

### **Certified Surgical Assistant Exam-Study Guide**

### **INTRODUCTION**

The CSA exam is developed by the National Commission for the Certification of Surgical Assistants (NCCSA), with support by the National Surgical Assistant Association (NSAA), and provides qualified surgical assistant candidates the opportunity to achieve "standards-based" national certification.

The 150 question Certified Surgical Assistant exam has been meticulously developed by Certified Surgical Assistant Subject Matter Experts under the guidance a leading psychometry firm specializing the development of examinations to accurately measure knowledge, skills and attributes (KSAs) of surgical assistant graduates, or other qualified professionals challenging the CSA examination.

Successfully passing the CSA examination requires a general knowledge of medicine and with a solid command surgical procedure knowledge in all surgical subspecialties, surgical anatomy, human physiology, surgical technique, medical terminology, and surgical instrumentation commonly used in surgery. The content and questions of the CSA exam have been verified by surgeons, and reflect a fundamental knowledge base competency for an entry-level surgical assistant.

Educators from current surgical assistant programs have input into the breadth of subject matter covered in the CSA exam, but have no knowledge of the specific questions, nor participate in creating the exam, specific exam questions, or the CSA Exam Study Guide.

### THE STUDY GUIDE

This study guide does not contain all the material a surgical assistant must command in his or her practice, nor does it cover the entire scope of didactic lectures in a surgical assistant training program.

The Table of Contents are not specifically indicative of sections on the actual examination, but provide a basic framework for study. Additional references are listed with which, a candidate choose for deeper subject matter review.

## SAMPLE QUESTIONS

Answers to the sample questions found in each section are located in Appendix IV, at the end of this study guide.



## TABLE OF CONTENTS

- **1. MEDICAL TERMINOLOGY**
- 2. PHYSIOLOGY and ORGAN SYSTEMS
- **3. SURGICAL ANATOMY**
- 4. SURGICAL PROCEDURES
- **5. SURGICAL TECHNIQUES**
- 6. APPENDIX

I. Greek/Latin Prefixes II. Supplemental Study Material III. Additional references for Review IV. Answers to Sample Questions

# PART 1: MEDICAL TERMINOLOGY

Understanding medical and surgical terminology is an essential component of communication in the OR, and to the understanding of medicine. Working in the OR setting for significant extended periods of time exposes medical professionals to terminology as it is used in patient care. Further study of medical terminology, however, is crucial to understanding medicine, and represents a large part of surgical assistant training curriculum.

#### A. ANATOMIC ORIENTATION:

Anatomic "orientation" terminology may be found in anatomy textbooks such as Gray's Anatomy, Alexander's Care of the Patient in Surgery, by Rothrock, and many others.

Successful completion of surgical procedures requires the surgeon and the assistant to accurately and efficiently navigate the steps in the proper sequence, and often in unison. Anatomic orientation terminology provides a key "language" for this communication.

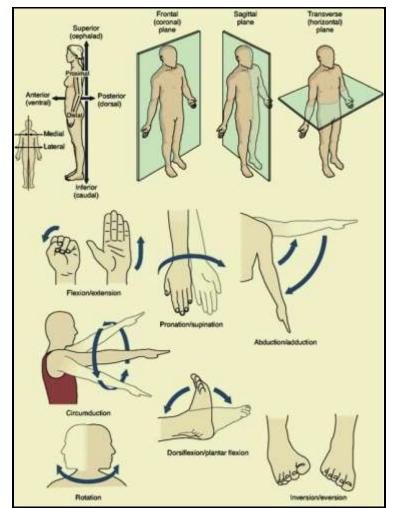


Image source: http://www.drugline.org/medic/term/orientation-anatomic-terms-of/, accessed 10/1/17, 11:00pm

#### Anatomic "Orientation" Vocabulary examples include:

- Anterior: The front, as opposed to the posterior.
- Anteroposterior: From front to back, as opposed to posteroanterior.
- **Caudad:** Toward the feet (or tail in embryology), as opposed to cranial.
- **Caudal:** Pertaining to, situated in, or toward the tail or the hind part. Or below another structure.
- **Cranial:** Toward the head, as opposed to caudad.
- **Deep:** Away from the exterior surface or further into the body, as opposed to superficial.
- **Distal:** Further from the beginning, as opposed to proximal.
- **Dorsal:** The back, as opposed to ventral.
- **Horizontal:** Parallel to the floor, a plane passing through the standing body parallel to the floor.
- Inferior: Below, as opposed to superior.
- Inferolateral: Below and to one side. Both inferior and lateral.
- Lateral: Toward the left or right side of the body, as opposed to medial.
- Medial: In the middle or inside, as opposed to lateral.
- **Posterior:** The back or behind, as opposed to the anterior.
- **Posteroanterior:** From back to front, as opposed to anteroposterior.
- **Pronation:** Rotation of the forearm and hand so that the palm is down (and the corresponding movement of the foot and leg with the sole down), as opposed to supination.
- **Prone:** With the front or ventral surface downward (lying face down), as opposed to supine.

- **Proximal:** Toward the beginning, as opposed to distal.
- **Sagittal:** A vertical plane passing through the standing body from front to back. The mid-sagittal, or median plane, splits the body into left and right halves.
- **Superficial:** On the surface or shallow, as opposed to deep.
- **Superior:** Above, as opposed to inferior.
- **Supination:** Rotation of the forearm and hand so that the palm is upward (and the corresponding movement of the foot and leg), as opposed to pronation.
- **Supine:** With the back or dorsal surface downward (lying face up), as opposed to prone.
- **Transverse**: A horizontal plane passing through the standing body parallel to the ground.
- Ventral: Pertaining to the abdomen, as opposed to dorsal.
- Vertical: Upright, as opposed to horizontal.

Source: http://www.medicinenet.com/script/main/art.asp?articlekey=9210, accessed 10/1/17, 10:20pm.

SAMPLE QUESTION 1.3: The surgeon asks you to first gently supinate, then gently pronate the operative wrist of a 14-year old patient in supine position. The operative extremity is positioned at 80 degrees to the torso. Which of the following most accurately describes the movement of the operative thumb (which direction it points) as you carry out the instructions?

- Thumb lateral, then back to medial.
- Thumb medial, then back to lateral.
- Thumb superior, then back inferior
- Thumb inferior, then back to superior

# SAMPLE QUESTION 1.2: With patient in the prone position, the dorsal roots of the spinal nerves are oriented:

- Deep to its corresponding ventral roots
- Superficial to its corresponding ventral roots
- Cranial to its corresponding ventral roots
- Caudal to its corresponding medial roots

To research the following questions 1.3 through 1.5, please refer to *Latin and Greek Roots of Medical Terminology* in Appendix I.

# SAMPLE QUESTION 1.3: A choledoco-duodenostomy refers to the surgical anastomosis of which of the following two structures:

- Gall bladder with the common bile duct
- Common bile duct and fundus of the stomach
- o Duodenum and common bile duct
- Pancreatic duct and antrum of the stomach

#### SAMPLE QUESTION 1.4: In knee arthroscopy, the antero-medial portal is placed:

- $\circ$  on the same side of the patella as the Ilio-tibial band.
- $\circ$  on the opposite side of the patella from the pes anserinus.
- superior to the quadriceps insertion on the patella.
- o proximal and anterior to the pes anserinus, medial to the patellar ligament.

#### SAMPLE QUESTION 1.5: Epidural anesthesia is administered:

- Anterior (deep to) to the lumbar or sacral nerve roots.
- $\circ$  Into the space between the spinal canal and the dura mater covering the nerve roots.
- Into precisely the same subarachnoid space as spinal anesthesia, but in the sacral area.
- Directly into the cerebral spinal fluid at any point from the ventricles in the brain, to the cauda equina.

Consider consulting the following sources for in depth study.

- <u>Atlas of Human Anatomy</u>, Frank H. Netter, MD, 6<sup>th</sup> Edition, Elsevier North Holland, Inc., New York, NY.
- <u>Gray's Anatomy, The Anatomical Basis of Clinical Practice</u>, 41st Edition, Susan Standring, Elsevier North Holland, Inc., New York, NY.
- <u>Human Anatomy</u>, R.M.H McMinn, R.T. Hutchings, second edition, Year Book Medical Publishers, Chicago, IL, 1988.
- <u>Human Anatomy, A Synoptic Approach</u>, Nicholas James Mizeres, Elsevier North Holland, Inc., New York, NY, 1981.
- <u>Essentials of Surgery</u>, James M Becker, MD, and Arthur F. Stucchi, PhD, Saunders, Philadelphia, PA, 2006.
- <u>Textbook of Medical Physiology</u>, 8<sup>th</sup> Edition, Arthur C Guyton, M.D., W.B Saunders Company, Philadelphia, PA. 1991.

### **PART II: ORGAN SYSTEMS and PHYSIOLOGY**

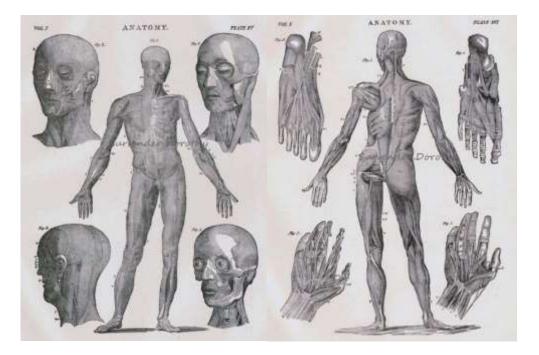
- A. The Musculoskeletal system:
  - a. Muscle Physiology:
- B. The Vascular System:
- C. The Cardio-Pulmonary System:
- D. The Nervous System:
- E. The Digestive System:
- F. The Endocrine System:
- G. The Excretory System:
- H. The Lymphatic System:

The arrangement of anatomic structures in the body support the physiologic function of the organ systems. These organ systems include the: musculoskeletal; cardio-pulmonary; circulatory; nervous; digestive; endocrine; excretory; reproductive; sensory; integumentary; and immune systems.

Surgical procedures in one region impact all the body systems to a greater or lesser degree. For this reason, the surgical assistant is well-served to carry a fundamental understanding of the physiology within each organ system, its anatomic locations/s in the body, and be ever vigilant to correctly identify organ system structures.

Avoiding or minimizing traumatic impact to structures peripheral to the procedure at hand, minimizes unnecessary mortality and morbidity of the case.

### A.The Musculoskeletal system:



Skeletal anatomy must be committed to memory, including the skull, spine, and distal extremities. Tubercles, tuberosities, fossae, canals, and fissures represent important features relative to connective tissue attachment, vascular supply, bone growth, and bone marrow function.

Joint alignment, articular cartilage, and soft tissue support; as well as muscular insertions, origins, and innervations; and principle including agonist/antagonist pairing should be studied. Such understanding underpins the importance for the identification and preservation of normal anatomy during surgery.

# SAMPLE QUESTION 2.1: The connective tissue between the patella and the tibial tuberosity in the knee facilitates quadriceps muscle contraction across the knee joint. What is this structure?

- Patellar Ligament
- o Quadriceps Tendon
- Vastis Lateralis
- Vastis Medialis

# SAMPLE QUESTION 2.2: The talus forms an articulation with which of the following lists of bones:

- Navicular, cuneiform, fibula and calcaneus
- Tibia, cuboid, fibula, and cuneiform
- o Calcaneus, navicular, tibia, and calcaneus
- Fibula, cuneiform, calcaneus, and tibia

SAMPLE QUESTION 2.3: The acetabulum, or hip socket, is comprised of the fusion of which of the three bone choices below?

- Ilium, sacrum, and pubis.
- Pubis, sacrum, and ischium.
- Pubis, ischium, and ilium.
- Sacrum, ischium, and ilium.



Image source; http://muscle.ucsd.edu/MusIntro/ecc.shtml, accessed 11/28//17

### a. Muscle Physiology:

Muscle tissues throughout the body, including striated, smooth, and cardiac muscle types operate via myofibril motor units activated by nerve impulse and neurotransmitter action. Acetylcholine release and reuptake represents one key biochemical step in muscle metabolism and may be acted on by anesthetic agents used in the operating room. Another point of pharmaceutical intervention comes from the calcium ion and potassium ion exchange following contraction.

Errant electrical stimulation may affect contractility of muscle tissue. Lactic acid buildup in muscles becomes a potential issue for patients who have not been moved during very long procedures. Sudden position change can have systematic effects.

SAMPLE QUESTION 2.4: A large bolus of potassium given intravenously to a patient may have catastrophic effects on cardiac muscle and ultimately arrest cardiac function. The mechanism for this problem is described in which of the following statements:

- Potassium in the intracellular space blocks repolarization of the muscle cell membrane
- Calcium and potassium inside the cell reach toxic levels
- Potassium displaces calcium across the nuclear membrane
- Calcium displaces sodium across the nuclear membrane

### **B.**The Vascular System:

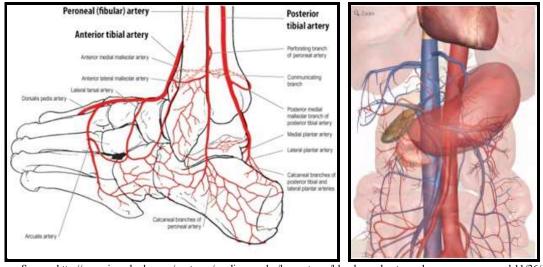


Image Source: http://www.innerbody.com/anatomy/cardiovascular/lower-torso/blood-supply-stomach-pancreas, accessed 11/26/17

During surgery, blood flow must be protected from disruption. A working knowledge of the blood supply to all organs, extremities, and tissues remains paramount to surgical success. Arteries, arterioles, capillaries, venules, and veins all have distinct properties and require specific handling. A working knowledge of this anatomy, as well as vascular tissue handling techniques, optimizes surgical success.

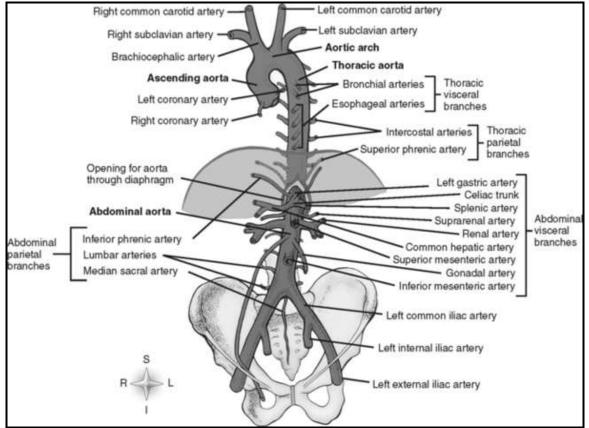


Image Source: https://musculoskeletalkey.com/abdominal-injuries/, accessed 12/22/17

Temporary blood flow restriction with cross clamping or the use of a tourniquet, or a variety of intraoperative bypass procedures carry their own sets of procedural caveats. Deliberate and permanent hemostasis for resection procedures also require precise planning and excellent technique.

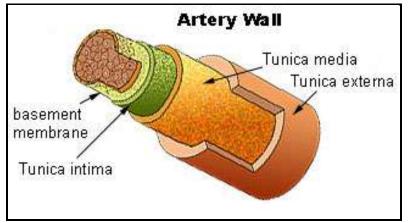
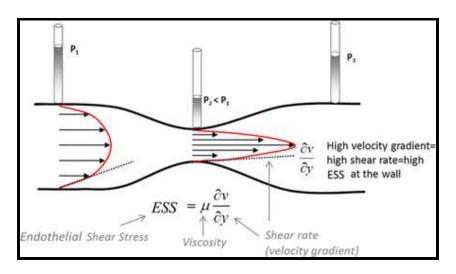


Image source: https://en.wikipedia.org/wiki/Tunica\_media#/media/File:Illu\_artery.jpg, accessed 12/2/17

Turbulence in the vasculature occurs with vascular injury or blockage. One measure of this phenomenon is "shear rate", defined as the local velocity gradient between adjacent blood flow. Shear rate, incidentally, has also been shown to be one of the main regulators of platelet activation and thrombosis. This basic understanding underpins the necessity for resecting aneurismal tissue with meticulous care.

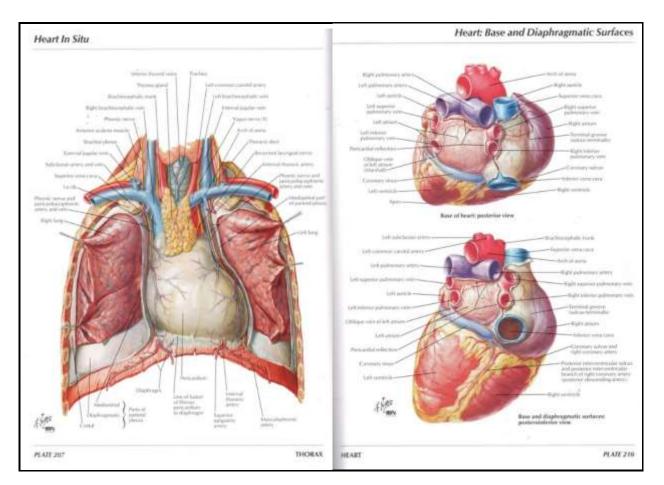


# **SAMPLE QUESTION 2.5:** The superior mesenteric artery provides primary blood supply for which of the following structures:

- o Esophagus
- Pancreas
- o Stomach
- o Spleen

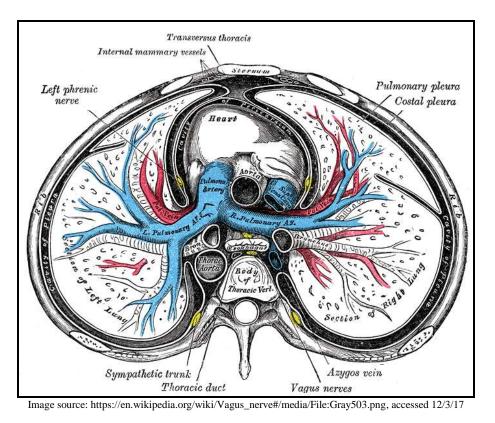
# **SAMPLE QUESTION 2.6:** The uterine artery is a most commonly a direct branch of the:

- o Internal iliac artery
- External iliac artery
- Common iliac artery
- o Gonadal artery



### **C.The Cardio-Pulmonary System:**

Cellular function throughout the tissues and organs of the body rely on the delivery of oxygen and nutrients, and facilitation of cellular waste removal. Immune and endocrine function depend on adequate circulation. Osmotic forces maintained at the cellular level, and physiologic safeguards such as vasodilation and vasoconstriction, preserve the integrity of the closed circulatory loop.



The surgical assistant must thoroughly understand the anatomic features of the thoracic cavity, including cardiovascular and pulmonary anatomy, including its innervation. He or she must also be fully aware of the challenge surgical procedures pose to a patient's normal hemodynamic status. Patient blood volume, blood pressure, oxygen saturation, and cardiac function must be protected. Additional parameters such as tourniquet time, patient positioning, clotting status, and autonomic nerve (vagal) responses should also be well understood, since they affect patients' immediate response to surgery.

Normal lab values should be part of a surgical assistant's working knowledge base, such as  $O_2$  saturation, clotting time, hemoglobin, hematocrit, etc.

# SAMPLE QUESTION 2.7: After what percent of total blood volume may arterial pressure AND cardiac output begin to significantly (and precipitously) drop?

- More than about 5%
- $\circ$  More than about 10%
- More than about 20%
- More than about 25%

# SAMPLE QUESTION 2.8: Putting a patient into Trendelenberg position has the effect of:

- Decreasing blood flow to the brain
- Decreasing blood flow to the coronary arteries
- Increasing blood flow to the brain
- Increasing blood flow to the coronary arteries

SAMPLE QUESTION 2.9: A history of crushing wound to the chest, a patient exhibits the following symptoms: low blood pressure; chest pain radiating to the neck, shoulders, and back; trouble taking deep breaths and rapid shallow breathing. Which of the following cardio-pulmonary conditions may responsible and require urgent surgery?

