MD.

Travis Brown

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Preface

This book is a collection of multiple choice questions (MCQs) to promote the learning of pathology in the framework of preclinical and clinical disciplines. The main features of the book are the following:

The MCQs are all of the type that is used for the Step 1 medical board exams in the United States and are written according to United States Medical Licensing Examination (USMLE) guidelines (i.e., patient-centered vignettes). All questions are “one best answer”; in most cases, there are five answer choices, but in some cases fewer or more choices are given.

Because the MCQs are about pathology, each question is based upon a specific pathologic condition. To correctly answer each question requires a student to use the information given to diagnose the condition, or, the question stem assumes that a student will know the diagnosis, and a question about the disease process is asked instead.

Each MCQ is provided with a level of difficulty, a learning objective, the correct answer, and an explanation.

There are three levels of difficulty: easy, medium, and hard. In general, an easy difficulty question requires only a diagnosis based upon the question stem, whereas a medium difficulty question requires not just the diagnosis of the condition based upon the question stem, but knowledge about that diagnosis so as to answer a question about it (i.e., the student is assumed to know the diagnosis, and a question about the diagnosis is asked), and hard difficulty questions are a combination of medium difficulty questions with less commonly known material about the diagnosis. Question ratings by their nature are subjective; however, every attempt was made to follow the above approach when determining the difficulty of a question. A single question may be easy for one student to answer and hard for another student to answer based upon their knowledge base and test-taking skills.

The learning objective is a brief behavioral statement written using an action verb. If a student can perform the action, then he or she should be able

to answer the question correctly. The explanation includes both the reasons why a given answer is correct and why the distractors are wrong.

Many questions are related to the highest levels of Bloom’s taxonomy (e.g., interpretation of data and solution of problems) rather than being simple recall questions.

Most MCQs are integrated questions, and a good knowledge of the relevant human physiology, biochemistry, microbiology, and elementary clinical medicine is a necessary prerequisite to determine the right answer to the question. Therefore, the question with its answer explanation can also be used as a powerful tool for reviewing and integrating the medical science disciplines.

The MCQs are grouped in chapters covering most topics presented in standard pathology textbooks. There are 20 to 40 MCQs in each chapter, totaling over 1000 questions.

MCQs are the learning tool most frequently used by medical students. This book is intended as an integrated tool for both course study and board exam preparation. Because the book is organized along clinical rather than strictly pathological lines, it should be useful for Step 1 preparation, but also for Step 2 exam preparation.

Pathology, especially the molecular aspect, is a fast-evolving discipline. The authors have checked sources believed to be reliable, in order to provide information that is in accordance with the currently accepted standards. However, the authors are aware that in several instances the pathology of disease is still controversial. They have tried, as much as possible, to avoid questions addressing controversial issues.

This book is not intended to be a substitute for pathology textbooks. Students are strongly advised to consult their textbooks of pathology for more in-depth coverage of the subject matter.