- Pericarditis
- Cardiac Asynchrony
- Cardiac Tamponade
- Pericardial Effusion

# SAMPLE QUESTION 2.10: Which of the following may be a cause of acute cyanosis in a patient undergoing a surgical procedure:

- Lower than normal hemoglobin
- Higher than normal hemoglobin
- Lower than normal hematocrit
- Higher than normal hematocrit

### **D.The Nervous System:**

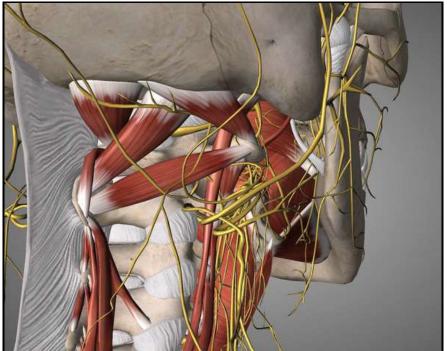


Image source: https://farm8.staticflickr.com/7392/27081043110\_9aea88f11e\_b.jpg, accessed 12/2/17

The complex, delicate structures that make up the nervous system — the brain, spinal cord and peripheral nerves — are susceptible to various types of injury ranging from gross trauma and neurodegenerative diseases, to localized iatrogenic injury during treatment.

Neuroanatomy must be learned from a systematic perspective, that is, with emphasis on the somatic and autonomic function of the brain and central nervous system. For the surgical assistant, however, an in-depth knowledge of neuroanatomy from a procedure-specific regional approach is also paramount.

Careful study of the cranial nerves and their function provides a surgical assistant the ability for high-level communication with the surgeon on the potential complications of misidentification of structures especially in head and neck procedures.

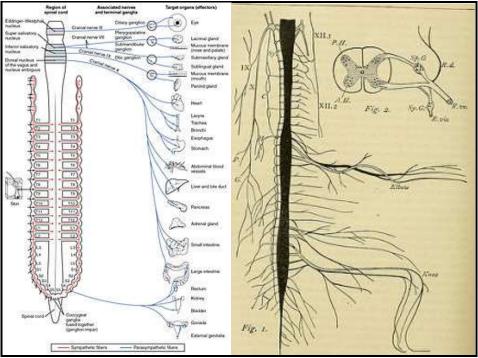


Image source: https://farm4.staticflickr.com/3922/14577738497\_b4c1614477\_b.jpg, accessed 12/2/17

In spinal surgery, the anatomy of the spinal cord and meningeal layers stand crucially relevant. The spinal nerves, their dorsal and ventral roots, and their exit points along the spinal canal must be protected. The bony anatomy of the spinal column itself should be studied.

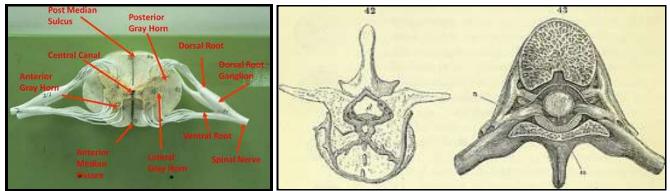


Image source: https://farm4.staticflickr.com/3922/14577738497\_b4c1614477\_b.jpg, accessed 12/2/17

In the periphery, location of nerve fibers relative to the organs and structures they innervate, as well as their relation to adjacent anatomical landmarks, takes the highest priority in most procedures. On the front end of many surgical procedures, identification of these nerve structures must be accomplished with certainty.

# SAMPLE QUESTION 2.11: Direct inadvertent stimulation of the Vagus nerve during carotid endarterectomy may have which of the following transient affects:

- Bradycardia
- Tachycardia
- Alkalosis
- Acidosis

SAMPLE QUESTION 2.12: A "foot drop" results from insufficiency of the extensor muscles in the foot, and may be caused by lumbar disc herniation (damage to a nerve root in the lumbar spine), or damage to/compression of the \_\_\_\_\_ nerve as it courses superficial to the fibular head.

- peroneal
- pudendal
- posterior tibial
- sural

#### SAMPLE QUESTION 2.13: The recurrent laryngeal nerve is a branch of the:

- Phrenic Nerve
- Facial Nerve
- Brachial Plexus
- Vagus Nerve

### **E. The Digestive System:**

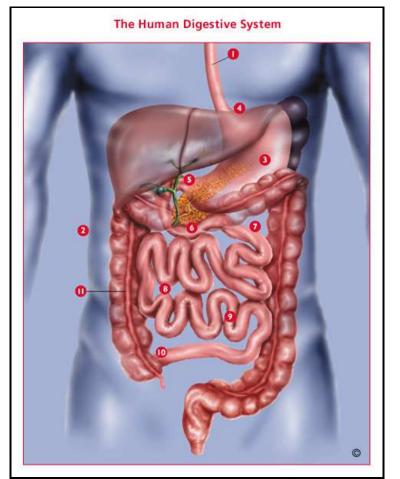


Image source: http://www.genesishealth.com/care-treatment/weight-management/expect/digestive\_diagram/, accessed 12/21/17

Surgery of the digestive system represents a very large segment of general surgical procedures and is thus very important to the surgical assistant. From the esophagus, through the diaphragm, and at numerous points along the alimentary canal, commonly performed surgical procedures address acute and chronic G.I. disease.

With the ever-expanding field of minimally invasive G.I. surgery, surgical assistants must be expert at open procedures, as well as laparoscopic/endoscopic cases. Access to each area of the abdomen, therefore, must be carefully planned and executed.

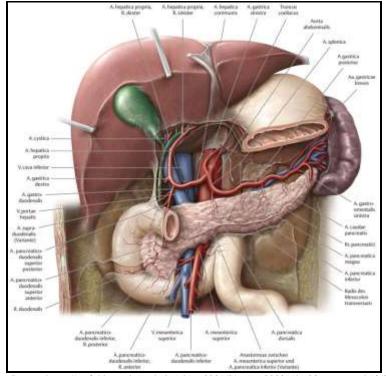
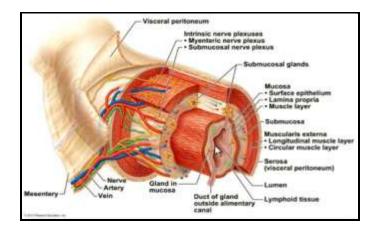


Image Source: https://eref.thieme.de/cockpits/clAna0001/0/coAna00031/4-6286, accessed 12/21/17

An understanding of blood supply, anatomic relationships, along with tissue-handling and anastomosis techniques represent crucial knowledge areas. Identification of G.I. tract pathology, infarction, perforation due to disease are important. Constant proactive prevention of intra-operative injury and post-operative surgical adhesions represent a skillset retained by the competent surgical professional.

An in-depth study of microscopic anatomy and physiology of the digestive system should also be undertaken. This fundamental understanding underpins the necessity for adherence to proper technique. Furthermore, crucial production of digestive enzymes, hormones and chemical messengers are carried out in the pancreas, liver, and cells within the epithelial layers of the G.I tract itself and must be maintained to facilitate normal digestion of nutrients.



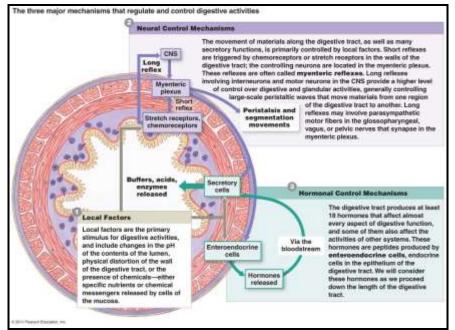


Image source: http://anatomyandphysiologyi.com/digestive-system-histology-alimentary-canal/, accessed 12/21/17 Image Source: http://www2.highlands.edu/academics/divisions/scipe/biology/faculty/harnden/2122/notes/digest.htm, accessed 12/21/17

Perforation of the digestive system carries dire consequences for patients, and presents a surgical emergency.

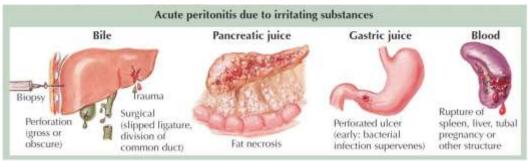


Image source: https://www.learningmedical.co/archives/1403, accessed 12/22/17

# SAMPLE QUESTION 2.14: The anatomic region bordered by the cystic duct, the common hepatic duct, and the cystic artery is referred to as:

- Tetralogy of Fallot
- Calot's triangle
- Circle of Willis
- Anatomical snuffbox

# **SAMPLE QUESTION 2.15:** The inferior mesenteric artery serves as principal blood supply to which of the following structures:

- The Ileocecal Valve
- The Caecum
- The Hepatic Flexure of the colon
- The Splenic Flexure of the colon

**SAMPLE QUESTION 2.16:** The short gastric arteries are direct branches of which of the following:

- Splenic Artery
- Left Gastric Artery
- Right Gastric Artery
- Right Gastroepiploic Artery

### F. The Endocrine System:

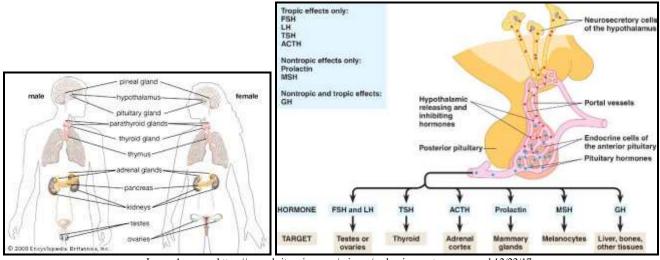


Image 1 source: https://www.britannica.com/science/endocrine-system, accessed 12/22/17 Image2 source: http://bio1152.nicerweb.com/Locked/media/ch45/adenohypophysis.html, accessed 12/22/17

The endocrine system works alongside of the nervous system to form the hormonal control systems of the body. Hormones are distributed by glands through the bloodstream and carry widespread, long-lasting, and powerful effects on cells of organs and tissues throughout the body.

Many hormones produced by the endocrine system are classified as tropic hormones. A tropic hormone, such as those produced by the pituitary gland, such as TSH, ACTH, and FSH, function as triggers for the release of another hormone in another gland,

A large percentage of surgery directly involving the endocrine system include procedures on the thyroid and parathyroid glands, the adrenal glands, the pancreas, the reproductive organs, and the pituitary gland. Careful study of the anatomy, function, control, and hormones produced by these glands must be undertaken.

Surgery on these areas, furthermore, carry significant risk to vital structures adjacent to the glands themselves, thus intraoperative identification of structures is key. Minimally

invasive approaches often improve outcomes, but also add complexity to these procedures.

# SAMPLE QUESTION 2.17: Which of the flowing statements are true regarding total thyroidectomy procedures?

- Potential post-op complications are relatively minor
- The presence of hyperparathyroidism should be carefully monitored postoperatively
- The open approach generally utilizes a low transverse collar incision
- Most complications are immediately apparent through intra-operative diagnostic testing

# SAMPLE QUESTION 2.18: During total nephrectomy and/or adrenalectomy, which of the following poses the greatest intra-operative risk from a systemic perspective, during the manipulation of the adrenal gland?

- Rapidly dropping blood glucose levels.
- Rapidly elevating blood glucose levels.
- Rapid blood pressure change.
- Disseminated intravascular coagulopathy (DIC).

# **SAMPLE QUESTION 2.19: Which of the following are true statements regarding the pancreas?**

- The pancreas is a mixed exocrine and endocrine organ.
- The pancreas lies in direct relation to the portal vasculature, the biliary tree, the vena cava, the celiac ganglia, and the spleen its vasculature.
- Endocrine and exocrine function are distributed throughout the head, neck, body, and tail sections.
- All of the above are true statements.

### G. The Reproductive System:

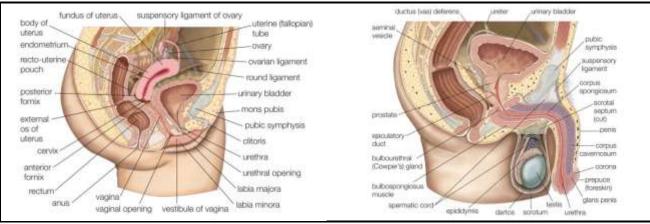


Image source: https://www.thoughtco.com/reproductive-system-373583, accessed 12/22/17

Reproductive surgery represents a very large proportion of surgical procedures performed, and surgical assistants must be thoroughly educated in reproductive anatomy, function, and pathology. By default, gross anatomy of the pelvis becomes critical, including skeletal structures and landmarks, innervation and vascular supply, and the extremely relevant pelvic floor.

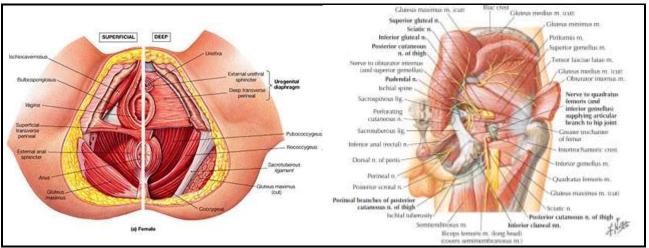


Image Source: https://www.learningmedical.co/medical/anatomy, accessed 12/22/17

Structures and external landmarks of the lower abdominal wall play key roles in the surgical approach to the pelvis. Pelvic systems and structures must be studied by the competent surgical assistant, especially with regard to female reproductive procedures.

SAMPLE QUESTION 2.20: The fold of peritoneum that connects the sides of the uterus to the walls and floor of the pelvis is known as the:

- Pelvic ligament.
- Round ligament.
- Broad ligament.
- Poupart's ligament.

# **SAMPLE QUESTION 2.21: Innervation to the external genitalia are supplied by the:**

- Inferior hypogastric plexus
- Pudendal nerve and its branches
- Pelvic splanchnic nerves
- Inferior gluteal nerve and its branches

# 

### H. The Excretory System:

Image source: http://www.flspinalcord.us/organs-of-excretory-system/excretory-system-organs-med-health-daily-organs-of-excretory-system/#s, accessed 12/22/17

The excretory system performs the function of eliminating wastes produced in maintaining homeostasis. There are organ systems of the body that are involved in this process such as sweat glands, lungs, and the kidneys. The liver plays an important role as well, in detoxifying metabolites for excretion elsewhere.

Sweat glands actively excrete lactic acid, urea, as well as various salts, pulling water from the tissues. This process produces several critical affects. Alveolar structure within

the lungs facilitate carbon dioxide and other toxic gases release from hemoglobin, as well as the uptake of oxygen.

One of the most important functions of the kidney is the filtration and excretion of nitrogenous waste products from the blood. The measurements of elevated blood urea nitrogen (BUN) and creatinine serve as indicators of decreased renal function indicative of the decreased clearance of these waste products.

Through a complex physiologic process, the kidney nephron also maintains blood pH, regulates water content in blood, and therefore further affects systemic blood volume and blood pressure. The urinary system carries the waste products and fluids (urine) from the body.

Thorough knowledge of kidney anatomy, the urinary system, and normal blood chemistry and osmotic forces involved in excretion are necessary for complete understanding of this complex process.

# SAMPLE QUESTION 2.22: The passage of urine from the kidney into the urinary bladder follows which of the following pathways:

- Renal calyx, collecting tubules, renal pelvis, Bowman's capsule, and urethra.
- Collecting ducts, renal pelvis, urethra, Bowman's capsule, and ureters
- o Bowman's capsule, collecting ducts, renal calyx, renal pelvis, and ureter
- Collecting ducts, renal pelvis, renal calyx, Bowman's capsule, and ureter

SAMPLE QUESTION 2.23: Following anesthesia, the speed of emergence is directly related to alveolar ventilation (an excretory function of the lung) and inversely related to blood gas solubility. Which of the following statements is also likely true?

- Hypoventilation lengthens the time taken to exhale the anesthetic agent and delays recovery.
- Hyperventilation lengthens the time taken to exhale the anesthetic agent and delays recovery.
- Hypoventilation shortens the time taken to exhale the anesthetic agent and delays recovery.
- Hypoventilation lengthens the time taken to exhale the anesthetic agent and speeds up recovery.

# SAMPLE QUESTION 2.24: All but which one of the following may cause acute kidney failure:

- Hypovolemia due to hemorrhage
- Obstruction of urinary flow
- Suprarenal cross-clamping of the aorta
- Optimized cardiac output

### I. The Lymphatic System:

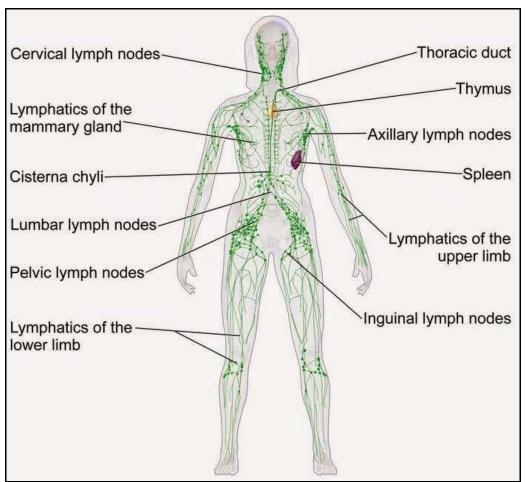


Image Source: http://biologyexplain.blogspot.com/2015/03/human-lymphatic-system.html, accessed 12/22/17

Lymph is the extracellular fluid in which cells bathe. An adult body contains around 10 liters of lymph, consisting of salts, sugars, amino acids, hormones, coenzymes, neurotransmitters, fatty acids and the metabolic waste products. The lymphatic has no central pump nor fixed vascular enclosure, per se. Movement of lymph occur through peristalsis, and muscular action of surrounding tissues.

Blood components do not come in direct contact with the tissue cells, but must exit the blood vessels and pass into the interstitial lymphatic fluid. The lymph then carries out cellular exchanges, and subsequently carry materials which do not re-enter the blood stream through the lymphatic vessels, through plexi and lymph nodes before entering the large lymphatics trunks for ultimate collection and drainage to the subclavian vein. The lymph nodes, spleen, and thymus gland comprise integral parts of this system.

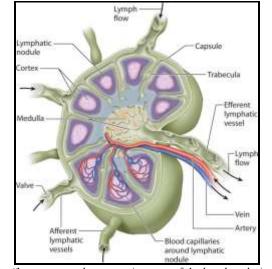


Image source: http://humananatomylesson.com/anatomy-of-the-lymph-nodes/, accessed 12/22/17

- Lymph nodes produce lymphocytes, and screens the lymph and engulfs the harmful pathogens, poisons, and abnormal (cancerous) cells.
- The spleen is a chief site for immune cell formation, acts as a reservoir for blood, and functions in the destruction of old blood (red and white) cells.
- The thymus gland harbors and produces lymphatic cells, thus influences the entire immune system.

SAMPLE QUESTION 2.25: A lymph node dissection near a cancerous tumor may confirms may the presence of cancer cells. Removal of the entire downstream chain of lymph nodes may be performed to eliminate further lymphatic spread. Which of the following statement most accurately describes a "Sentinel" lymph node biopsy?

- Removal and biopsy of successive lymph nodes starting at the known tumor site along the lymphatic pathway until all nodes in a region are resected.
- Needle biopsy of all regional nodes and removal of only the "affected" ones.
- Biopsy and removal of the single most affected node.
- Removal and biopsy of successive lymph nodes starting at the known tumor site along the lymphatic pathway until a "negative" node is discovered.

#### Consider consulting the following sources for in depth study.

- <u>Atlas of Human Anatomy</u>, Frank H. Netter, MD, 6<sup>th</sup> Edition, Elsevier North Holland, Inc., New York, NY.
- <u>Gray's Anatomy, The Anatomical Basis of Clinical Practice</u>, 41st Edition, Susan Standring, Elsevier North Holland, Inc., New York, NY.

- <u>Human Anatomy</u>, R.M.H McMinn, R.T. Hutchings, second edition, Year Book Medical Publishers, Chicago, IL, 1988.
- <u>Human Anatomy, A Synoptic Approach</u>, Nicholas James Mizeres, Elsevier North Holland, Inc., New York, NY, 1981.
- <u>Essentials of Surgery</u>, James M Becker, MD, and Arthur F. Stucchi, PhD, Saunders, Philadelphia, PA, 2006.
- <u>Textbook of Medical Physiology</u>, 8<sup>th</sup> Edition, Arthur C Guyton, M.D., W.B Saunders Company, Philadelphia, PA. 1991.
- https://study.com/academy/lesson/antagonist-muscle-definition-examples.html
- http://nerve.wustl.edu/nd\_transfers\_foot.php

## PART III: SURGICAL ANATOMY

Anatomy represents one of the most important components of this examination, as a solid command of this subject differentiates an exceptional assistant from a good one.

Surgical anatomy is "applied" anatomy in surgery. Identifying the anatomical structures in the surgical field is critical, and not the same as memorizing points on a Netter's diagram.

Mastery of surgical anatomy requires being fully cognizant of the anatomical structures "next to", "adjacent to", and especially "deep" to, the immediate operative site. It is this awareness which prevents collateral damage to hidden structures. Unseen structures must never be out of mind.

Understanding anatomic "relations" is key to individuals providing exposure for their surgeons.

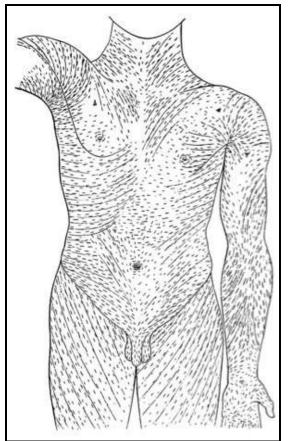
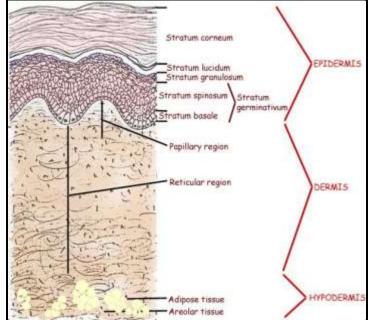


Image Source: https://www.medicalexamprep.co.uk/langers-lines-surgical-incisions/, accessed 12/24/17

### A.The Skin:

The simplest rule for making incisions in the most favorable direction is to follow natural folding lines: "Proper incisions come together naturally, and improper ones tend to gape." - Gottfried Lemperle, M.D., PhD

Anatomical landmarks on the skin are routinely used by physicians and surgeons to diagnose and treat patients. Palpation of underlying structures enable surgeons to effectively plan incision sites. Surgical assistants must become familiar with these landmarks, especially as they relate to incision sites, patient positioning and padding, graft harvest, and grounding pad placement in conjunction with the use of electrocautery.



A study of Langer's Lines should be helpful also, as a background for understanding.

Image Source: https://lionden.com/ap1out-skin.htm, accessed 12/23/17

The skin layers should be understood, with a working knowledge on its neurovascular supply, and relative thickness in different parts of the body. Skin must be properly protected during procedures, and anatomically re-approximated at closure.

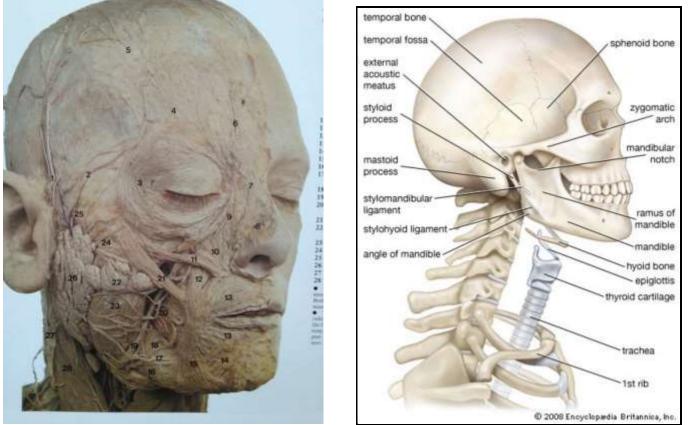


Image Source: http://anatomybody101.com/human-anatomy-muscles-face-2/human-anatomy-muscles-face-6f4027703fd8fed6ec570912d0505945/ accessed 12/23/17 Image 2 Source: http://humananatomylibrary.com/anatomy-of-the-neck-bones/, accessed 12/23/17

### **B.Head and Neck:**

Head and neck surgical anatomy presents a significant challenge to prospective students. Knowledge of the cranial nerves, their locations, and the structures they innervate are extremely important. The more common surgical sites to know surgical anatomy for include the eyes, the face, the neck, and the anterior and posterior spine.

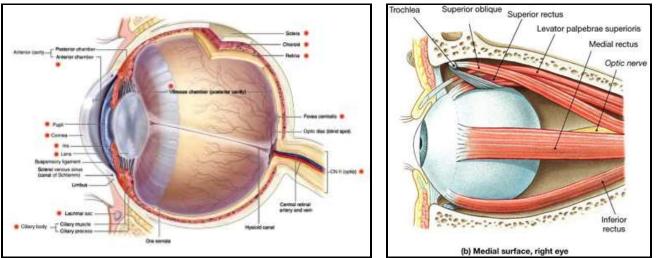


Image Source 1: http://cheap-auto-insurance-in-florida.com/science-anatomy-of-the-human-eye/anatomy-of-the-human-eye/biology-forums-diagrammatic-viewvitreous-humor-is-illustrated-only-in-bottom-part-eyeball-anterior-segment/, accessed 12/23/17 Image Source 2: http://www.thecityedition.com/Pages/Archive/Winter08/RestoringVision.html, accessed 12/23/17.

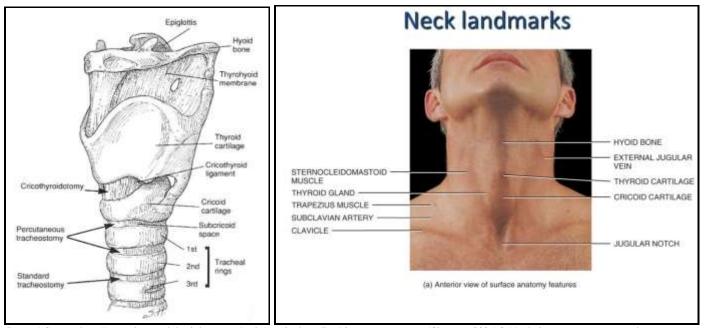


Image 1 Source: http://www.derangedphysiology.com/main/required-reading/airway-management/Chapter%202.1.3.1/technique-percutaneous-tracheostomy, accessed 12/23/17. Image 2 Source: http://slideplayer.com/slide/10011230/, accessed 12/23/17.

The surface anatomy of the neck should be known, and the anatomical triangles of the neck offer excellent focal points for detailed study. The carotid arteries, the thyroid and parathyroid glands, parotid glands, anterior trachea, lymphatic pathways, and myriad other neurovascular structures in this region should be studied in detail.

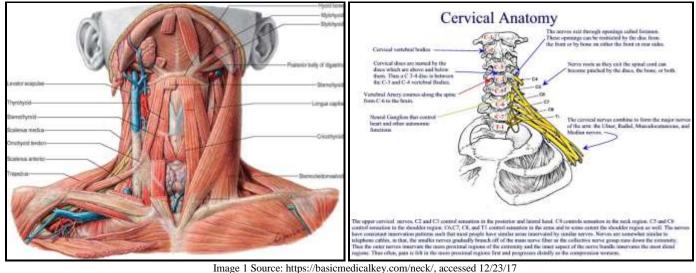


Image 2 Source: http://emeraldcoastpain.com/answers-to-your-pain-questions/cervical-spine-anatomy, accessed 12/23/17.

#### SAMPLE QUESTION 3.1: Which of the following is cranial nerve #10:

- Hypoglossal nerve.
- Vagus nerve.
- Acoustic nerve.
- o Facial nerve.

SAMPLE QUESTION 3.2: Which anatomical triangle has the following boundaries: Superior: Posterior belly of the digastric muscle. Lateral: Medial border of the sternocleidomastoid muscle. Inferior: Superior belly of the omohyoid muscle.

- The carotid triangle
- The suboccipital triangle
- The anterior triangle
- The submental triangle

#### SAMPLE QUESTION 3.3: The external carotid artery may be identified by the:

- Absence of branches in the neck, inferior to the common carotid bifurcation
- $\circ$  Presence of branches in the neck, inferior to the common carotid bifurcation
- $\circ$   $\,$  Presence of branches in the neck, superior to the common carotid bifurcation
- $\circ~$  Absence of branches in the neck, superior to the common carotid bifurcation

# **SAMPLE QUESTION 3.4:** Primary superficial sensation to the cheek and nose derives from:

- Mandibular branch of CN V (Trigeminal)
- Maxillary branch of CN V (Trigeminal)
- Ophthalmic branch of CN V (Trigeminal)
- Geniculate branch of CN VII (Facial)

### **C.The Thorax:**

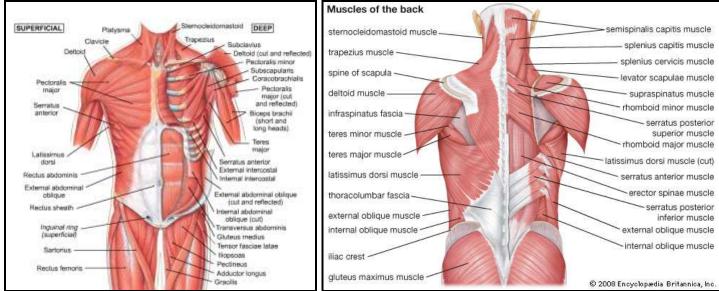


Image Source : http://www.uocodac.com/diagram-of-upper-body/, accessed 12/23/17

The thoracic cavity is well-suited for the protection of the heart and lungs. Bony and muscular anatomy bears this out. Access to the chest cavity, pleural cavity, pericardium, mediastinum, and to the thoracic spine require precise structure identification.

All structures within are vital to life, and crucial for the assistant to commit to memory. Endoscopic approaches and especially robotic procedures have raised the anatomical bar, and require in depth anatomical knowledge for identification of structures on a minute scale.

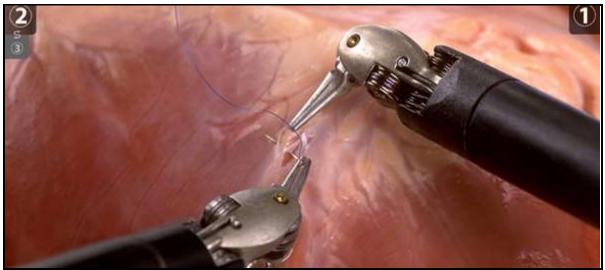
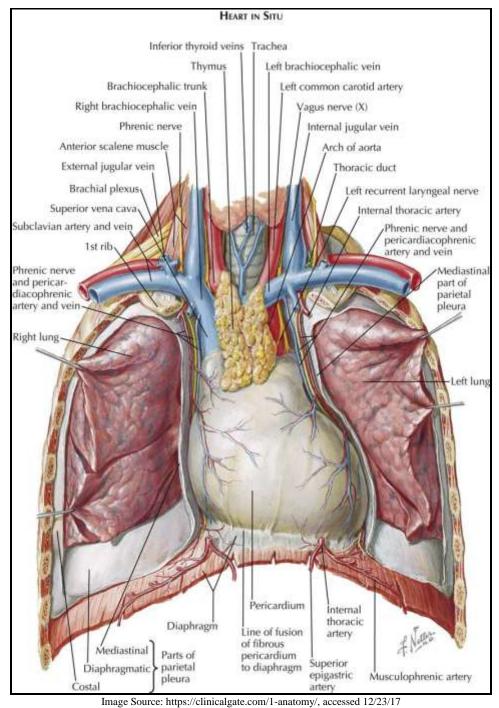


Image source: https://medstaff.hoag.org/in-the-know/Pages/Home.aspx?Edition=Nov+2012, accessed 12/29/17





Open heart surgical procedures have steadily increased in numbers, and have become important professional avenues for the surgical assistant. Complete command of cardiac anatomy is only part of what is necessary. Assisting in bypass procedures requires a more extensive familiarity with structures in the thoracic cavity.

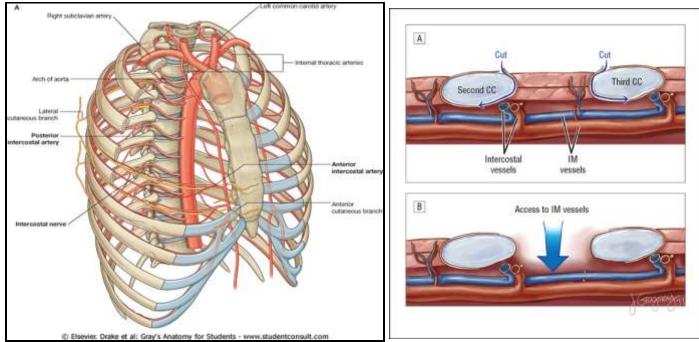
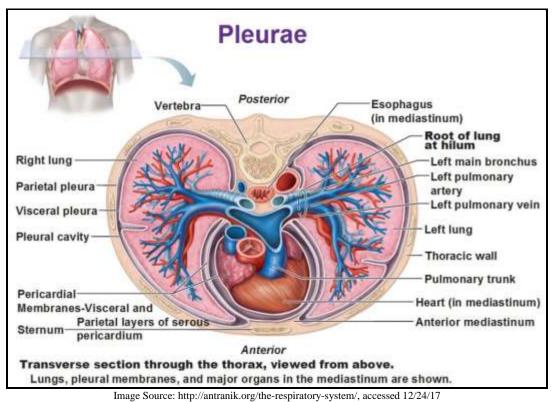


Image 1 source: https://www.tapasrc.com/bypass-surgery?lightbox=i0hs3, accessed 12/24/17 Image 2 source: https://jamanetwork.com/journals/jamaotolaryngology/fullarticle/1699769, accessed 12/24/17



b. The Lungs:

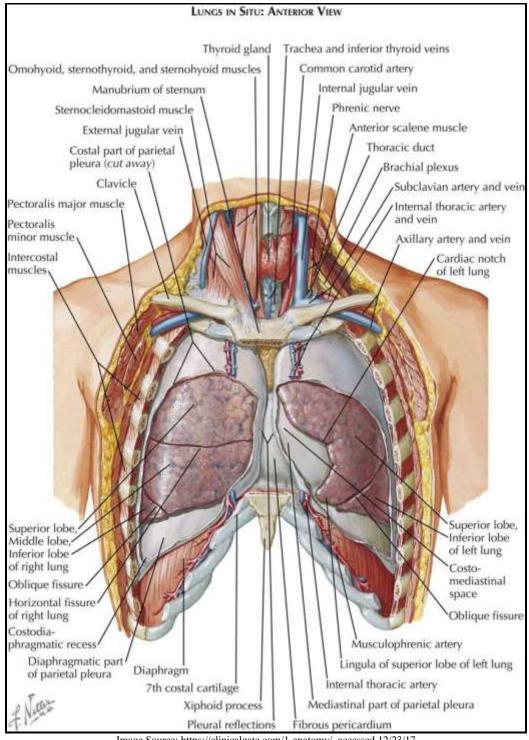


Image Source: https://clinicalgate.com/1-anatomy/, accessed 12/23/17

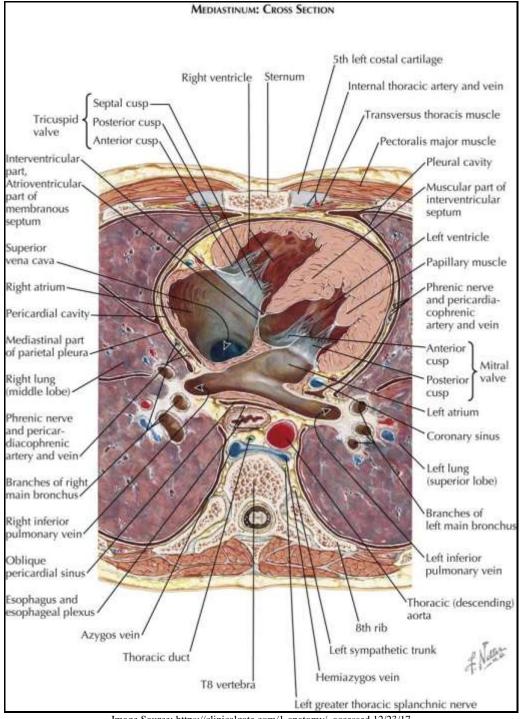


Image Source: https://clinicalgate.com/1-anatomy/, accessed 12/23/17

#### c. The Mediastinum:

The mediastinum lies within the thorax and is enclosed laterally by pleurae. It is bordered by the chest wall anteriorly, the lungs laterally, the spine posteriorly, and contains all the organs of the thorax except the lungs. It is continuous superiorly with the loose connective tissue of the neck, and extends inferiorly to the thoracic surface of the diaphragm.

# **SAMPLE QUESTION 3.5:** Contents of the thoracic outlet, which may be affected by thoracic outlet syndrome, include which of the following lists of structures?

- Brachial artery and vein, and brachial plexus.
- Subclavian vein and artery, and brachial plexus.
- Thoracic duct, brachial plexus, and superior vena cava.
- Ascending aorta, brachial plexus, and thoracic duct.

#### **SAMPLE QUESTION 3.6:** The tricuspid valve of the heart lies between the:

- Left atrium and left ventricle
- Left ventricle and the aorta
- The right ventricle and the pulmonary artery
- The right atrium and the right ventricle

## **SAMPLE QUESTION 3.7: Internal mammary arteries are direct branches of which of the following?**

- o Common Carotid artery/s
- o Aorta
- Thyrocervical trunk
- o Subclavian artery/s

#### **D.The Abdominal Wall:**

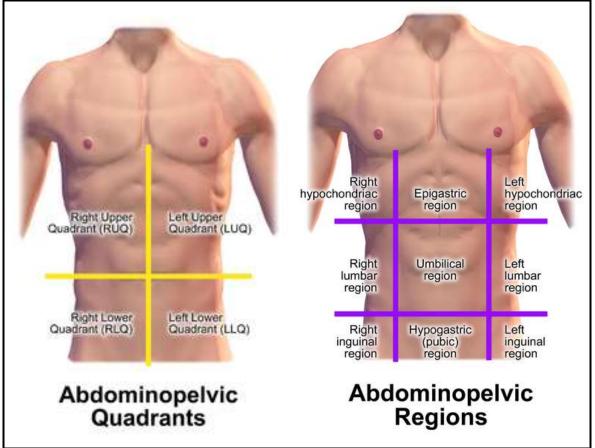


Image Source: https://commons.wikimedia.org/wiki/File:Blausen\_0006\_AbdominopelvicRegions.png, accessed 12/24/17 The abdominal cavity is contained superiorly by the diaphragm, anteriorly by the abdominal wall, and inferiorly by the pelvic floor. Anatomical features of these boundaries should be known. The pelvic floor structure is very complex, and varies between male and female.

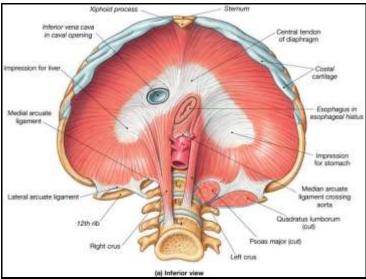


Image source: http://paydayloans-mo.com/anatomy-of-the-diaphragm/thoracic-cavity-simply-simple-anatomy-of-the-diaphragm/, accessed 12/24/17

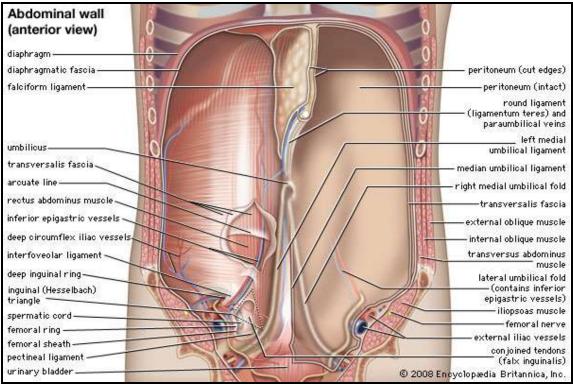


Image Source: https://www.britannica.com/science/abdominal-cavity, accessed 12/24/17

Reproductive, urological, and hernia procedures require thorough knowledge here, and represent "standard fare" for many practicing surgical assistants. An assistant should recognize the varied abdominal surgical incisions used in different surgical scenarios. Ideally an incision should provide easy access to the desired structures, heal quickly, and minimize scarring. Abdominal musculature should not be transected, but split, if possible and the incision should be amenable to extension if required. A complete understanding of the abdominal wall facilitates the required planning to achieve optimal results.