*Walter L. Kemp, MD, PhD
Travis Brown, MD*

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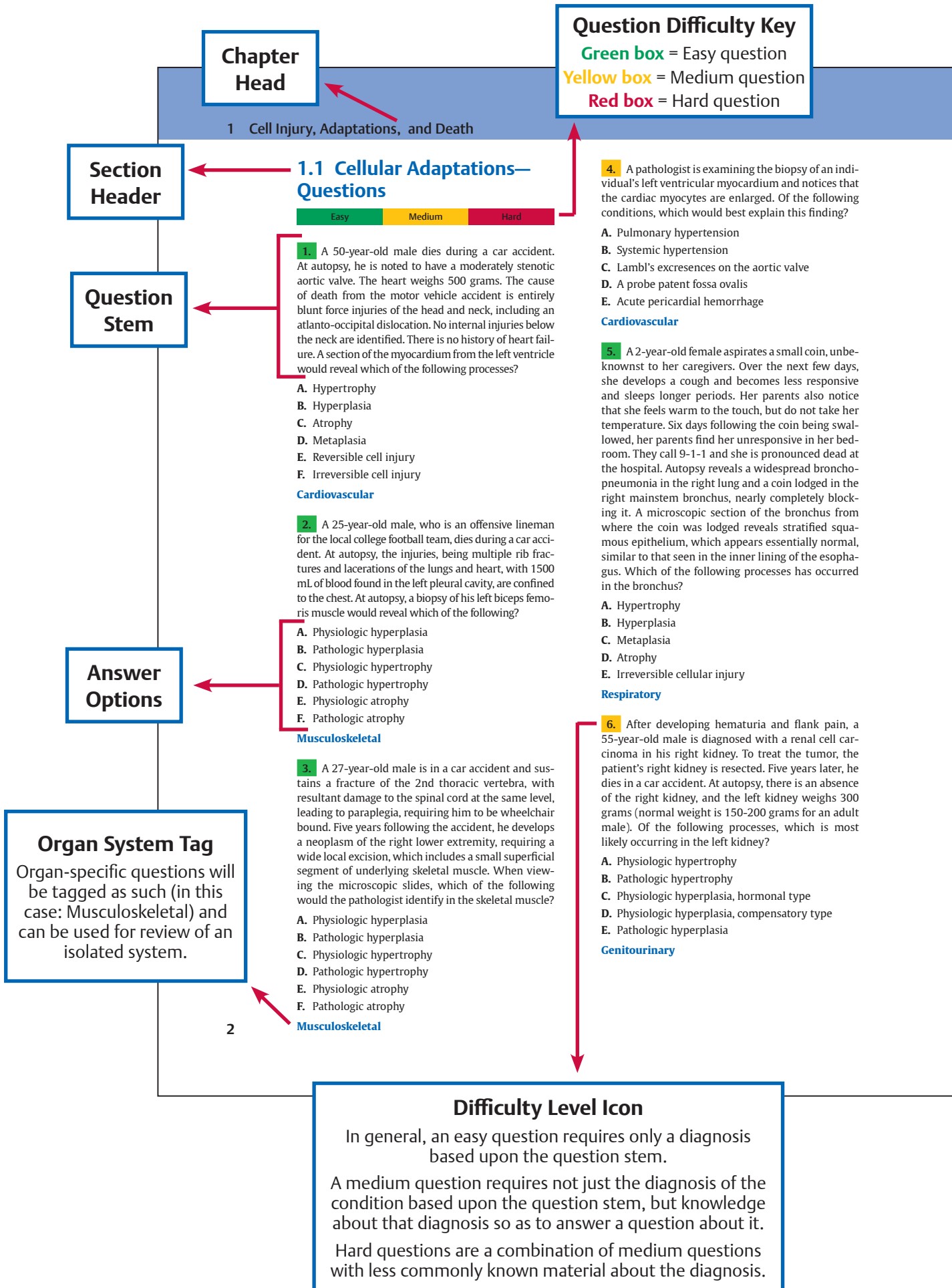
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Mykhaylo Yakubovskyy, Ross University School of Medicine

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How to Use This Series



Chapter Head

Question Difficulty Key

Green box = Easy question
Yellow box = Medium question
Red box = Hard question

Indicates Question Difficulty

1 Cell Injury, Adaptations, and Death

4. Correct: Systemic hypertension (B).

The pathologist is viewing hypertrophy of the cardiac myocytes. While identification of enlarged cells themselves is a difficulty, enlarged rectangular nuclei (i.e., boxcar nuclei) serve as a marker of cardiac myocyte hypertrophy. Increased blood pressure in the systemic vessels would put strain on the left ventricle and lead to hypertrophy (B). Pulmonary hypertension would cause similar changes in the right ventricular myocardium (A). Lamb's excrescences are incidental small nodules on the valve leaflets that are of no physiologic consequence (C). A probe patent fossa ovalis is usually of no physiologic significance (D). However, if a left to right shunt developed, this condition could potentially lead to volume overload in the right atrium and ventricle, with resultant hypertrophy and dilation, but the left ventricle would not be affected. An acute pericardial hemorrhage would not explain hypertrophy, as cardiac myocyte hypertrophy does not develop over such a short period of time, but instead requires a longer exposure to the stimulus (E).

5. Correct: Metaplasia (C).

The bronchus is usually lined by respiratory epithelium (pseudostratified columnar epithelium); however, when the nature of the stimulus to the epithelium changes, which, in this case is trauma caused by the pressure from the coin, the epithelium can change to a different form to better handle the abnormal stimulus. The transition from one epithelium type to another is termed metaplasia (C). In the lung, squamous metaplasia most commonly is a result of cigarette smoking, and, in this situation, metaplasia can lead to dysplasia and finally to carcinoma, accounting for the presence of squamous cell carcinomas in the lung. If the coin is removed, the epithelium could transition back to respiratory epithelium; therefore, the change is reversible, and not irreversible cellular injury. (A-B, D-E) are incorrect based on the previously discussed information.