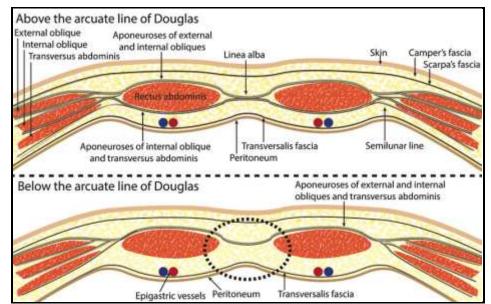
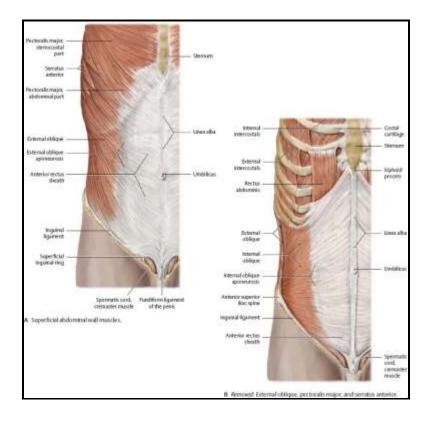


Image Source: https://www.researchgate.net/figure/Drawings-show-axial-views-of-the-anatomy-of-the-anterior-abdominal-wall-with-special\_318356173, accessed 12/24/17.



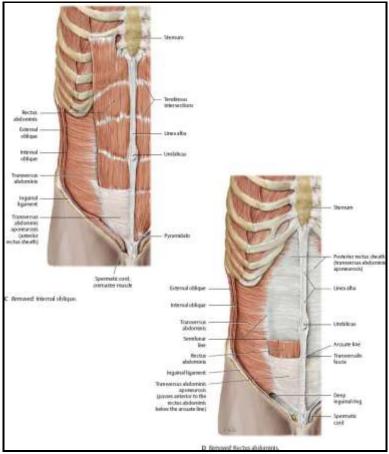


Image source https://doctorlib.info/medical/anatomy/13.html, accessed 12/24/17

**SAMPLE QUESTION 3.8:** In the diagram below, which of the noted incisions would avoid contact with the posterior rectus sheath?

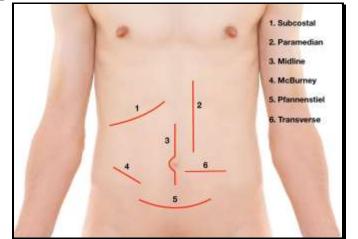


Image Source: https://www.medicalexamprep.co.uk/langers-lines-surgical-incisions/, accessed 12/24/17.

SAMPLE QUESTION 3.9: In the diagram in question 3.8 above, which of the noted incisions would allow a single-layer fascial closure?

**SAMPLE QUESTION 3.10:** In the diagram above, which of the noted incisions is designed for anterior access to the spleen, and avoids the cutaneous nerves and innervation to the rectus muscle?

### **E.The Abdominal Cavity:**

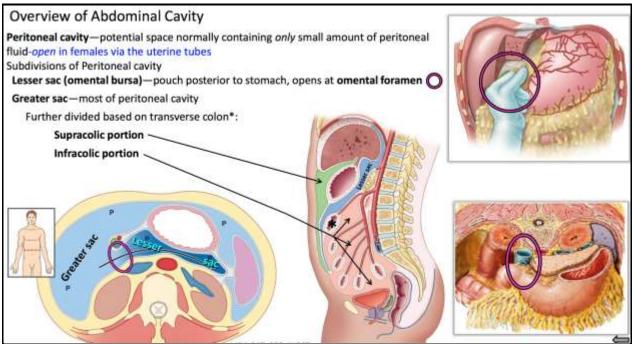


Image Source: https://www.memorangapp.com/flashcards/68281/GSAnatomy+G28b+Orientation+to+Abdominal+Cavity/, accessed 12/24/17

To say that the abdomen contains vital structures would be an understatement. An assistant must know this material. Anatomic relationships are rarely more crucial.

Much of the digestive tract, and reproductive tract (in women) occupy the peritoneal space, and therefore warrant careful consideration here. In the retroperitoneal space, dwells the great vessels and lymphatic chain, and urinary system.

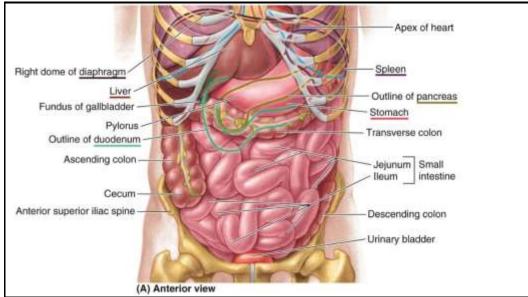


Image Source: https://humananatomyly.com/human-stomach-3d-structure/human-stomach-3d-structure-lovely-stomach-human-anatomy-36-about-remodel-anatomyhuman-body/, accessed 12/24/17

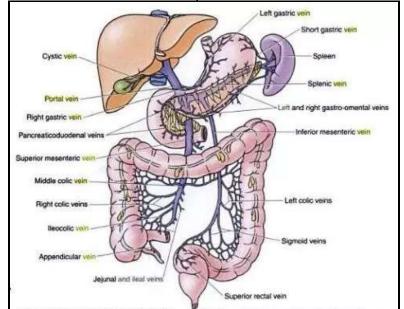


Image source: organs-the-histology-of-the-suprarenal-gland-development-of-the-2-external-features-of-the-fe/<u>https://anatomytopics.wordpress.com/2008/12/27/27-the-portal-vein-the-portal-systemic-anastomoses-the-lymphatic-dranaige-of-the-abdominal-and-pelvic-, accessed 12/24/17.</u>

Most every structure within the abdominal cavity is important with respect to surgical anatomy. The anatomical relations of the pancreas, in general terms, defines the abdomen. A surgical assistant must understand the visceral arterial supply, the portal circulation, the biliary tree, the contents of the greater and lesser sac, as well as the genitourinary system in the pelvis.

The peritoneal cavity takes on even greater complexity when you consider what is NOT within the peritoneal cavity, but remains in the abdominal cavity. And this distinction takes on additional importance in the female pelvis.

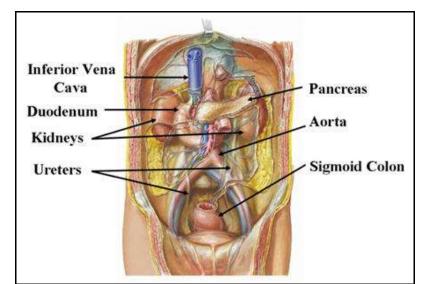


Image Source: http://www.edoctoronline.com/medical-atlas.asp?c=4&id=22017&m=4&p=260&cid=1064&s=, accessed 12/24/17

The retroperitoneal space is extremely relevant to surgery, as more minimally invasive approaches are devised to access the abdominal structures from outside of the peritoneum.

# **SAMPLE QUESTION 3.11:** Which of the following structures are considered entirely within the peritoneal cavity?

- o Kidneys
- Urinary bladder
- Transverse colon
- $\circ$  Pancreas

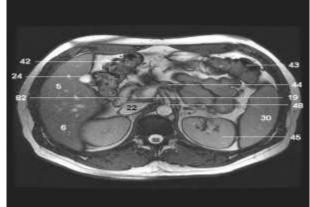
### **SAMPLE QUESTION 3.12:** The superior mesenteric artery and inferior mesenteric artery anastomose through which of the following vessels?

- o Azygos artery
- Marginal artery
- o Hemiazygos artery
- Peripheral communicating artery

#### SAMPLE QUESTION 3.13: The cystic artery arises from which of the following vessels?

- Common hepatic artery
- o Gastroduodenal artery
- Right hepatic artery
- Right gastric artery

## SAMPLE QUESTION 3.14: The Abdomen Axial MRI image below, which number identifies the left kidney?



- o 82
- o 45
- o 22
- o 30

# **SAMPLE QUESTION 3.15:** Which portion of the liver would you expect to find medial and slightly superior to the gall bladder?

- o Right Lobe
- Left Lobe
- Caudate Lobe
- Quadrate Lobe

#### F. The Abdominal Pelvis

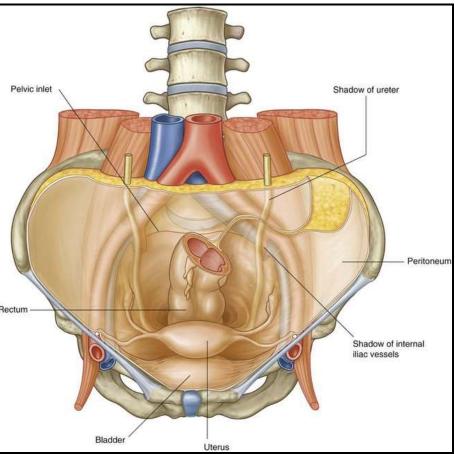
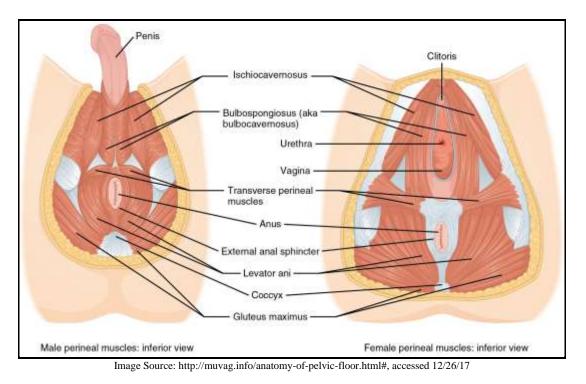


Image source: https://basicmedicalkey.com/abdomen/, accessed 12/26/17

The inferior most elements of the abdominal cavity are contained within the pelvis. Many of the structures are covered by peritoneum, but are accessible through open abdominal procedures, transvaginal access, laparoscopy, and robotic assisted procedures. Patient positioning and incision site placement dictate visualization and identification of vital structures.

Preperitoneal and retroperitoneal spaces may be also accessed through the abdominal wall.

#### G. The Pelvic Floor



The muscular and ligamentous tissues are the floor of the abdomen become essential especially lower GI, reproductive procedures, and oncological procedures. Robotic-assisted pelvic dissections bring new levels of detail into view, enabling much better resolution of crucial pelvic innervation identification and preservation.

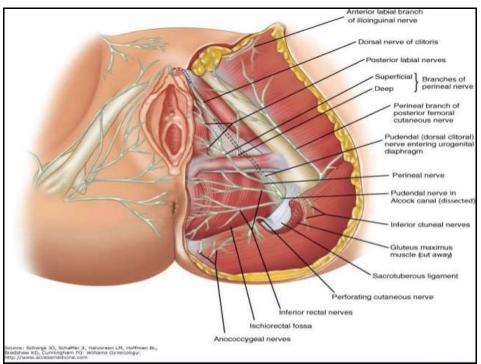


Image Source: https://www.slideshare.net/drsowjanyakurakula/pelvic-floor, accessed 12/26/17

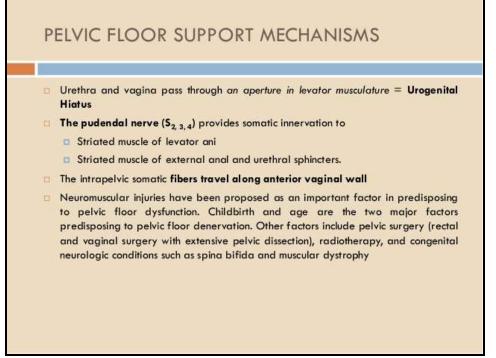


Image Source: Image Source: https://www.slideshare.net/drprashantbansal/evaluation-of-patients-with, accessed 12/26/17, accessed 12/26/17

# SAMPLE QUESTION 3.16: Damage to which of the following nerves during pelvic node dissection may lead to problems with micturition and/or bladder control in the patient:

- $\circ$  The pelvic nerve
- The hypogastric nerve
- The pudendal nerve
- $\circ$  Any of the above

#### SAMPLE QUESTION 3.17: The inferior epigastric artery courses:

- Within the internal inguinal ring
- Medial to the internal inguinal ring
- Lateral to the internal inguinal ring
- Within the external inguinal ring

### **SAMPLE QUESTION 3.18:** The pneumonic "NAVY" is used to identify neurovascular structures in the:

- Carotid triangle
- Posterior triangle of the neck
- Lumbar triangle
- Femoral triangle

#### H. The Spine

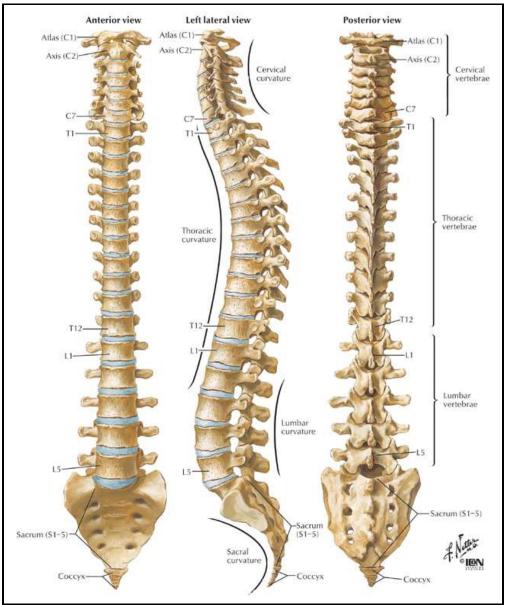


Image Source: http://www.backpain-guide.com/Chapter\_Fig\_folders/Ch05\_Anatomy\_Folder/4OverallSpine.html, accessed 12/26/17

The surgical bony anatomy of the spine becomes important for the assistant during spine and trauma cases. The neuroanatomy, however, distribution of spinal nerves remains critical in every procedure to some degree. A thorough knowledge or peripheral nerve anatomy from the dermatomes to the autonomic nerves and spinal reflex pathways are a requirement for the competent assistant.

Innervations originating from the cervical plexus and brachial plexus to the sacral plexus control key body functions, and require diligence by the surgical team for their correct identification and preservation during surgical procedures.

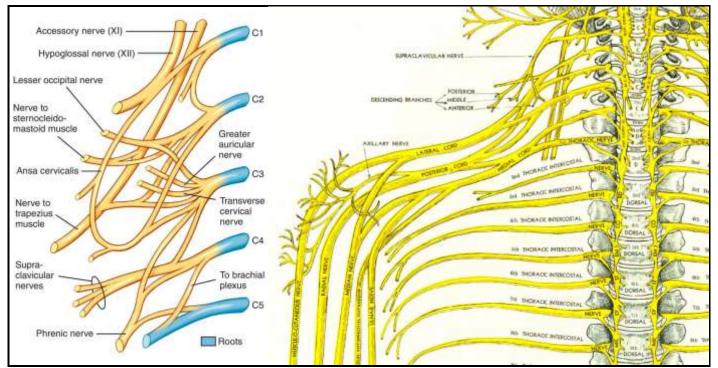


Image source: http://medical-dictionary.thefreedictionary.com/\_/viewer.aspx?path=MosbyMD&name=cervical-plexus.jpg&url=http%3A%2F%2Fmedical-dictionary.thefreedictionary.com%2Fcervical%2Bplexus, accessed 12/26/17

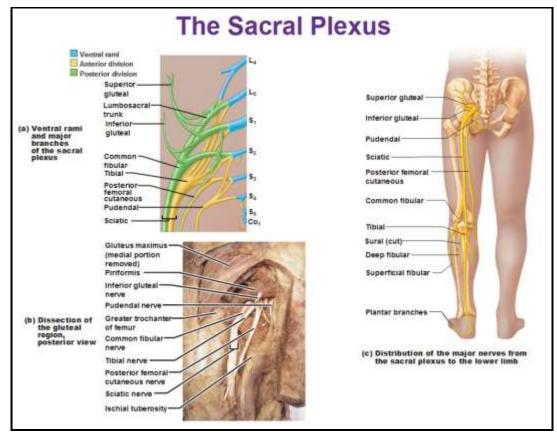
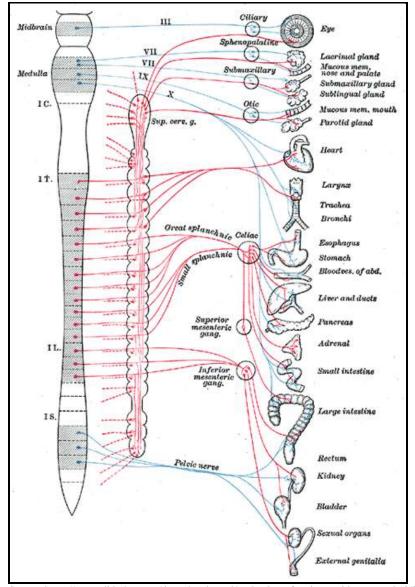
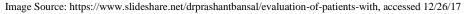


Image source: http://anatomyid.com/lower-extremity-innervation-chart/lower-extremity-innervation-chart-peripheral-nervous-system-spinal-nerves-and-plexuses/, accessed 12/26/17.



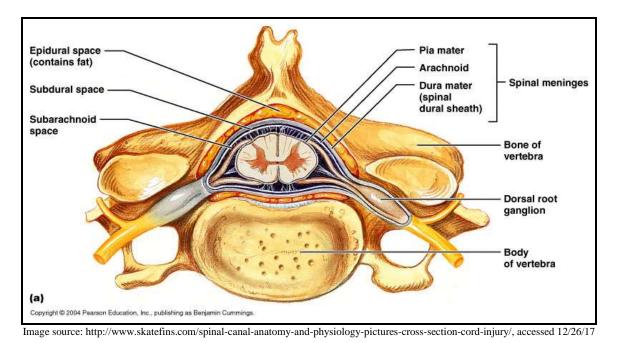


#### I. The Autonomic Nerves

The autonomic nervous system is made up of the sympathetic and parasympathetic systems, and act as "automatic" response and control to the internal organs, including the blood vessels, stomach, intestine, liver, kidneys, bladder, genitals, lungs, pupils, heart, and sweat, salivary, and digestive glands. We do not think of the autonomic nerves, but we must identify and protect them as they receive information about the body and external environment, and respond by stimulating body processes, usually through the sympathetic division, or inhibiting them, usually through the parasympathetic division.

Most of the ganglia for the sympathetic division are located just outside the spinal cord on both sides of it. The ganglia for the parasympathetic division are located near or in the organs they connect with. Overall, the two divisions work together to ensure that the body responds appropriately to different situations.

#### J. The Spinal Canal:



Especially in spine surgery, such detail may prove helpful to the assistant for the purpose of developing meticulous technique for the protection of adjacent structures during routine procedures.

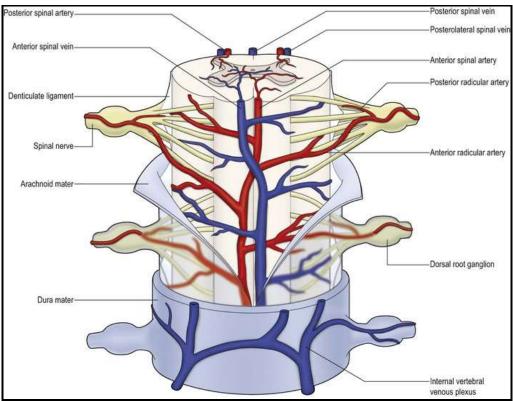


Image Source: https://neupsykey.com/vasculature-of-the-central-nervous-system/, accessed 12/23/17

## **SAMPLE QUESTION 3.19:** The lumbosacral trunk joins with the sacral plexus to form the largest nerve in the body known as the:

- Trigeminal nerve
- Femoral nerve
- Brachial plexus
- Sciatic nerve

# **SAMPLE QUESTION 3.20:** Thickening of the ligamentum flavum may provide the cause of which one of the following pathologic conditions:

- Pyloric stenosis
- Lateral recess stenosis
- Foraminal stenosis
- Central spinal stenosis

## **SAMPLE QUESTION 3.21:** Which of the following structures is innervated by a branch/branches of the cervical plexus?

- o Trapezius muscle
- Omohyoid muscle
- Coracobrachialis muscle
- Pectoralis minor muscle

#### K. The Upper Extremity

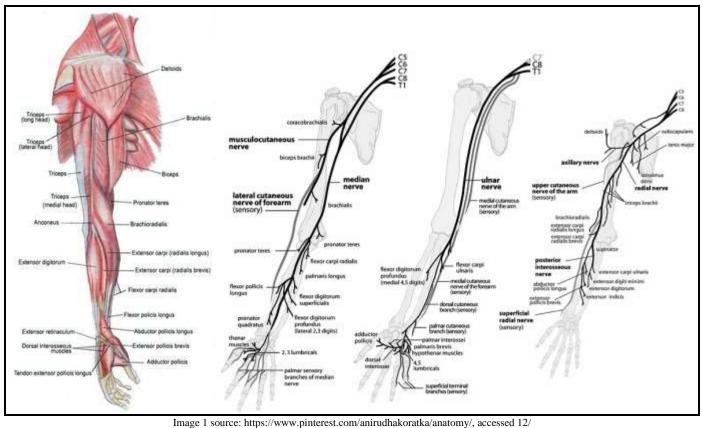


Image 2 source: https://www.orthopaedicsone.com/display/Clerkship/Peripheral+Nerves+of+the+Upper+Extremity, accessed 12/26/17

Skeletal, muscular, vascular, and neuroanatomy of the upper extremity should be studied. In addition, structures of the shoulder joint, the elbow joint, and wrist joint encountered during common upper extremity joint surgery should be committed to memory. Innervation to the upper extremity muscles plays a major role in traumatology, limb salvage, and quality of life.

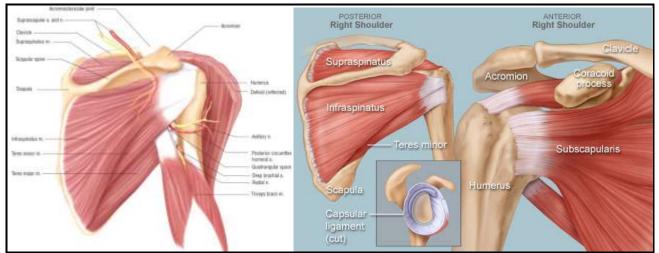


Image 1 Source: http://academicdepartments.musc.edu/radiology/divisions/interventional/atlas/upperextremity.html, accessed 12/26/17.

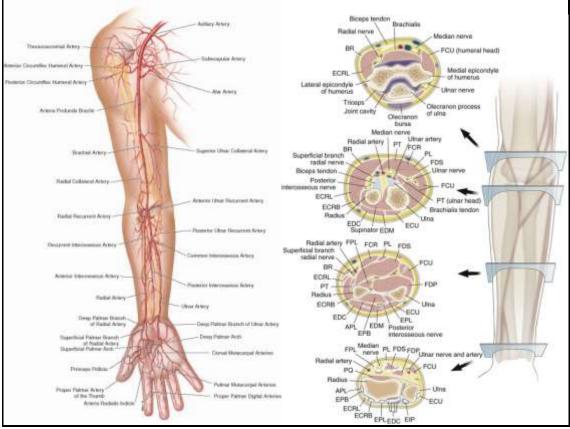


Image 2 source: https://clinicalgate.com/elbow-and-forearm/, accessed 12/27/17.

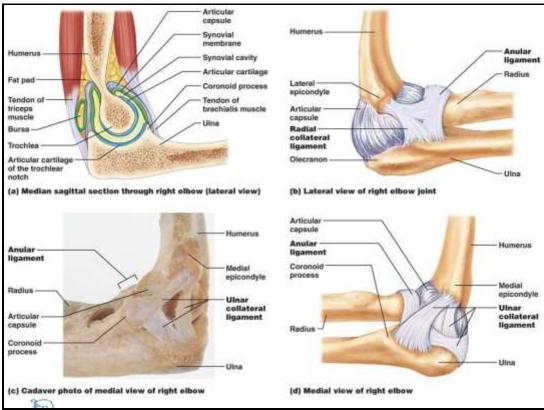


Image source: http://howtorelief.com/elbow-joint/, accessed 12/26/17.

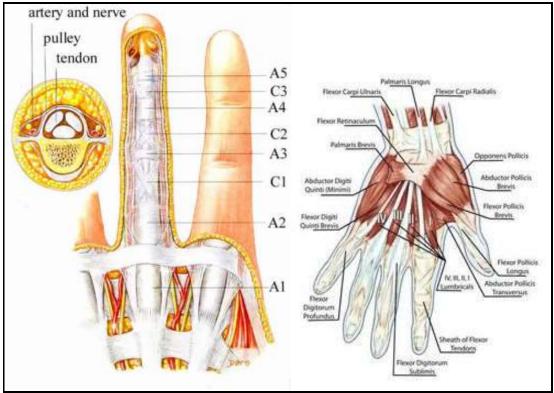


Image 1 source: http://www.davidlnelson.md/articles/Tendon\_laceration.htm, accessed 12/26/17. Image source: https://www.pinterest.com/anirudhakoratka/anatomy/, accessed 12/26/17

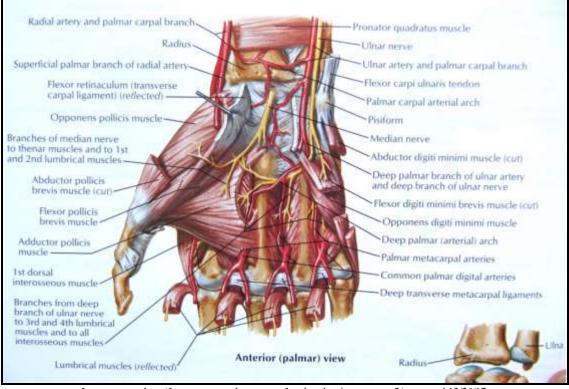


Image source: http://humananatomylesson.com/hand-and-wrist-anatomy-2/, accessed 12/26/17.

# **SAMPLE QUESTION 3.22: Danger to which of the following nerves must be considered during carpal tunnel decompression:**

- Brachial plexus
- Median nerve
- Musculocutaneous nerve
- Thoracodorsal nerve

SAMPLE QUESTION 3.23: Fasciotomy of which compartments in the forearm, will relieve compression on the median and ulnar nerves, and the radial and ulnar arteries?

- Deep and superficial volar
- Dorsal and mobile wad
- Mobile wad and anterior
- Dorsal and posterior

# **SAMPLE QUESTION 3.24:** Which of the listed muscles originates at the supraglenoid tubercle in the shoulder?

- Long head of the biceps
- Short head of the biceps
- Coracobrachialis
- Supraspinatus

# SAMPLE QUESTION 3.25: Which of the following ligaments is used as an important landmark in shoulder arthroscopy:

- o Ulnar collateral ligament
- Coracoacromial ligament
- Radial collateral ligament
- o Volar ligament

#### L. The Lower Extremity

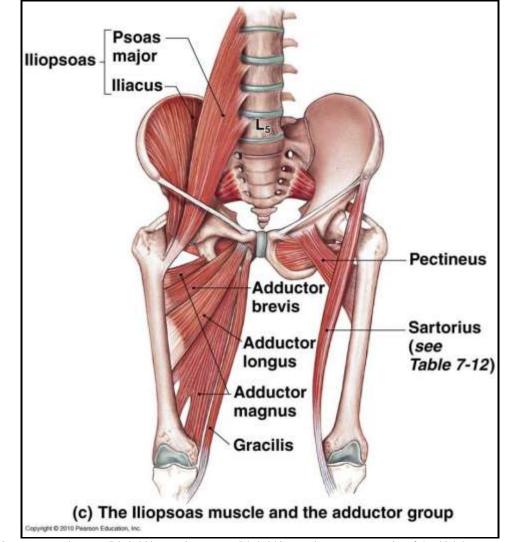
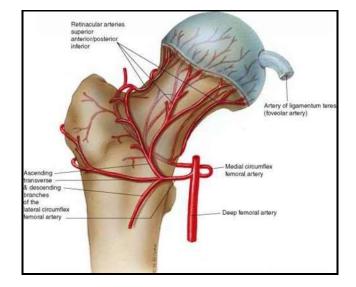
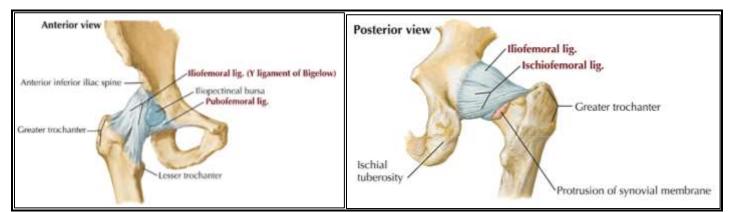


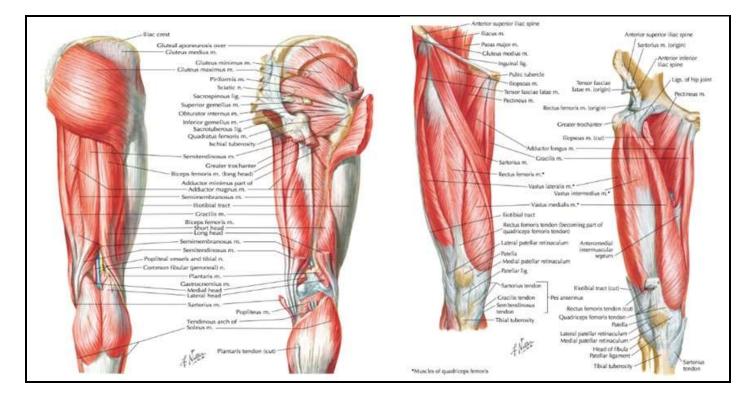
Image source: https://humananatomylesson.co/labeled-hip-muscles-anatomy/labeled-hip-muscles-anatomy-muscles-of-the-thigh-human-anatomy-system/, accessed 12/26/17.

Skeletal, muscular, vascular, and neuroanatomy of the lower extremity should be studied. In addition, structures of the pelvic girdle, hip joint, the knee joint, and ankle joint encountered during common lower extremity surgery should be committed to memory.

Vascular bypass procedures in the lower extremity and throughout the body, require special knowledge of vascular pathways in the leg.







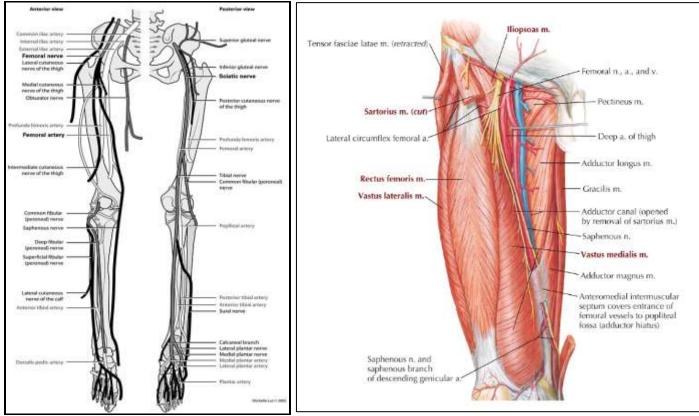


Image Source: https://www.orthopaedicsone.com/display/Clerkship/Peripheral+Nerves+and+Arteries+of+the+Lower+Extremity, accessed 12/26/17.

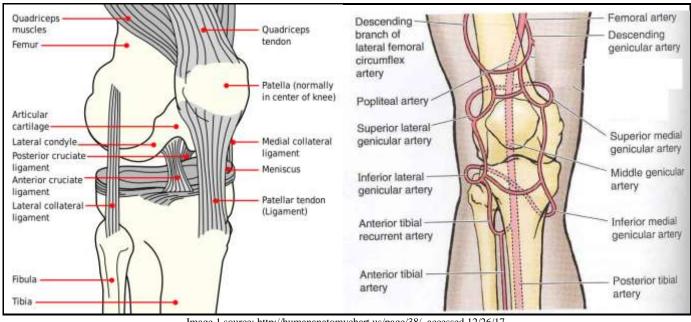
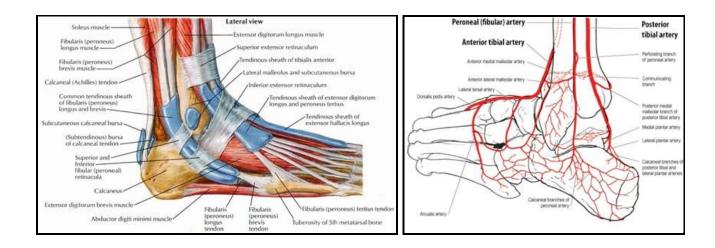


Image 1 source: http://humananatomychart.us/page/38/, accessed 12/26/17.

Image 2 source: https://academic.amc.edu/martino/grossanatomy/site/Medical/CASES/Lower%20limb/POP\_UPS/popliteal%20anspop\_up5.htm, accessed 12/26/17.



SAMPLE QUESTION 3.26: Which of the following are branches of the sciatic nerve which ultimately supply innervation to the distal lower extremity (foot) flexors?

- Tibial nerve
- Pudendal nerve
- Peroneal nerve
- o Fibular nerve

SAMPLE QUESTION 3.27: Difficult access to this artery for control of blood loss make posterior cruciate ligament surgery potentially more perilous:

- Posterior tibial artery
- Femoral artery
- Anterior tibial artery
- Popliteal artery

## SAMPLE QUESTION 3.28: What is the surgical significance of the adductor hiatus in the thigh?

- Its opening marks the location for the distal anastomosis during in femoral-popliteal bypass.
- It is the location of the hamstring aponeurosis.
- It marks the divergence of the peroneal nerve.
- It marks the location of the last adductor muscle insertion on the tibia.

#### SAMPLE QUESTION 3.29: Where would you locate the posterior tibial pulse?

- Posterior to the lateral epicondyle
- o Posterior to the lateral malleolus
- Posterior to the medial epicondyle
- Posterior to the medial malleolus

#### Consider consulting the following sources for in depth study.

- <u>Atlas of Human Anatomy</u>, Frank H. Netter, MD, 6<sup>th</sup> Edition, Elsevier North Holland, Inc., New York, NY.
- <u>Gray's Anatomy, The Anatomical Basis of Clinical Practice</u>, 41st Edition, Susan Standring, Elsevier North Holland, Inc., New York, NY.
- <u>Human Anatomy</u>, R.M.H McMinn, R.T. Hutchings, second edition, Year Book Medical Publishers, Chicago, IL, 1988.
- <u>Human Anatomy, A Synoptic Approach</u>, Nicholas James Mizeres, Elsevier North Holland, Inc., New York, NY, 1981.
- <u>Essentials of Surgery</u>, James M Becker, MD, and Arthur F. Stucchi, PhD, Saunders, Philadelphia, PA, 2006.
- <u>Textbook of Medical Physiology</u>, 8<sup>th</sup> Edition, Arthur C Guyton, M.D., W.B Saunders Company, Philadelphia, PA. 1991.
- http://slideplayer.com/slide/10011230/

### **PART IV: SURGICAL PROCEDURES**

#### A. Cardio-Thoracic and Vascular Surgery

- a. Carotid Endarterectomy
- b. Coronary Artery Bypass

#### **B.** General Surgery:

- a. Appendectomy
- b. Cholecystectomy
- c. Inguinal Herniorrhaphy
- d. Mastectomy
- e. Partial Colectomy

#### C. Neurosurgery/Orthopedic Surgery:

a. Lumbar Laminectomy/Discectomy

#### **D. Orthopedic Surgery:**

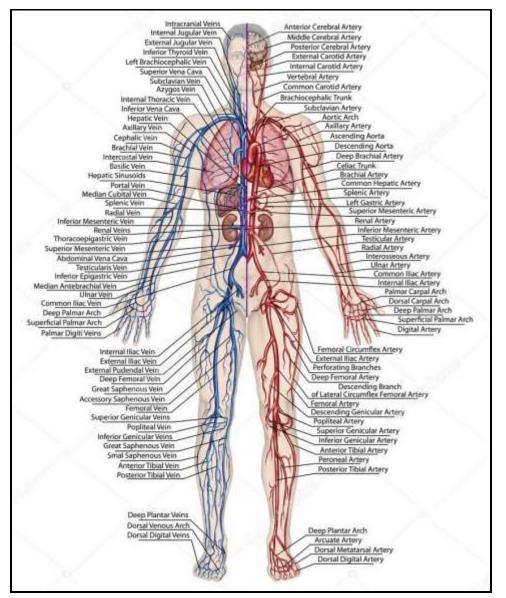
- a. \*ORIF Skeletal Fracture
- b. Total Joint Arthroplasty

Any surgical assistant challenging this examination must undertake independent study of surgical anatomy, and the ordered steps of commonly performed surgical procedures, as well as the specific skillset required to assist in the procedure.

In this section of the study guide, we will provide only a simplified overview of several most-commonly performed surgical procedures in the US, as reported in a recent study by the University of Rochester. We have removed some procedures from the published list which do not require an assistant to perform them. And we have removed two which may not be crucial for the entry-level assistant. We have added two procedures\* we find sufficiently relevant for discussion here.

It is not the goal of this study guide to review each procedural step, and discuss in detail the surgical anatomy, or indorse any particular approach. The goal is to support general understanding, and stimulate further study in these areas. When possible, questions have been written with overarching principles in mind, for application in many surgical situations.

Each procedure has been organized by surgical subspecialty, and listed in alphabetical order.



### A.Cardio-Thoracic/Vascular Surgery

Image Source: http://muvag.info/venous-system-anatomy.html, accessed 12/28/17.

Atherosclerosis is a disease process which involves both large and small arteries, and tends to occur at certain locations including the coronary arteries, the proximal carotid arteries, the infrarenal aorta, and the superficial femoral arteries.

Foam cells	Fatty streak	Intermediate lesion	Atheroma	Fibrous plaque	Complicated lesion/rupture
	5	5	L	1	
-	-		Concernant of the local division of the loca	Press	<b>Anterio</b>
From first decade		Endothelial dystunctio		From fourth decade	
Growth mainly by lipid accumulation				Smooth muscle and collagen	Thrombosis, hematoma

Image Source: http://archive.li/Yrn5t, accessed 12/28/17.

a. Carotid Endarterectomy:

Acute stenosis and/or downstream ischemia from embolized plaque or loosened thrombus may be life threatening, especially when this occurs in the carotid or coronary arteries.

Endarterectomy is one surgical treatment option, and consists of opening the artery and removing the portion of the intima and media layers, containing the plaque lesion. Bypass is another alternative, utilizing autograft, allograft, or synthetic conduit to span the area of occlusion.

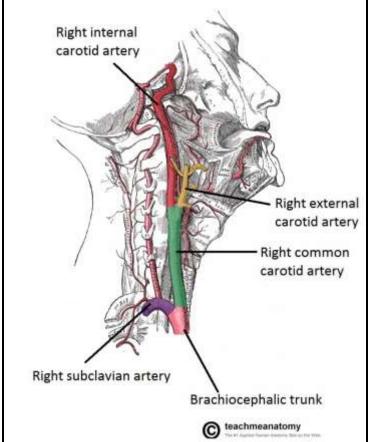


Image source: http://humananatomylibrary.com/intracranial-internal-carotid-artery-anatomy/intracranial-internal-carotid-artery-anatomy-majorarteries-of-the-head-and-neck-carotid-teachmeanatomy/, accessed 12/28/17.

The carotid endarterectomy procedure is performed to remove the plaque from the area of common carotid bifurcation, are often performed under regional or local anesthesia, and may or may not require an intra-operative shunt to be used. Reasons for shunting include low back pressure from internal carotid artery, or measured reduction in neurologic status of the patient. Either of these intra-operative indicators may manifest themselves only after internal carotid cross-clamping.



A vertical incision anterior and parallel to the sternocleidomastoid muscle is used. The Subcutaneous tissue and fascia are dissected, and the muscle mobilized for access of the carotid sheath below. The common facial vein at the level of the bifurcation is divided, and the jugular vein retracted laterally to expose the carotid bifurcation. Vessel loops are placed on the common carotid, and on the internal and external branches.