6. Correct: Physiologic hyperplasia, compensatory type (D).

Because of the absence of the right kidney, the left kidney has a higher workload, and in response, the left kidney increases the number of cells in its structure to handle this increased workload and thus, the organ weight has increased. The cells in the kidney are capable of division, and thus hyperplasia can occur (unlike in the cardiac or skeletal muscle). The hyperplasia is physiologic in nature because it is stimulated by an increased workload, and it is to compensate for the loss of the other kidney (D). (A-C, E) are incorrect based on previously discussed information.

7. Correct: Ubiquitin-proteasome (E).

The patient has disuse atrophy of the upper and lower extremities. The two primary processes occurring in atrophy are decreased protein synthesis and increased protein degradation. Protein degradation is accomplished by binding of ubiquitin to the substances to be degraded followed by its subsequent destruction by proteasomes (E). Cyclooxygenase and thromboxane A₂ and 12-lipoxygenase-lipoxin A₄ function in inflammation (A, B), and plasmin-C_{3a} in the complement cascade (C), both of which could be active in the muscle to some degree but are not the main source of protein degradation, and p53-Bax functions in apoptosis (D), which might be occurring to some small degree but is not the main cause of the protein degradation.

1.5 Cellular Injury— Answers and Explanations

Easy

Medium

Hard

8. Correct: Karyorrhexis of nuclei (E).

After 1 hour of ischemia, some of the affected myocytes would have irreversible damage, in this case, represented by the subendocardial myocardial infarct. Of the choices, only karyorrhexis of the nuclei is characteristic of irreversible injury, i.e., necrosis (E), whereas the other choices are seen with reversible injury (A-D). Other microscopic features of irreversible ischemic injury (i.e., necrosis) include increased eosinophilia of the cytoplasm, and other nuclei changes including karyolysis (i.e., fading of the chromatin) and pyknosis (i.e., shrinkage of the nucleus). Karyorrhexis is fragmentation of the nucleus. As the thrombus was lysed relatively early, myocytes closer to the epicardium may have had signs of reversible injury, but not irreversible injury.

9. Correct: Thrombus of distal branch of left renal artery (E).

The gross description is that of an infarct, which has coagulative necrosis. In coagulative necrosis, the normal organ architecture is preserved in the beginning phases of the development of the infarct. A thrombus of a branch of the renal artery can produce an infarct of the cortex of the kidney (E). Infarcts are typically wedge-shaped, essentially exhibiting the downstream effects of a blockage of the arterial system, with the amount of organ affected increasing moving distal from a single point, the tip of the wedge. Preservation of architecture does not occur with liquefactive necrosis (as could be seen with a bacterial pyelonephritis) or caseous necrosis (as could be seen with a tuberculosis infection), and by their nature, tumors do not have preservation of architecture within their boundaries (A-D).

Correct Answer

Correct Answer Explanation

Incorrect Answer Explanation

About the Authors

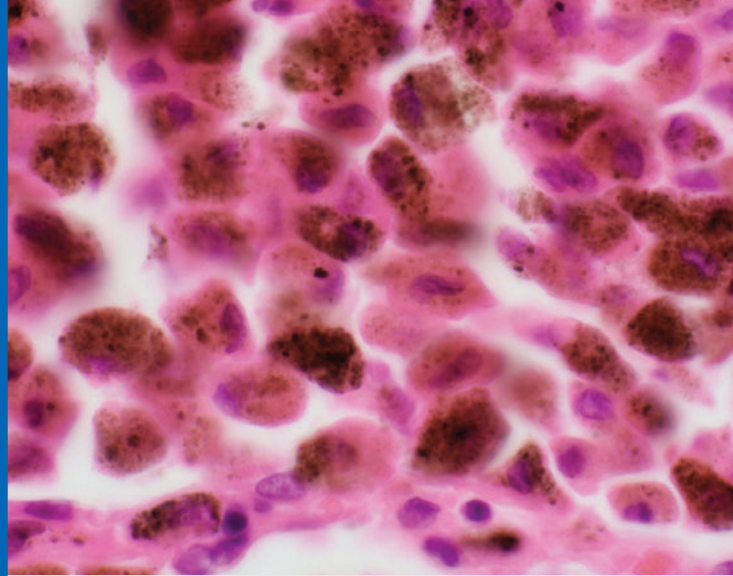
Walter L. Kemp, MD, PhD, graduated from Creighton University School of Medicine, following which he was a resident in anatomic and clinical pathology at the University of Texas Southwestern Medical Center, and forensic fellow at the Dallas County Medical Examiner's office. After completing his medical training, he was an assistant professor of pathology at the University of Texas Southwestern for two years, being awarded one of the outstanding teacher awards from the second-year medical school class each of those two years. For the next ten years he was the deputy state medical examiner for the state of Montana, during which time he earned his MA and PhD in anthropology from the University of Montana. Beginning

in July 2015, he became an associate professor of pathology at the University of North Dakota School of Medicine and Health Sciences, and, in his first year won both the local Golden Apple Award for teaching, and the UNDSMHS's Portrait Award. He has written a pathology review book, a coroner training manual, and has been author or a coauthor for fourteen articles on various topics in medicine.

Travis Brown, MD, graduated from UT Southwestern Medical School in Dallas, Texas. He completed his family medicine residency at John Peter Smith Hospital in Fort Worth, Texas. He is a father of two, medical columnist, and practicing family physician in Midlothian, Texas.

Chapter 1

Cell Injury, Adaptations, and Death



LEARNING OBJECTIVES

1.1 Cellular Adaptations

- ▶ Discuss examples of the gross and microscopic features produced by hypertrophy, hyperplasia, atrophy, and metaplasia and list disease processes each can result from
- ▶ Distinguish between physiologic adaptation and pathologic adaptation
- ▶ List the mediators involved with cellular adaptation

1.2 Cellular Injury

- ▶ List the morphologic features of reversible and irreversible cellular injury and describe the circumstances and physiologic process under which each occurs
- ▶ List the reactive oxygen species and describe their effects
- ▶ Describe the mechanisms of reversible and irreversible cellular injury
- ▶ Describe the process of apoptosis, including the cellular mediators involved

1.3 Cellular Accumulations, Calcification, and Aging

- ▶ List and describe the forms of cellular accumulations and list the circumstances or conditions under which they are found
- ▶ Compare and contrast the different forms of calcification
- ▶ Describe the function of the telomerase

1.1 Cellular Adaptations— Questions

Easy

Medium

Hard

1. A 50-year-old male dies during a car accident. At autopsy, he is noted to have a moderately stenotic aortic valve. The heart weighs 500 grams. The cause of death from the motor vehicle accident is entirely blunt force injuries of the head and neck, including an atlanto-occipital dislocation. No internal injuries below the neck are identified. There is no history of heart failure. A section of the myocardium from the left ventricle would reveal which of the following processes?

- A. Hypertrophy
- B. Hyperplasia
- C. Atrophy
- D. Metaplasia
- E. Reversible cell injury
- F. Irreversible cell injury

Cardiovascular

2. A 25-year-old male, who is an offensive lineman for the local college football team, dies during a car accident. At autopsy, the injuries, being multiple rib fractures and lacerations of the lungs and heart, with 1500 mL of blood found in the left pleural cavity, are confined to the chest. At autopsy, a biopsy of his left biceps femoris muscle would reveal which of the following?

- A. Physiologic hyperplasia
- B. Pathologic hyperplasia
- C. Physiologic hypertrophy
- D. Pathologic hypertrophy
- E. Physiologic atrophy
- F. Pathologic atrophy

Musculoskeletal

3. A 27-year-old male is in a car accident and sustains a fracture of the 2nd thoracic vertebra, with resultant damage to the spinal cord at the same level, leading to paraplegia, requiring him to be wheelchair bound. Five years following the accident, he develops a neoplasm of the right lower extremity, requiring a wide local excision, which includes a small superficial segment of underlying skeletal muscle. When viewing the microscopic slides, which of the following would the pathologist identify in the skeletal muscle?

- A. Physiologic hyperplasia
- B. Pathologic hyperplasia
- C. Physiologic hypertrophy
- D. Pathologic hypertrophy
- E. Physiologic atrophy
- F. Pathologic atrophy

Musculoskeletal

4. A pathologist is examining the biopsy of an individual's left ventricular myocardium and notices that the cardiac myocytes are enlarged. Of the following conditions, which would best explain this finding?