# SAMPLE QUESTION 4.1: Which two cranial nerves course through the operative field, and must be preserved?

- $\circ$  X and XII
- IX and VII
- $\circ$  VII and X
- $\circ~$  IV and VII

# SAMPLE QUESTION 4.2: At several points in the procedure, it is most critical to prevent emboli from entering the:

- Common carotid artery
- Facial artery
- o External carotid artery
- Internal carotid artery.

# **SAMPLE QUESTION 4.3:** The injection of lidocaine into the common carotid body prior to performing the arteriotomy is done to:

- Prevent sinus tachycardia
- Prevent sinus bradycardia
- Elicit sinus tachycardia
- o Elicit sinus bradycardia

#### **b.** Coronary Artery Bypass:

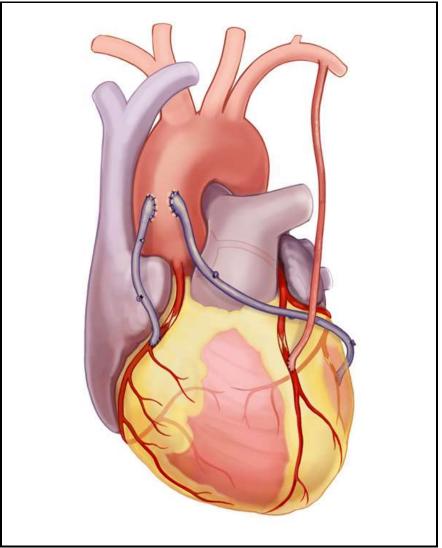


Image source: http://www.westchestermedicalcenter.com/coronary-bypass-surgery, accessed 12/28/17.

Coronary bypass surgery (CABG) is generally performed for patients who can undergo the procedure, and whose cardiac perfusion cannot be improved medically, or through minimally invasive angioplasty or coronary artery stenting. Some variation in procedures exist, but the goal remains for total revascularization to correct any deficient coronary circulation. Several conduits may be placed, utilizing reversed saphenous vein autografts, allografts, or autograft arteries-internal mammary/thoracic, and/or some others.

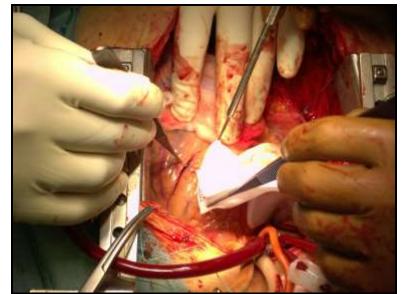


Image source: https://commons.wikimedia.org/wiki/File:Aorta\_koronar\_%C5%9Funtlama1.jpg, accessed 12/28/17.

Sternotomy is performed, and the patient is placed on coronary bypass (CBP) during key stages of the procedure, with ischemic time minimized. Patient blood is rerouted from the patient's venous side, through the CPB machine where it is oxygenated, medication levels and pH are optimized, carbon dioxide is removed, a cardioplegic solution is periodically added, then the blood is circulated back into the patient's arterial side at an ideal volume, temperature, and pressure. Throughout this many-faceted procedure, precisely-timed steps must be followed by a highly-trained surgical team.

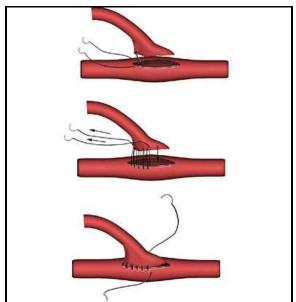


Image source: https://msurgery.ie/vascular-anastomosis, accessed 12/28/17.

Tissue handling, suture management, vein dissection, harvest, and preparation for implantationall require meticulous attention to detail. Surgical assistants in this field must achieve extraordinary skill levels and fine motor coordination.

# **SAMPLE QUESTION 4.4:** Patient blood perfusion includes the use of cardioplegic solution. The purpose of this solution is to:

- Increase clotting time
- Balance the pH of the blood
- $\circ$  Optimize  $0_2$  saturation
- o Reversibly arrest the heart beat

# **SAMPLE QUESTION 4.5:** The Greater Saphenous vein may be located distally at which of the following locations?

- Anterior to the lateral malleolus
- Posterior to the lateral malleolus
- Anterior to the medial malleolus
- Posterior to the medial malleolus

### **B.**General Surgery

#### a. Appendectomy:

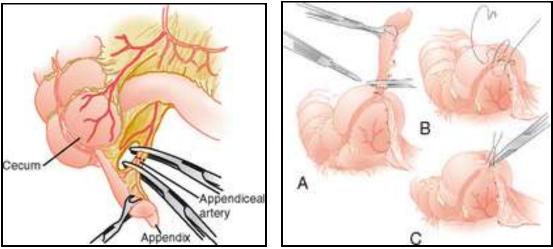


Image source: https://basicmedicalkey.com/open-appendectomy/, accessed 12/29/17.

An appendectomy is performed if there is either evidence of appendix rupture, or symptomatic appendicitis prior to rupture and well qualifies as an urgent procedure. The appendix is located in the right lower quadrant of the abdomen, at the junction of the terminal ileum, at the ileo-cecal valve.

Relatively simple suturing techniques have been developed to facilitate resection, minimize spilling, and invert the appendiceal stump. Surgical-stapling devices have made a big impact here.



Image source: https://www.laparoscopyhospital.com/lap%20app.htm, accessed 12/30/17.

Appendectomy may be carried out through a small open incision approximately one-third of the distance from the right anterior superior iliac spine to the umbilicus, through a low midline incision, or laparoscopically.

The appendectomy patient may present, or become, very sick and the risk for a contaminated/infected wound is ever present. Abscesses are not uncommon. Surgical drains may be considered.

# SAMPLE QUESTION 4.6: Which of the flowing represents the fascial planes passed through during an open procedure (external to internal) in this region, to reach the peritoneum:

- Scarpa's fascia, obliques, transversus abdominus, transversalis fascia.
- Transversalis fascia, transversus abdominus, Scarpa's fascia, obliques.
- Transversalis fascia, transversus abdominus, obliques, posterior rectus sheath.
- Obliques, transversus abdominus, transversalis fascia, posterior rectus sheath.

## SAMPLE QUESTION 4.7: According to AORN wound classification system, a ruptured appendix with no visual bowel contents represents:

- o Class I: Clean
- o Class II: Clean Contaminated
- Class III: Contaminated
- Class IV: Dirty Infected

#### **b.** Cholecystectomy:

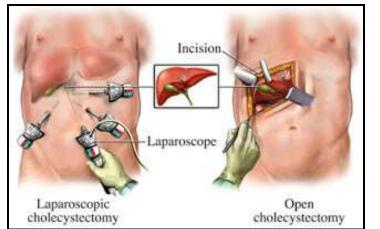


Image Source: https://www.ihealthblogger.com/problems-after-gallbladder-removal-cholecystectomy/, accessed 12/27/17

Cholecystectomy is performed routinely in most every OR, and in many ASCs across the country. Cholecystitis and cholelithiasis represent common diagnoses in the American adult population. Laparoscopic procedures far outpace open procedures in this day and time, and have proven to be as safe, effective, and in many cases more efficient.

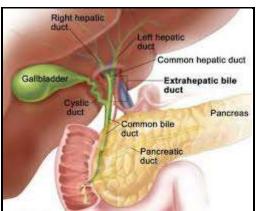


Image Source: http://www.toomarisurgery.com/gallbladder-surgery.html, accessed 12/27/17

The gall bladder lies inferior to the liver, in the right upper abdominal quadrant. Accurate identification of the cystic artery and cystic duct must be accomplished, as misadventure in this region may cause damage to the common bile duct, hepatic dusts, hepatic arteries, portal veins, or the pancreatic duct-all of which present challenging surgical repair to say the least, with significant post-op complication rates. Bile duct and arterial variability is the rule, rather than the exception in this region.

Intra-operative cholangiogram may be performed to confirm biliary tree patency, the presence or absence of stones, or to identify anomalous anatomy.

### SAMPLE QUESTION 4.8: As a first step to establishing a pneumoperitoneum for laparoscopic surgery, the closed Veress technique is performed:

- Through a small umbilical incision, elevating the anterior fascia with Kocher clamps and penetrating the abdominal wall with slow downward pressure on the trocar, followed by insufflation through the cannula.
- Through a small umbilical incision, elevating the anterior fascia with Kocher clamps and penetrating the abdominal wall with slow downward pressure with a Veress needle, followed by insufflation through the Veress needle to a desired pressure.
- Through a small umbilical incision, elevating the anterior fascia with Kocher clamps and penetrating the abdominal wall with slow downward pressure with a Veress needle, followed by confirmation of negative intra-abdominal pressure with a syringe and saline, then insufflation to a desired pressure through the Veress needle.
- Through a small umbilical incision, elevating the anterior fascia with Kocher clamps and incising the fascia and peritoneum, then under direct vision placing the trocar and cannula.

# SAMPLE QUESTION 4.9: Complete obstruction of the cystic duct may result in bile pigments to be reabsorbed, and the gall bladder becomes filled with clear mucoid substance which, in adults, requires cholecystectomy. This condition is known as:

- o Hydroadenitis
- Hydocoele
- Hydrocolloidal
- Hydrops

### SAMPLE QUESTION 4.10: Identification of the cystic duct may be facilitated by retracting the relevant structures in which of the following methods:

- Gallbladder retracted superiorly, and the redundant infundibular laterally
- Gallbladder retracted laterally, and the redundant infundibular medially
- Gallbladder retracted inferiorly, and the redundant infundibular superiorly
- Gallbladder retracted inferiorly, and the redundant infundibular medially

#### c. Inguinal herniorrhaphy:

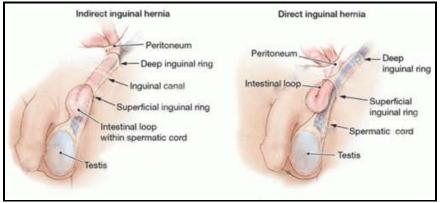


Image source: https://pedclerk.uchicago.edu/page/inguinal-hernias-hydroceles ,12/29/17.

Inguinal hernia occurs more frequently in men than women, and results from peritoneal tissue and/or abdominal contents entering the inguinal canal due to abdominal wall weakness. Hernias may become incarcerated and pose acute risk for strangulation, infection, and rupture. The inguinal canal opens into the abdomen at its internal ring, and exits the body cavity inferiorly through the external ring. Both rings have discrete structural elements, which must be understood for proper hernia classification and surgical repair. Inguinal hernias present as "direct", or "indirect" depending on the tissue layers involved.

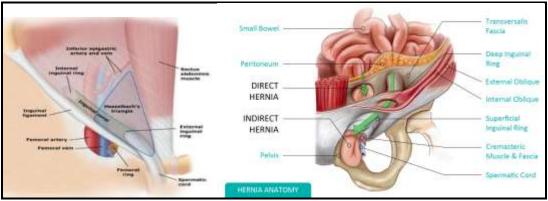


Image 1 source: http://www.worldsurgeryforum.net/2017/07/surgical-anatomy-of-inguinal-canal.html, accessed 12/27/17 Image 2 source: http://www.surgiconsent.com/open-hernia.html, accessed 12/27/17

In normal male anatomy, the spermatic cord (testicular artery, veins, cremaster muscle, and vas deferens) passes through the inguinal canal. In females, the round ligament does likewise.

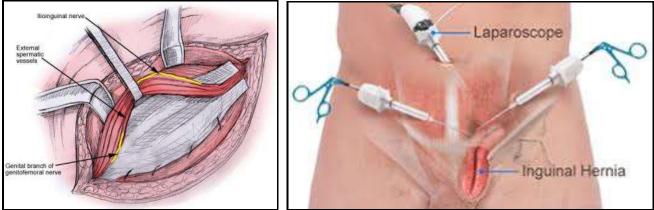


Image 1 source: https://emedicine.medscape.com/article/1534281-technique, accessed 12/29/17. Image 2 source: http://www.southwestaustinsurgical.com/inguinal-hernia/, accessed 12/29/17.

Inguinal Hernia Repair can be accomplished through an open incision, endoscopically through the retroperitoneal space, or laparoscopically through the peritoneal cavity. Surgical mesh is often used to strengthen the weakened areas, and a number of open techniques have been used with success over the years for open repair such as the Shuldice, Bassini, and McVay techniques.

## SAMPLE QUESTION 4.11: Which of the following nerve pairs are present and should be identified and preserved during inguinal hernia repair, especially in open procedures:

- Ilio-hypogastric and femoral
- Ilio-inguinal and ileo-hypogastric
- Genitofemoral and ileo-inguinal
- Ileo-hypogastric and genitofemoral

### **SAMPLE QUESTION 4.12: Direct inguinal hernias are identified by tissue herniation:**

- Within the spermatic cord through the internal inguinal ring
- Inferior to the inguinal ligament
- Within Hasselbach's triangle outside the cord structure and internal inguinal ring.
- Directly through the abdominal wall in the region of the umbilicus

#### d. Mastectomy:

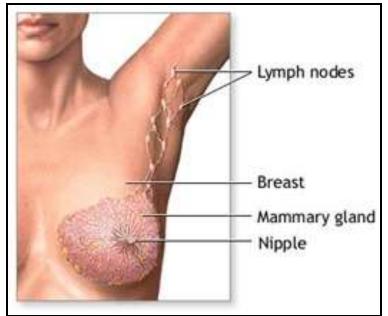


Image source: http://acelebrationofwomen.org/2012/10/mastectomy-4-types-women-in-recovery/, accessed 12/27/17

Mastectomy is the removal of all breast tissue, including the nipple and the areola, leaving well-perfused, viable skin flaps intact for primary closure or reconstruction. Mastectomy may be performed as surgical treatment of breast cancer or as prophylaxis for high-risk patients. Simple mastectomy removes only glandular breast tissue, while radical or modified radical mastectomies also include surgical dissection and removal of axillary lymph nodes and possibly underlying muscle tissue, and require significantly longer recovery time and may have significantly greater complication rates.

All types of mastectomy carry with them technical challenges and require a high level of tissue handling-skill and anatomical expertise. Skin edges must be preserved, and axillary neurovascular structures identified and protected.

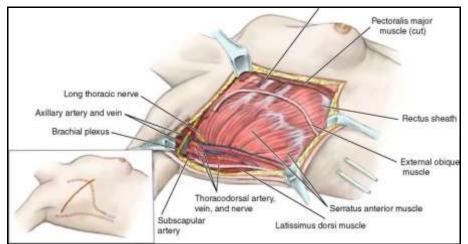


Image source: http://aibolita.com/womens-diseases/40572-technique-of-radical-mastectomy.html, accessed 12/27/17.

Breast reconstruction procedures have been developed such as tram and free flaps, as well as skin and tissue sparing techniques involving localized treatment strategies with complex imaging.

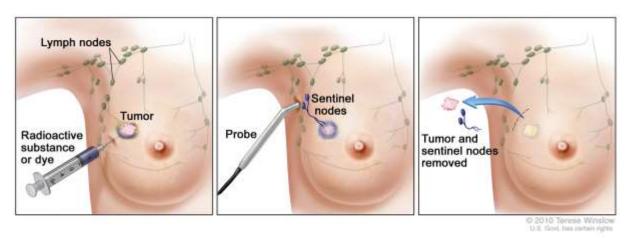


Image source: http://acelebrationofwomen.org/2012/10/mastectomy-4-types-women-in-recovery/, accessed 12/27/17.

## SAMPLE QUESTION 4.13: Intra-operative superficial and deep suction drain placement with compression dressings following mastectomy procedures reduce the incidence of which of the following complications:

- $\circ~$  Paresthesia on the undersurface of the arm
- o Lymphedema
- Post-op seroma
- Neoplasm recurrence

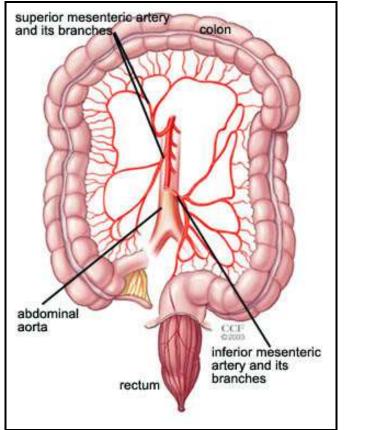
### SAMPLE QUESTION 4.14: "Straight-up" skin retraction during dissection serves to:

- Decrease skin perforation and/or thermal damage from cautery.
- Maximize trans-illumination of the surgical site.
- Minimize risk to deep vascular structures.
- Minimize post-op bleeding.

### **SAMPLE QUESTION 4.15: Damage to the long thoracic nerve during axillary node dissection may cause:**

- o Paralysis of the latissimus dorsi
- Paralysis of the trapezius
- o Paralysis of the pectoralis major
- o Paralysis of the serratus anterior

#### e. Partial Colectomy:



 $Image \ source \ https://my.clevelandclinic.org/health/diseases/17136-intestinal-ischemic-syndrome/follow-up-care?view=print, accessed 12/27/17.$ 

Surgical resection of the colon represents a large percentage of GI surgery in the U.S. for the treatment of cancer, diverticular disease, as well as inflammatory bowel conditions. In most cases, only a portion of the colon requires resection. Such procedures are termed partial or hemi-colectomies. These are classified further by the segment of the colon to be removed such as right or left hemi-colectomy, or sigmoid colectomy, etc..



Image Source: https://synapse.koreamed.org/search.php?where=aview&id=10.3393/jksc.2009.25.6.380&code=0009JKSC&vmode=PUBREADER, accessed 12/27/17.

Abdominal surgery has been historically conducted through an open midline incision but laparoscopic and laparoscopic-assisted techniques have also become widespread and effective. Principles of abdominal surgery must be followed, such as reducing G.I. content spillage into the peritoneal cavity, and the optimized utilization of instrumentation to maintain exposure, and protect adjoining structures.

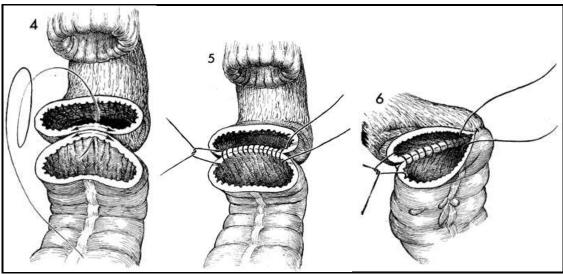


Image Source:

http://www.atlasofpelvicsurgery.com/7Colon/5AnteriorResectionoftheColonWithLowAnastomosisUsingtheGambeeSutureTechnique/chap7sec5.html, accessed 12/27/17.

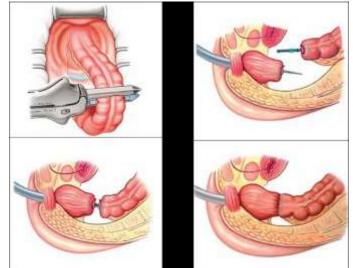


Image Source: https://www.anastomoseal.eu/the-challenge-anastomotic-leakage/, accessed 12/27/17.

Knowledge of the mesenteric vascular supply, and bowel anastomosis techniques are also critical for success in either situation. In addition to several traditional bowel suturing techniques for end-to-end, or end-to-side anastomoses in open procedures, standard open and laparoscopic stapling techniques have become widely-used and successfully employed. An assistant must know every step in any case, have a firm grasp of suture management or device manipulation and function, and as in all sub-specialties of surgery, establish and maintain hemostasis and exposure throughout the procedure. Proper closure remains key.

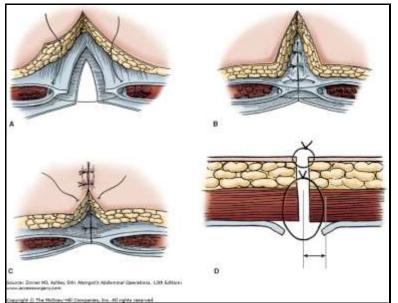


Image Source: http://accesssurgery.mhmedical.com/content.aspx?bookid=531&sectionid=41808782, accessed 12/27/17.