- A. Pulmonary hypertension
- B. Systemic hypertension
- C. Lambl's excrescences on the aortic valve
- D. A probe patent fossa ovalis
- E. Acute pericardial hemorrhage

Cardiovascular

5. A 2-year-old female aspirates a small coin, unbeknownst to her caregivers. Over the next few days, she develops a cough and becomes less responsive and sleeps longer periods. Her parents also notice that she feels warm to the touch, but do not take her temperature. Six days following the coin being swallowed, her parents find her unresponsive in her bedroom. They call 9-1-1 and she is pronounced dead at the hospital. Autopsy reveals a widespread bronchopneumonia in the right lung and a coin lodged in the right mainstem bronchus, nearly completely blocking it. A microscopic section of the bronchus from where the coin was lodged reveals stratified squamous epithelium, which appears essentially normal, similar to that seen in the inner lining of the esophagus. Which of the following processes has occurred in the bronchus?

- A. Hypertrophy
- B. Hyperplasia
- C. Metaplasia
- D. Atrophy
- E. Irreversible cellular injury

Respiratory

6. After developing hematuria and flank pain, a 55-year-old male is diagnosed with a renal cell carcinoma in his right kidney. To treat the tumor, the patient's right kidney is resected. Five years later, he dies in a car accident. At autopsy, there is an absence of the right kidney, and the left kidney weighs 300 grams (normal weight is 150-200 grams for an adult male). Of the following processes, which is most likely occurring in the left kidney?

- A. Physiologic hypertrophy
- B. Pathologic hypertrophy
- C. Physiologic hyperplasia, hormonal type
- D. Physiologic hyperplasia, compensatory type
- E. Pathologic hyperplasia

Genitourinary

7. A 90-year-old male with severe dementia has been bedridden for 5 years. Physical examination reveals no decubitus ulcers on his back, buttocks, or lower extremities; however, his upper and lower extremities are reduced in circumference, the lower extremities more so than the upper extremities, with apparent significant loss of muscle mass. Which of the following combinations of molecular mediators is most responsible for the decreased size of the skeletal muscles?

- A. Cyclooxygenase-Thromboxane A₂
- B. 12-Lipoxygenase-Lipoxin A₄
- C. Plasmin-C3a
- D. p53-Bax
- E. Ubiquitin-proteasome

Musculoskeletal

1.2 Cellular Injury—Questions

Easy

Medium

Hard

8. A 56-year-old male with a history of smoking and hypertension develops an occlusive thrombus in his left anterior descending coronary artery following rupture of an atherosclerotic plaque. He survives the event, but therapeutic lysis of the thrombus is not accomplished until 1 hour after its formation. He is told that he sustained a subendocardial myocardial infarct. If a biopsy of the subendocardial myocytes was performed 24 hours after the occlusion of the vessel, of the following, which intracellular change would be expected to be identified?

- A. Swelling of the mitochondria
- B. Dilation of the rough endoplasmic reticulum
- C. Nuclear clumping of chromatin
- D. Lipid vacuoles in the cytoplasm
- E. Karyorrhexis of nuclei

Cardiovascular

9. The husband of a 62-year-old female found her unresponsive on the couch in their apartment when he returned home from work. Despite the efforts of emergency responders, she was pronounced dead at the hospital. An autopsy reveals a well-demarcated wedge-shaped yellow lesion in the cortex of the left kidney with preservation of normal gross architecture. Of the following, what is the most likely etiology for this autopsy finding?

- A. *Mycobacterium tuberculosis* infection
- B. *Klebsiella* bacterial infection
- C. Renal cell carcinoma
- D. Metastatic colonic adenocarcinoma
- E. Thrombus of distal branch of left renal artery

Genitourinary

10. In his autopsy report, a pathologist describes a 5 x 3 cm focus of liquefactive necrosis. The source of the liquefactive necrosis was a thrombus occluding an artery, and the autopsy was performed 2 days following the event that produced the liquefactive necrosis. In which of the following sections of the autopsy report would this lesion most likely be described?

- A. Central nervous system
- B. Cardiovascular system
- C. Respiratory system
- D. Hepatobiliary system
- E. Genitourinary system

Central nervous system

11. A 37-year-old male with a history of chronic alcohol abuse and gallstones is brought to the emergency room by a friend. The patient has been complaining of severe abdominal pain for 3 days following a bout of increased alcohol consumption. Laboratory testing in the emergency room indicates an elevated amylase and lipase. Despite treatment, the patient dies. An autopsy of the individual most likely will reveal which of the following in the greater omentum?

- A. Coagulative necrosis
- B. Liquefactive necrosis
- C. Gangrenous necrosis
- D. Caseous necrosis
- E. Fat necrosis
- F. Fibrinoid necrosis

Gastrointestinal

12. A pathologist is examining a section of kidney and notes hydropic change in the proximal convoluted tubule epithelial cells. Damage to or decreased function of which of the following cellular structures is most important in directly causing this finding?

- A. Rough endoplasmic reticulum
- B. Smooth endoplasmic reticulum
- C. Sodium-potassium pump
- D. Phagocyte oxidase
- E. Cytoskeletal proteins

Genitourinary

13. For his research, a scientist exposes cultured cells to certain forms of radiation. Following the exposure, he can examine intracellular proteins for evidence of cross-linking. Of the following, which has the highest propensity for causing such protein changes?

- A. Superoxide
- B. Hydrogen peroxide
- C. Hydroxyl radical
- D. Nitric oxide
- E. Oxidized glutathione

N/A

14. A scientist is studying the effects of an experimental medication, IST-151, on cultured hepatocytes. The medication, unfortunately, results in the death of the hepatocytes and appears to do so predominantly through activation of an intracellular endonuclease, which damages the nucleus of the cell, leading to death. Of the following mechanisms of cellular injury, which one is the most direct in mediating the previously described effects (i.e., activation of the endonuclease)?

- A. Mitochondrial damage resulting in decreased production of ATP
- B. Mitochondrial damage leading to increased production of reactive oxygen species
- C. Calcium influx into the cell
- D. Breakdown of lysosomal membranes
- E. DNA damage leading to activation of pro-apoptotic proteins

N/A

15. A 46-year-old female receives radiation therapy of the neck for a neoplasm of the thyroid gland. After therapy, it is noted that her thyroid gland has markedly decreased in size, leading to hypothyroidism, and she must be placed on a thyroid replacement therapeutic drug regimen. Of the following, which statement is most characteristic regarding the process by which the thyroid gland decreased in size?

- A. The plasma membranes of the thyroid follicular cells lysed
- B. Prominent calcium influx led to marked activation of phospholipase
- C. Ischemic injury induced by the radiation led to coagulative necrosis
- D. Few, if any, inflammatory cells would have been seen histologically
- E. Damage to cytoskeletal elements led to dissolution of the cells

Endocrine

16. A scientist is studying apoptosis. By the introduction of a naturally occurring chemical, she wishes to shorten the life span of cultured cells that are derived from a human liver and that have been exposed to radiation. Which of the following effects, if caused by the introduced chemical, would produce her desired outcome?

- A. Increased concentration of bcl-2
- B. Increased concentration of bcl-xL
- C. Increased concentration of BH3 proteins
- D. Decreased concentration of Bax
- E. Decreased concentration of Bad

N/A

17. A 61-year-old female receives radiation therapy of the neck for a neoplasm of the larynx. After therapy, it is noted that her thyroid gland has markedly decreased in size, leading to hypothyroidism. During the decrease in size of the thyroid gland, biopsies of the parenchyma would have revealed cells with increased eosinophilia, and fragmented nuclei, but essentially no surrounding inflammatory reaction. Of the following cellular components, which one most directly contributed to this lack of an inflammatory reaction?

- A. Phospholipase
- B. Phagosome oxidase
- C. CD95
- D. Phosphatidylserine
- E. Phosphatidylinositol

Endocrine

1.3 Cellular Accumulations, Calcification, and Aging—Questions

Easy

Medium

Hard

18. A 40-year-old chronic alcoholic with no other medical history died after an alcohol-related seizure, in which he fell down the stairs at his house and fractured his neck. An autopsy is performed that reveals a diffusely golden-yellow discolored liver. Microscopic examination of the liver reveals almost every hepatocyte to be filled with one large vacuole or a few smaller vacuoles. Which of the following mechanisms most likely caused this intracellular inclusion?