### **SAMPLE QUESTION 4.16: Retroperitoneal structures are most at risk of inadvertent damage in which of the following procedures:**

- Transverse Colectomy
- Left Colectomy
- Loop Colostomy
- Sigmoid Colectomy

#### SAMPLE QUESTION 4.17: The right colic artery is a branch of the:

- Middle Colic Artery
- Superior Mesenteric Artery
- Inferior Mesenteric Artery
- Left Colic Artery

### SAMPLE QUESTION 4.18: Three distinct and visible longitudinal bands of smooth muscle running the length of the colon are referred to as:

- Taenia Coli
- o Haustrae
- Sacculations
- Semi-lunar plicae

### SAMPLE QUESTION 4.19: The primary difference between the Cushing and Connell suturing techniques for GI anastomosis include which of the following:

- The Cushing stitch penetrates the mucosal layer, while the Connell does not.
- The Connell stitch penetrates the mucosal layer, while the Cushing does not.
- The Cushing stitch is interrupted, while the Connell is a running stitch.
- The Connell stitch is interrupted, while the Cushing is running stitch.

#### **C.Neurosurgery/Orthopedic Surgery:**

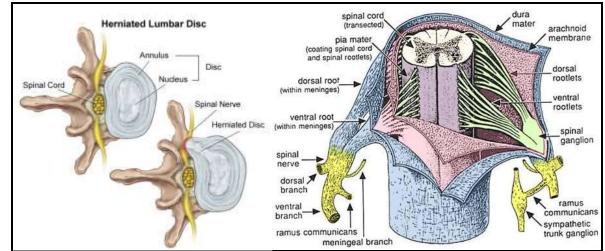


Image 1 source: http://www.flspinalcord.us/lumbar-herniated-disc-exercises/lumbar-herniated-disc-exercises-bodi-empowerment-dr-ken-nakamura-downtown-torontochiropractor/#s, accessed 12/28/17.

Image 2 source: https://www.orthobullets.com/spine/2004/spinal-cord-anatomy, accessed 12/27/17.

The following procedure is commonly performed by either neurosurgeons or orthopedic surgeons and an assistant.



Image source: https://sohrabgolloglymd.com/microscopic-discectomy-procedure/microsurgery-microdiscectomy/, accessed 12/29/17.

#### a. Lumbar Laminectomy/Discectomy

The intervertebral discs consist of an outer annular fibrosis, and an inner nucleus pulposus. In certain regions of the spine more often than others, as is the case of the lower lumbar spine, this intervertebral cushion may fail under load. This may result suddenly following a sudden twisting injury.

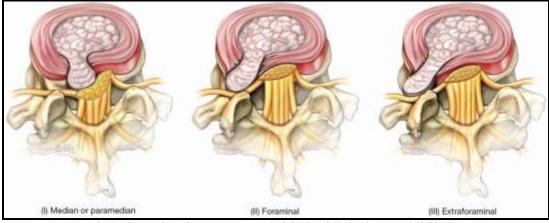


Image Source: http://jss.amegroups.com/article/view/3535/html, accessed 12/28/17.

A bulge in the annulus may result in irritation of the overlying spinal cord structures. An annular rupture with expulsion of the nucleus material into either the spinal canal or the spinal foramina may also occur, putting direct pressure on or causing damage to the cord or spinal nerve structures. Spinal canal or spinal foraminal stenosis may occur secondarily due to a chronic degenerative process.

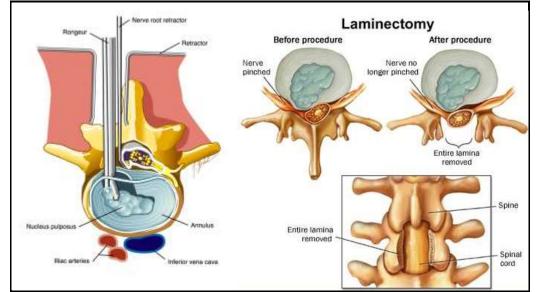


Image 1 source: http://www.backpain-guide.com/Chapter\_Fig\_folders/Ch13\_Decomp\_Folder/Ch13\_2\_Microdisc.html, accessed 12/28/17. Image 2 source: http://www.back-surgery.com/spine-surgery-procedures/laminectomy/, accessed 12/28/17

The goal of Lumbar Discectomy is to remove the expelled disc material from the spinal canal and/or spinal foramina. The goal of Lumbar Laminectomy is to remove overlying laminar bone to relieve spinal canal or spinal foraminal stenosis. The ultimate goal in both procedures is to relieve the neurologic symptoms of pain and/or weakness associated with pressure on the spinal cord and/or spinal nerves. One, or both, of these procedures may be required.

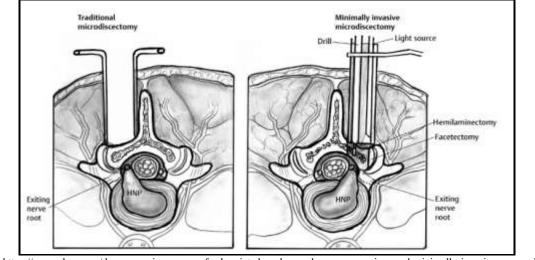


Image source: https://neupsykey.com/decompressive-surgery-for-herniated-nucleus-pulposus-open-micro-and-minimally-invasive-approaches/, accessed 12/28/17.

Minimally invasive alternatives to traditional open incisions have been progressively introduced. Mini-incisions with surgical telescopes (loupes) or microscopes are now used routinely. Full endoscopic techniques have also been developed.

### SAMPLE QUESTION 4.20: The ligament encountered just anterior to the dorsal lamina during laminotomy is known as the:

- Posterior longitudinal ligament
- Ligamentum flavum
- Interspinous ligament
- o Intertransverse ligament

### SAMPLE QUESTION 4.21: The typical suction tip used in lumbar spine surgery is known as the:

- $\circ$  Poole suction tip
- Renton suction tip
- Frazier suction tip
- Yankauer suction tip

### SAMPLE QUESTION 4.22: Spinal ganglia and nerve roots are protected by which two tissue layers listed below?

- Pia mater and arachnoid mater.
- Denticulate ligament and pia mater.
- Arachnoid mater and dura mater.
- Dura mater and denticulate ligament.

#### **D.Orthopedic Surgery:**

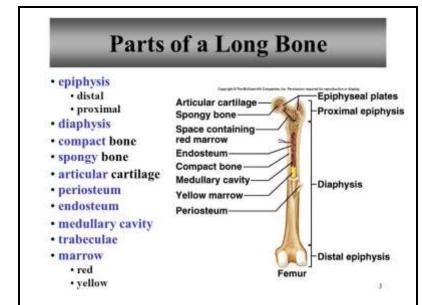
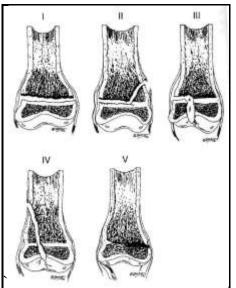


Image source: http://anatomybody101.com/epiphysis-human-anatomy/epiphysis-human-anatomy-slide-3/, accessed 12/28/17.

#### a. \*ORIF Skeletal Fracture

Fracture healing is usually divided into three stages: inflammatory, reparative, and remodeling. These stages may overlap slightly, and due to varying healing rates of patients based on age and relative health, it remains difficult to provide a precise time frame for each phase.



 $Image \ Source: \ https://www.med-ed.virginia.edu/courses/rad/peds/ms_webpages/ms2 bsalter.html, \ accessed \ 12/28/17.$ 

Fracture classifications have been established from several perspectives such as fracture pattern, relationship to growth plates and/or joints, and anatomical location. For example, the standard classification for physeal fractures shown above, was set forth by

Salter and Harris and used extensively in pediatrics. This classification divides fractures into five types (I - IV) based on whether the metaphysis, physis, or epiphysis is involved as demonstrated radiographically. Salter-Harris fracture classifications have been historically considered standard, and should be reviewed.

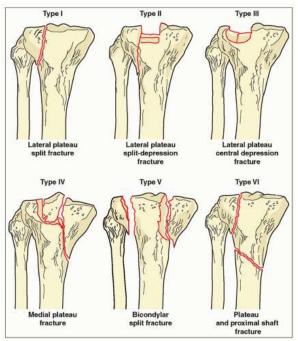


Image Source: http://emdaily.cooperhealth.org/content/orthopedic-injuries-around-nfl-dez-bryant-s-tibial-plateau-fracture, accessed 12/27/17.

Another example of fracture classification (Schatzker) above, specifically describes tibial plateau fractures, and generally dictates fixation method.

An assistant must study and learn the various fracture classification systems, as these have been paired with alternative procedures for optimizing surgical results.

The overall objectives of open reduction and internal fixation (ORIF) include: adequately exposing the fracture site with minimal soft-tissue stripping; removal of soft tissue and debris from the fracture line; establish a temporary anatomical reduction; permanently stabilize the reduction through rigid fixation.

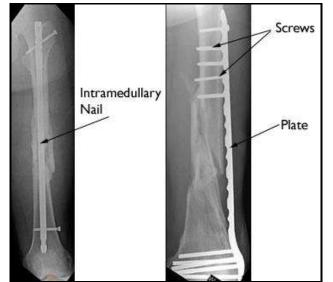


Image source: https://orthoinfo.aaos.org/en/treatment/internal-fixation-for-fractures/, accessed 12/28/17.

Fixation modalities vary by manufacturer, material, construct design, and fixation hardware. All are designed to provide maximum stability, maximize stress distribution, and minimize stress-shielding, or post-op callus formation and non-union.

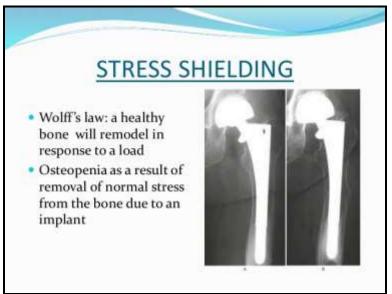
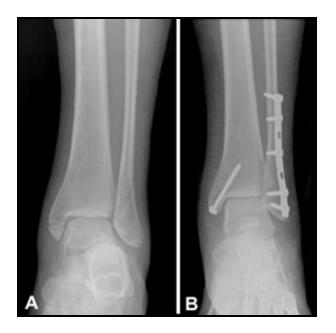


Image Source: https://www.slideshare.net/vivekmathewphilip/metallurgy-in-orthopaedics-76114706, accessed 12/28/17.



### SAMPLE QUESTION 4.23: In the radiographic images above, which of the following fixation strategies has been used.

- External fixation
- Intra-medullary rodding
- Internal fixation
- Fibular strut-grafting

## SAMPLE QUESTION 4.24: Heads of locking screws are machined to make threaded contact with the reciprocal plate. The mechanical advantage of such screws is best described by which of the following:

- o threaded screw heads maximize friction between the plate and the bone.
- threaded screw heads allow axial glide within the hole for compression across the facture.
- $\circ$  threaded screw heads allow for easier and faster insertion.
- threaded screw heads facilitate mechanical coupling to the plate for angular screw stability.

### SAMPLE QUESTION 4.25: In accordance with AO standards, rigid fixation across the epiphyseal plate is generally considered:

- Contraindicated in pediatric surgery.
- Indicated in pediatric surgery.
- Contraindicated in geriatric surgery.
- Preferable in every surgical situation.

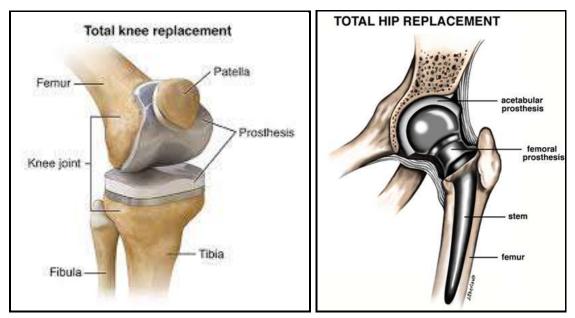


Image 1 source: http://mahiclinic.com/total-knee-replacement-surgery/index.html, accessed 12/28/17. Image 2 source: https://www.oahct.com/index.php/specialties/hip/total-hip-replacement, accessed 12/28/17.

#### b. \*Total Joint Arthroplasty

Total joint arthroplasty procedures are common, and require substantial surgical assistance. In this study guide, we will only touch on knee and hip procedures. Total joint replacement of the shoulder, ankle, elbow, wrist, PIP, TMJ, and others are also performed.

As for every arthroplasty procedure, pre-operative planning supports intra-operative efficiency as these cases require tray upon tray of size-specific instrumentation. Pre-op imaging must be displayed in the surgical suite, and several sets of intra-operative images may be needed as well.

Meticulous sterile technique must be employed in arthroplasty cases, as implantable devices are used. Post-op infection is generally ranked as the single greatest complication. Extensive personal protective equipment such as ventilated head gear and double gloving are required for the surgical team, and specialized patient prep and draping is performed.

The steps of arthroplasty in each joint are surgeon specific, but highly standardized, with variation according to the device manufacturer's specification, and with some variation due to patients' unique anatomy. In general, however, the surgical steps must become nearly automatic and repeatable to achieve the most consistent outcomes. This is true for about every arthroplasty procedure, with any manufacturer's device. And a surgical assistant is well-served to commit these steps to at least "muscle" memory...



Image source: https://ryortho.com/breaking/total-knee-replacement-surgery-in-hospital-or-outpatient/, accessed 12/28/17.

**Knee arthroplasty** is normally performed through an anterior midline skin incision. The arthrotomy is made medial to the patella, and the patella dislocated laterally. The knee is then secured in flexion with one of a variety of table-mounted positioners. The order of bone cuts is generally: patella; femur; then tibia. Implant placement generally follows in the order of: femur; tibia; then patella. Cement is often used.

## SAMPLE QUESTION 4.26: Which of the following structures inserts into the tibial tubercle and may need some distal and medial release during the arthrotomy phase of knee arthroplasty:

- o Medial collateral ligament
- o Lateral collateral ligament
- Quadriceps tendon
- Patellar ligament

SAMPLE QUESTION 4.27: Which of the following locations for collateral ligament release may be required during the tibial trial phase of knee arthroplasty:

- Medial proximal insertion
- Medial distal insertion
- o Lateral proximal insertion
- o Lateral distal insertion

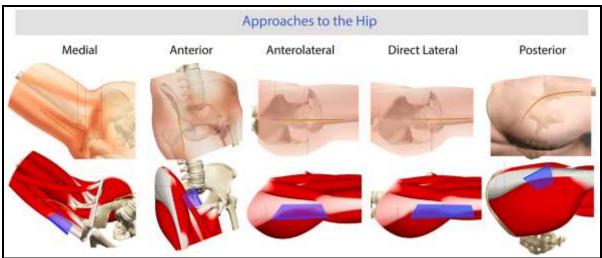


Image source: https://www.orthobullets.com/recon/12116/tha-approaches, accessed 12/28/17.

**Hip arthroplasty** may be performed through several incisional approaches. The pros and cons of each range from body habitus of patient, post-op dislocation rate, learning curve required to master it, abductor mechanism violation requirements, relative risk of nerve damage, ease of exposure, etc. These should be reviewed, and at least become somewhat intuitive based on your knowledge of hip anatomy.

Once the capsule is excised, the hip is dislocated, and the femoral head removed, the acetabular and trochanteric preparation may be accomplished. The acetabulum is reamed, and prosthesis fit. Then the femur can be prepared, followed by femoral stem and ball insertion. Matching leg length and femoral neck offset angle of the operative side, to the inoperative side are of crucial importance.

SAMPLE QUESTION 4.28: Which one of the following approaches for hip replacement spares the hip abductors and may lead to fewer post-op dislocations, but requires a specialized OR table (Hana) to perform?

- o Anterior
- o Anterolateral
- Direct lateral
- Posterior

SAMPLE QUESTION 4.29: Which of the following muscle structures is primarily classified as a hip abductor, and may be considered problematic when transected and reapproximated, or otherwise violated during hip replacement surgery?

- o Gluteus maximus
- o Iliopsoas
- o Pectineus
- o Gluteus medias

Consider consulting the following sources for in-depth study.

- 1. <u>Alexander's Care of the Patient in Surgery</u>, 15<sup>th</sup> Edition, Jane C. Rothrock, PhD, RN, Published by Elsevier, St. Louis, Mo, 2015.
- 2. <u>Atlas of Human Anatomy</u>, Frank H. Netter, MD, 6<sup>th</sup> Edition, Elsevier North Holland, Inc., New York, NY.
- 3. <u>Atlas of Surgical Operations</u>, 10th Edition, Robert H. Zollinger, Jr., McGraw-Hill, 2011.
- 4. "AO Foundation Online Surgical Reference", Executive Editors: Chris Colton, Steve Krikler, Joseph Schatzker, Peter Trafton, Richard Buckley, https://www2.aofoundation.org/wps/portal/surgery.
- 5. <u>Campbell's Operative Orthopaedics</u>, 15th Edition, Frederick M Azar, MD, et al, Elsevier, 2014.
- 6. <u>Essentials of Surgery</u>, James M Becker, MD, and Arthur F. Stucchi, PhD, Saunders, Philadelphia, PA, 2006.
- "General Principles of Internal Fixation", Published by Medscape, Nov 30, 2015, Ronald Lakatos, MD, https://emedicine.medscape.com/article/1269987overview#showall.
- 8. <u>Gray's Anatomy, The Anatomical Basis of Clinical Practice</u>, 41st Edition, Susan Standring, Elsevier North Holland, Inc., New York, NY.
- 9. <u>Handbook of Clinical Anesthesia</u>, 7th Edition, Paul G. Barash, Bruce F. Cullen, Lippincot-Williams and Wilkins, 2013
- 10.<u>Human Anatomy</u>, R.M.H McMinn, R.T. Hutchings, second edition, Year Book Medical Publishers, Chicago, IL, 1988.
- 11.<u>Human Anatomy, A Synoptic Approach, Nicholas James Mizeres, Elsevier North</u> Holland, Inc., New York, NY, 1981.
- 12.<u>Rutherford's Vascular Surgery</u>, 8<sup>th</sup> Edition, Cronenwett and Johnston, Published by Elsevier-Saunders,
- 13.<u>Surgical Recall</u>, 6th Edition, Dr. L. H. Blackbourne, MD, Lippincott Williams & Wilkins, 2011.
- 14.<u>Textbook of Medical Physiology</u>, 8<sup>th</sup> Edition, Arthur C Guyton, M.D., W.B Saunders Company, Philadelphia, PA. 1991.
- 15.<u>Youmans Neurological Surgery</u>, Volumes 1-4, 6<sup>th</sup> Edition, H. Richard Winn, Published by Elsevier-Saunders.
- 16.<u>Sabiston Textbook of Surgery, The Biological Basic of Modern Surgical Practice</u>, 20<sup>th</sup> Edition, Townsend, Published by Elsevier.

#### **PART V: SURGICAL TECHNIQUES**

- A. Surgical Hemostasis B. Knot -Tying
- C. Wound Closure

#### **A.Surgical Hemostasis**

The aim of surgical hemostasis is to not only eliminate blood from the operative field, but stop or prevent the flow of blood from the incised or transected vessel. Several methods are available for the assistant to employ intra-operatively. We will mention a few techniques. The most critical consideration, however, is surgical judgement. WHERE and WHEN to use each method remains up to the assistant to learn during training, from their surgeons, and by experience.

Cut vessels will retract and contract. In very small vessels, natural coagulation mechanism of the blood may occur, including temporary-platelet plug formation, followed by permanent-fibrin clot. In surgery, however, you may not wish to wait for this to take place. A wrong call here, may result in post-op hematoma, or hemorrhage. Even small blood vessels should be controlled prior to transection if possible.

Once bleeding begins, there are mechanical methods, thermal methods, chemical, and biological methods to stop it. Mechanical methods include digital-direct pressure, tourniquet, ligation (clamp and tie), suture ligation, surgical clips, bone wax, and patient/limb positioning. Thermal methods include cryo-therapy, electrocauterization, harmonic devices, and lasers. Chemical and biological methods include absorbable collagen, absorbable gelatin, microfibrillar collagen, oxidized cellulose, and pharmaceutical agents such as oxytocin, epinephrine, and thrombin.

Methods for achieving hemostasis cannot be described here and fully understood. These must be learned by doing.