- A. Abnormal metabolism
- B. A defect in protein folding
- C. The lack of an enzyme
- D. Ingestion of indigestible material

Hepatobiliary

19. A deceased poorly controlled diabetic is found in his messy apartment during a welfare check initiated by concerned friends. At the time of autopsy, his kidneys are noted to be pale. Vitreous electrolyte analysis indicates a vitreous glucose of 576 mg/dL and acetone is detected in the blood. A diagnosis of diabetic ketoacidosis is made. Microscopic examination of the kidneys reveals small clear vacuoles in the renal tubular epithelial cells. Of the following, what is the most likely contents of these vacuoles?

- A. Lipofuscin
- B. Triglycerides
- C. Hemosiderin
- D. Glycogen
- E. Carbon

Genitourinary

20. A research scientist wants to conduct an experiment using lipofuscin as the substrate to see how it forms and what adverse effects its presence in the cells might create. He collaborates with a medical examiner's office to obtain tissue for his research. All other factors being equal, which of the following might be expected to contain the greatest amount of lipofuscin in each of the parenchymal cells?

- A. Liver from a 15-year-old
- B. Liver from a 40-year-old
- C. Liver from a 75-year old
- D. Pancreas from a 15-year-old
- E. Pancreas from a 40-year-old
- F. Pancreas from a 75-year-old

Hepatobiliary

21. A forensic pathologist is examining a section of skin. Just underneath the dermis is a large collection of macrophages, each containing a stippled, or somewhat chunky-appearing, yellow-brown pigment. The pathologist orders a Prussian blue stain, which causes the pigment to appear blue. Of the following, which is the most likely etiology for the pigment?

- A. Abnormal protein accumulation in an alcoholic
- B. Previous trauma that resulted in hemorrhage
- C. Wear-and-tear pigment in an older individual
- D. Cigarette smoking
- E. Normal melanin accumulation in a darkly pigmented individual

Integumentary

22. A 36-year-old male crashes while skiing and sustains a large laceration of his thigh, which ultimately heals by secondary intention, leaving a large scar. Six years later, he notices a firm, but ill-defined, mass at the site of the scar. Other than the laceration of the thigh, his past medical history is essentially negative. He consults a surgeon who removes the mass. The mass has a gritty texture to it, and under the microscope appears to be fibrosis with scattered clusters of rounded and globular basophilic material. No cartilage or bone is identified. Which of the following processes is occurring at this site?

- A. Metaplastic calcification
- B. Dysplastic calcification
- C. Dystrophic calcification
- D. Metastatic calcification
- E. Disuse calcification

Integumentary

23. A researcher is studying a form of lung cancer in which she identifies a gene for a telomerase in the DNA of the tumor cells. Which of the following abilities would this gene provide the cancer cells with?

- A. Invade through basement membrane
- B. Invade through wall of blood vessel
- C. Implant in organs to form a metastasis
- D. Increased rate of mitotic activity
- E. Ability to divide for an indefinite length of time

N/A

1.4 Cellular Adaptations—Answers and Explanations

Easy

Medium

Hard

1. Correct: Hypertrophy (A)

Because of the stenotic aortic valve, increased pressure is placed on the left ventricular myocardium, which responds by increasing the size of the cells, which is hypertrophy (A). The myocardium has adapted to the increased pressure, and since then there has been no heart failure and no reversible or irreversible cell injury (E, F). Cardiac myocytes are essentially not capable of division and are increasing in size, not decreasing, so neither hyperplasia nor atrophy is occurring (B, C), and there is no switch in type of cell (e.g., cardiac muscle to another form of mesenchymal tissue), so metaplasia is not occurring (D).

2. Correct: Physiologic hypertrophy (C)

As the decedent is athletic, there is a stimulus causing enlargement of the biceps femoris muscle, and as athletic activity is a normal activity, the resultant enlargement of the skeletal muscle cells would be considered physiologic and not pathologic. The skeletal muscle cells cannot divide, so they would respond to increased workload by increasing in size (hypertrophy), and not by increasing in number (hyperplasia) (C). (A-B, D-E) are incorrect based on the previously discussed information.

3. Correct: Pathologic atrophy (F)

Damage to the spinal cord can lead to deinnervation of the lower extremities. Deinnervation is one mechanism causing atrophy, and, as the deinnervation was due to a traumatic injury, the resultant atrophy would be considered pathologic (F) and not physiologic (E). As there is neither an increase in the size of the skeletal muscle cells, nor an increase in their number, the other answers are incorrect (A-D).

4. Correct: Systemic hypertension (B)

The pathologist is viewing hypertrophy of the cardiac myocytes. While identification of enlarged cells themselves is a difficulty, enlarged rectangular nuclei (i.e., boxcar nuclei) serve as a marker of cardiac myocyte hypertrophy. Increased blood pressure in the systemic vessels would put strain on the left ventricle and lead to hypertrophy (B). Pulmonary hypertension would cause similar changes in the right ventricular myocardium (A). Lambl's excrescences are incidental small nodules on the valve leaflets that are of no physiologic consequence (C). A probe patent fossa ovalis is usually of no physiologic significance (D). However, if a left to right shunt developed, this condition could potentially lead to volume overload in the right atrium and ventricle, with resultant hypertrophy and dilation, but the left ventricle would not be affected. An acute pericardial hemorrhage would not explain hypertrophy, as cardiac myocyte hypertrophy does not develop over such a short period of time, but instead requires a longer exposure to the stimulus (E).

5. Correct: Metaplasia (C)

The bronchus is usually lined by respiratory epithelium (pseudostratified columnar epithelium); however, when the nature of the stimulus to the epithelium changes, which, in this case is trauma caused by the pressure from the coin, the epithelium can change to a different form to better handle the abnormal stimulus. The transition from one epithelium type to another is termed metaplasia (C). In the lung, squamous metaplasia most commonly is a result of cigarette smoking, and, in this situation, metaplasia can lead to dysplasia and finally to carcinoma, accounting for the presence of squamous cell carcinomas in the lung. If the coin is removed, the epithelium could transition back to respiratory epithelium; therefore, the change is reversible, and not irreversible cellular injury. (A-B, D-E) are incorrect based on the previously discussed information.

6. Correct: Physiologic hyperplasia, compensatory type (D)

Because of the absence of the right kidney, the left kidney has a higher workload, and in response, the left kidney increases the number of cells in its structure to handle this increased workload and thus, the organ weight has increased. The cells in the kidney are capable of division, and thus hyperplasia can occur (unlike in the cardiac or skeletal muscle). The hyperplasia is physiologic in nature because it is stimulated by an increased workload, and it is to compensate for the loss of the other kidney (D). (A-C, E) are incorrect based on previously discussed information.

7. Correct: Ubiquitin-proteasome (E)

The patient has disuse atrophy of the upper and lower extremities. The two primary processes occurring in atrophy are decreased protein synthesis and increased protein degradation. Protein degradation is accomplished by binding of ubiquitin to the substances to be degraded followed by its subsequent destruction by proteasomes (E). Cyclooxygenase and thromboxane A2 and 12-lipoxygenase-lipoxin A4 function in inflammation (A, B), and plasmin-C3a in the complement cascade (C), both of which could be active in the muscle to some degree but are not the main source of protein degradation, and p53-Bax functions in apoptosis (D), which might be occurring to some small degree but is not the main cause of the protein degradation.

1.5 Cellular Injury— Answers and Explanations

Easy

Medium

Hard

8. Correct: Karyorrhexis of nuclei (E)

After 1 hour of ischemia, some of the affected myocytes would have irreversible damage, in this case, represented by the subendocardial myocardial infarct. Of the choices, only karyorrhexis of the nuclei is characteristic of irreversible injury, i.e., necrosis (E), whereas the other choices are seen with reversible injury (A-D). Other microscopic features of irreversible ischemic injury (i.e., necrosis) include increased eosinophilia of the cytoplasm, and other nuclei changes including karyolysis (i.e., fading of the chromatin) and pyknosis (i.e., shrinkage of the nucleus). Karyorrhexis is fragmentation of the nucleus. As the thrombus was lysed relatively early, myocytes closer to the epicardium may have had signs of reversible injury, but not irreversible injury.

9. Correct: Thrombus of distal branch of left renal artery (E)

The gross description is that of an infarct, which has coagulative necrosis. In coagulative necrosis, the normal organ architecture is preserved in the beginning phases of the development of the infarct. A thrombus of a branch of the renal artery can produce an infarct of the cortex of the kidney (E). Infarcts are typically wedge-shaped, essentially exhibiting the downstream effects of a blockage of the arterial system, with the amount of organ affected increasing moving distal from a single point, the tip of the wedge. Preservation of architecture does not occur with liquefactive necrosis (as could be seen with a bacterial pyelonephritis) or caseous necrosis (as could be seen with a tuberculosis infection), and by their nature, tumors do not have preservation of architecture within their boundaries (A-D).