### SAMPLE QUESTION 5.1: A frazier tip suction held to the back of a Cottonoid® pattie are likely used to clear the operative field in which of the following:

- Laparoscopic surgery
- Endoscopic surgery
- Open abdominal surgery
- Microsurgery

#### SAMPLE QUESTION 5.2: Which of the following cauterization devices would be appropriate in tight spaces, with high risk for collateral nerve tissue nearby?

- Bipolar cautery forceps
- Pencil-tip cautery
- Needle-tip cautery
- Monopolar "pincher" cautery

SAMPLE QUESTION 5.3: When passing sutures for deep ligation with a tonsil hemostat, how far from the tip is most "optimal" for the suture to be clamped?

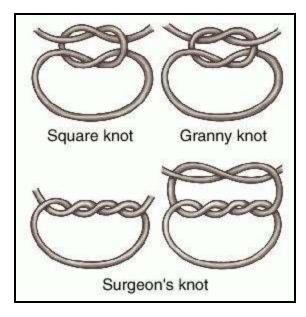
- At back of the jaw for maximum security.
- At the half-way point on the jaw.
- The suture should exit the jaw of the clamp at the very tip.
- $\circ$  2mm from the tip.

Characteristics of Sutur	AND TRACK OF A		
Suture	Knot Security	Wound Security	Tissue Reactivity
Absorbable Sutures	-		100.000 go. to 2000
Surgical Gut	Poor	5-7 days	moderate
Chromic Gut	Fair	10-14 days	moderate
Polyglactin (vicryl)	Good	30 days	mild
Polyglycolic (dexon)	Best	30 days	mild
Polydixanone (PDS)	Fair	45-60 days	least
Polyglyconate (Maxon)	Fair	45-60 days	least
Nonabsorbable Sutures			
Nylon	Good	Good	Minimal
Polypropylene	Least	Best	Least
Silk	Best	Least	Most

Image Source: https://www.slideshare.net/praveensurgeon/wound-closure-techniques, accessed 12/29/17.

#### **B.Knot-Tying**

Suture characteristics have been researched, and this information should be fully understood by the assistant. Ultimate failure or success of a specific material or surgical knot is generally not known intraoperatively. A surgeon has the benefit of knowing for sure as they follow their patients throughout their recovery. Surgeons generally know if their assistant's knot-tying technique stands the test of time.



That said, knot-tying is a skill which can vastly improve an assistant's standing with their surgeon. It is not easy, but can only be mastered with MUCH practice. For this reason, some surgeons tie everything themselves...

Whether performing two-hand ties, one-hand-ties, arthroscopic/extra-corporal sliding knots, learn them right, and do them right. A granny knot slips. Square not slips very little. Surgeon's knots slip less than that. KNOW the difference in practice. And whether you're tying it free-hand, or with an instrument, your knot performs as well as you tie it.

### SAMPLE QUESTION 5.4: When tying #2-0 Vicryl® sutures, how many alternate throws produce a secure knot?

- o Three
- o Four
- The number your surgeon wants.
- The number your surgeon wants plus one.

### **SAMPLE QUESTION 5.5:** Which of the following features represent a disadvantage of monofilament suture material?

- Not preferable in infected situations.
- Not preferable near the skin.
- Poor relative knot security compared with braided material.
- Higher reactivity than braided material.

#### **C.Wound Closure**

#### Selection of Wound Closure Devices

Closure Technique	Advantages	Disadvantages
Sutures	Meticulous closure Greatest tensile strength	removal, anesthesia, greatest reactivity, cost, slow
Staples	fast, low reactivity	Less meticulous
Tape closure	low reactivity, fast, patient comfort, no needles, cost	lowest tensile strength can not get wet or use around hair
Tissue Adhesives	fast, patient comfort, low reactivity, cost, no needles	strength < sutures, dehiscence over high tension areas

Image Source: https://www.slideshare.net/praveensurgeon/wound-closure-techniques, accessed 12/29/17.

Most often, responsibility for wound closure and dressing remains in the hands of the competent surgical assistant. In general, the surgeon selects the method, but the surgical assistant carries it out. A surgical assistant must understand the physiology of tissue healing, and the philosophy behind each type of closure, including its benefits and limitations.

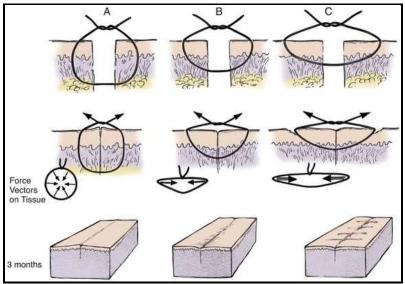
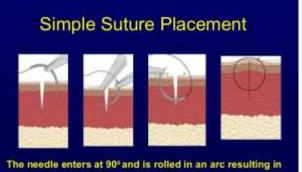


Image source: https://pocketdentistry.com/4-wound-closure-techniques/, accessed 12/28/17.

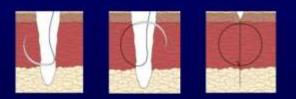
Tissue edges must be "approximated", that is, placed at opposition with minimum tension. Dead-space elimination is paramount, so multiple layered closures are generally better. Foreign material must also be kept at a minimum, and tight closures must not also produce strangulated tissue. This is a finely-honed art in the best of hands. For the purpose of this study guide, we will only mention a few points.

#### You must master this craft.



The needle enters at 90° and is rolled in an arc resulting in equidistant entry and exit points. Taking more depth than width gives desired edge eversion.

#### Placement of Dermal Sutures



Note that the knot is buried in the depth of the wound and the suture is in the dermis not fat



Image Source: https://www.slideshare.net/praveensurgeon/wound-closure-techniques, accessed 12/29/17.

#### SAMPLE QUESTION 5.6: "Eversion" of skin edges for staple closure means:

- Turn the skin edges under for tighter closure.
- Turn the skin edges up, that is, line up the dermal margins
- Overlap one side over the other for double strength.
- Leave a large gap between the skin-edges to allow for drainage.

Consider consulting the following sources for in-depth study.

- <u>Essentials of Surgery</u>, James M Becker, MD, and Arthur F. Stucchi, PhD, Saunders, Philadelphia, PA, 2006.
- <u>Alexander's Care of the Patient in Surgery</u>, 15<sup>th</sup> Edition, Jane C. Rothrock, PhD, RN, Published by Elsevier, St. Louis, Mo, 2015.
- <u>Atlas of Surgical Operations</u>, 10th Edition, Robert H. Zollinger, Jr., McGraw-Hill, 2011.
- <u>Suture and Surgical Hemostasis, A Pocket Guide</u>, First Edition, Rebecca Pieknik, Saunders-Elsevier, St Louis, Mo, 2006.

#### **APPENDIX I. Latin and Greek roots of Medical Terminology**

General familiarity with Latin and Greek roots of medical terminology enable surgical assistants to quickly grasp the anatomic and/or physiologic significance of named anatomical structures. The Latin or Greek word "roots" listed below may appear as a prefix, a suffix, or in combinations to describe not only anatomic structures, but disease states, health conditions, medical definitions, and more.

See the chart below for the first section (A,B) and appendix A for C-Z) for the most often used examples.

A: PREFIX/ SUFFIX	Greek and/or Latin Meaning	Examples
ab-	from; away from	abduction
abdomin-	Of or relating to the abdomen	abdomen, abdominal
ad-	at, increase, on, toward	adduction
aden-	Of or relating to a gland	adenocarcinoma, adenoma, adenotyphus
aesthesi-(BrE)	sensation	anesthesia
-al	pertaining to	abdominal, femoral
-algia, alg(i)o-	pain	myalgia
an-	not, without	analgesia
angi-	blood vessel	angiogram, angioplasty
ante-	Describing something as positioned before, or in front of another thing	antepartum
anti-	Describing something as 'against' or 'opposed to' another	antibody, antipsychotic
arteri(o)-	Of or pertaining to an artery	arteriole, artery
arthr-	Of or pertaining to the joints, limbs	arthritis, pseudoarthosis
articul-	joint	articulation
-ary	pertaining to	biliary tract, coronary
-ase	enzyme	lactase, amylase,
ather-	fatty deposit, soft gruel-like deposit	atherosclerosis
atri-	an atrium (esp. heart atrium)	atrioventricular
aur-	Of or pertaining to the ear	Aural, auricular nerve
axill-	Of or pertaining to the armpit (uncommon as a prefix)	Axilla, axillary roll,

<b>B: PREFIX/ SUFFIX</b>	Greek and/or Latin Meaning	Examples
bacteri-	pertaining to bacteria	bacteriophage, bactericide
bio-	life, living, containing tissue	biologic implant,
blast- or -blast	germ or bud	blastomere, blastoma, osteoblast
blephar(o)-	of or pertaining to the eyelid	blepharoplasty

		biceps brachii, brachium of inferior
brachi(o)-	of or relating to the arm	colliculus
brachy-	Indicating 'short' or less commonly 'little'	brachycephalic artery
brady-	'slow'	bradycardia
bronch(i)-	of or relating to the bronchus	bronchitis, bronchiolitis obliterans
bucc(o)-	Of or pertaining to the cheek	buccolabial, buccinator muscle

C: PREFIX/ SUFFIX	Greek and/or Latin Meaning	Examples
carcin-	cancer	carcinoma
cardi-	Of or pertaining to the heart	cardiology
carp-	Of or pertaining to the wrist	carpal fracture
-cele	pouching, hernia	hydrocele, varicocele
-centesis	surgical puncture for aspiration	amniocentesis
cephal(o)-	Of or pertaining to the head (as a whole)	hydrocephalus
cerebell(o)-	Of or pertaining to the cerebellum	cerebellum
cerebr-	Of or pertaining to the brain	cerebrology
cervic-	Of or pertaining to the neck, the cervix	cervical vertebrae
chol(e)-	Of or pertaining to bile	cholemia, cholecystitis
cholecyst(o)-	Of or pertaining to the gallbladder	cholecystectomy
chondr(i)o-	cartilage, gristle, granule, granular	chondromalacia
chrom(ato)-	color	hemochromatosis
-cidal, -cide	killing, destroying	bacteriocidal
circum-	Denoting something as 'around' another	circumcision
clast	break	osteoclast
CO-	with, together, in association	coenzymes
col-, colo-, colono-	colon	colonostomy
colp(o)-	Of or pertaining to the vagina	colposcopy
contra	against	contraindicate
coron(o)-	pertaining to heart	coronary heart disease
cortic(o)	Cortex, or outer region	adrenal cortex, corticosteriod
cost-	Of or pertaining to the ribs	costochondral
crani(o)-	Belonging or relating to the cranium	craniotomy
-crine, crin(o)	to secrete	endocrine, exocrine
cry(o)-	cold	cryoablation
cutane-	skin	subcutaneous
cyan(o)-	Denotes a blue color	cyanosis
cyst(o)-, cyst(i)-	Of or pertaining to the urinary bladder	cystotomy
cyt(o)-, -cyte	cell	cytokine, leukocyte

D: PREFIX/ SUFFIX	Greek and/or Latin Meaning	Examples
-dactyl(o)-	Of or pertaining to a finger, toe	polydactyly
de-	from, down, or away from	dehydrate
dens, dentis-	Of or pertaining to teeth	dentist

dermat(o)-,		
derm(o)-	Of or pertaining to the skin	epidermis, hypodermic, xeroderma
-desis	binding	arthrodesis
dextr(o)-	right, on the right side	dextrocardia
di-	apart, separation	dilation, distal,
dia-	through, during, across	dialysis, diaphysis
digit-	Of or pertaining to the finger [rare as a root]	extensor digitorum brevis
diplo-	twofold	diploid, diplosis
-dipsia	suffix meaning "(condition of) thirst"	dipsomania, oligodipsia, polydipsia
dis-	separation, taking apart	dissection, dislocation
dors(o)-, dors(i)-,		
dorsum	Of or pertaining to the back	dorsal, dorsocephalad
	duodenum, twelve: upper part of the small	
duodeno-	intestine (12 " average), connects to the stomach	duodenostomy, duodenal atresia
dys-	bad, difficult, defective, abnormal	dysentery, dysphagia, dysphasia

E: PREFIX/ SUFFIX	Greek and/or Latin Meaning	Examples
-eal	pertaining to	corneal, esophageal, perineal
-ectasia, -ectasis	expansion, dilation	bronchiectasis, telangiectasia
-ectomy	denotes surgical removal, resection, excision	mastectomy
-emesis	vomiting condition	hematemesis
-emia	blood condition (Am Engl)	anemia
encephal(o)-	Of or pertaining to the brain, (cerebro-)	encephalogram
endo-	Denotes something as 'inside' or 'within'	endocrinology, endospore
eosin(o)-	Red	eosinophil granulocyte
enter(o)-	Of or pertaining to the intestine	gastroenteritis
epi-	on, upon	epicardium, epidermis, epidural,
episi(o)-	Of or pertaining to the pubic region, loins, vulva	episiotomy
erythr(o)-	Denotes a red color	erythrocyte
-esophageal, - esophago-	gullet (American English)	esophagus
ex-	out of, away from	excision
exo-	Denotes something as 'outside' another	exophthalmos, exoskeleton
extra-	outside	extradural hematoma

F: PREFIX/ SUFFIX	Greek and/or Latin Meaning	Example(s)
faci-	Of or pertaining to the face	Facioplegic
fibr-	fiber	fibril, fibrinous pericarditis, fibroblast
fil-	fine, hair-like	Filament, filum terminale
foramen	hole, opening, or aperature, particularly in bone	Foramen magnum
fore-	before or ahead	foregut
fossa	A hollow or depressed area; trench or channel	fossa ovalis
front-	Of or pertaining to the forehead	frontonasal

G: PREFIX/ SUFFIX	Greek and/or Latin Meaning	Example(s)
galact(o)-	milk	Galactorrhea
gastr(o)-	Of or pertaining to the stomach	Gastric bypass
-genic	Formative, pertaining to producing	Cardiogenic shock
genu-	Of or pertaining to the knee	Genu valgum
gingiv-	Of or pertaining to the gums	Gingivitis
glauc(o)-	Denoting a grey or bluish-grey colour	Glaucoma
gloss(o)- , glott(o)-	Of or pertaining to the tongue	Glossopharyngeal nerve
gluco-	sweet	Glucocorticoid
glyc(o)-	sugar	Glycolysis
-gnosis	knowledge	diagnosis, prognosis
gon(o)-	seed, semen; also, reproductive	Gonorrhea
-gram, -gramme	record or picture	Angiogram
-graph	instrument used to record data or picture	Electrocardiograph
-graphy	process of recording	Angiography
gyno-, gyneco-	woman	Gynecomastia

H: PREFIX/ SUFFIX	Greek and/or Latin Meaning	Example(s)
halluc, hallux	to wander in mind, innermost/first digit on the hind foot	Hallucination, Flexor Hallucis Longus
hemat-, haemato-	Of or pertaining to blood	Hematology, older form Haematology
hema- or hemo-	blood (AmE)	Hemal, Hemoglobin
hemangi or hemangio-	blood vessels	Hemangioma
hemi-	one-half	Cerebral hemisphere
hepat- (hepatic-)	Of or pertaining to the liver	Hepatology, Hepatitis
heter(o)-	Denotes something as 'the other' (of two), as an addition, or different	Heterogeneous
hidr(o)-	sweat	Hyperhidrosis
hist(o)-, histio-	tissue	Histology
home(o)-	similar	Homeopathy
hom(o)-	Denotes something as 'the same' as another or common	Homologous chromosomes
humer(o)-	Of or pertaining to the shoulder (or [rarely] the upper arm)	Humerus
hydr(o)-	water	Hydrocephalus

hyper-	Denotes something as 'extreme' or 'beyond normal'	Hypertension
hyp(o)-	Denotes something as 'below normal'	Hypovolemia,
hyster(o)-	Of or pertaining to the womb, the uterus	Hysterectomy, Hysteria

I: PREFIX/ SUFFIX	Greek and/or Latin Meaning	Example(s)
-i-asis	condition, formation, or presence of	Mydriasis
iatr(o)-	Of or pertaining to medicine, or a physician (uncommon as a prefix; common as a suffix, see - iatry)	latrogenic condition
-iatry	Denotes a field in medicine of a certain body component	Podiatry, psychiatry
-ic	pertaining to	Hepatic artery
-icle	small	Ovarian follicle
idio-	self, one's own	Idiopathic
ileo-	ileum	lleocecal valve
infra-	below	Infrahyoid muscles
inter-	between, among	Interarticular ligament
intra-	within	intramural
ipsi-	same	Ipsilateral
irid(o)-	iris	Iridectomy
isch-	restriction	Ischemia
ischio-	Of or pertaining to the ischium, the hip-joint	Ischioanal fossa
-ism	condition, disease	Dwarfism
-ismus	spasm, contraction	Hemiballismus
iso-	Denoting something as being 'equal'	Isotonic
-ist	one who specializes in	Pathologist
-ite	the nature of, resembling	Hermaphrodite
-itis	inflammation	Tonsillitis
-ium	structure, tissue	pericardium

J: PREFIX/ SUFFIX	Greek and/or Latin Meaning	Example(s)
juxta (iuxta)	Near to, alongside or next to	Juxtaglomerular apparatus

K: PREFIX/ SUFFIX	Greek and/or Latin Meaning	Example(s)
kal-	potassium	hyperkalemia
kary-	nut, nucleus ("nut")	eukaryote
kerat-	cornea (eye or skin), ("horn")	keratoscope
kine-	movement	akinetopsia, kinesthesia
kyph-	humped	kyphoscoliosis

L: PREFIX/ SUFFIX	Greek and/or Latin Meaning	Example(s)
labi-	Of or pertaining to the lip	labiodental
lacrim(o)-	tear	Lacrimal canaliculi
lact(i)-, lact(o)	milk	Lactation
lapar(o)-	Of or pertaining to the abdominal wall, flank	Laparotomy
laryng(o)-	Of or pertaining to the larynx, lower throat cavity	Larynx
latero-	lateral	Lateral pectoral nerve
lei(o)-	smooth	Leiomyoma
-lepsis, -lepsy	attack, seizure	Epilepsy, narcolepsy
lept(o)-	light, slender	Leptomeningeal
leuc(o)-, leuk(o)-	Denoting a white color	Leukocyte
lingu(a)-, lingu(o)-	Of or pertaining to the tongue	Linguistics
lip(o)-	fat	Liposuction
liss(os)-	smooth	Lissencephaly
lith(o)-	stone, calculus	Lithotripsy
-logist	Denotes someone who studies a certain field (the field oflogy); a specialist;	Oncologist, pathologist
-logy	Denotes the academic study or practice of a certain field; the study of	hematology, urology
lumb(o)-, lumb(a)-	Of or relating to the part of the trunk between the lowest ribs and the pelvis.	Lumbar vertebrae
lymph(o)-	lymph	Lymphedema
lys(o)-, -lytic	dissolution	Lysosome
-lysis	Destruction, separation	Paralysis

M: PREFIX/ SUFFIX	Greek and/or Latin Meaning	Example(s)
macr(o)-	large, long	macrophage
-malacia	softening	osteomalacia
mamm(o)-	Of or pertaining to the breast	mammogram

mammill(o)-	Of or pertaining to the nipple	mammillaplasty, mammillitis
manu-	Of or pertaining to the hand	Manufacture
mast(o)-	Of or pertaining to the breast, pectoral area.	Mastectomy
meg(a)-, megal(o)-, - megaly	enlargement, million	Splenomegaly, megameter
melan(o)-	black color	Melanin
mening(o)-	membrane	Meningitis
men-	month, menstrual cycle	menopause, menorrhagia
mes-	middle	mesoderm
met, meta-	after, beside, beyond or change	metacarpal, metacarpus, metacromion,
-meter	instrument used to measure or count	sphygmomanometer
-metry	process of measuring	optometry
metr-	Pertaining to conditions or instruments of the uterus	metrorrhagia
micr-	denoting something as small, or relating to smallness, millionth	Microscope
milli-	thousandth	milliliter
mon(o)-	single	infectious mononucleosis
morph-	form, shape	morphology
muscul(o)-	muscle	Musculoskeletal system
my(o)-	Of or relating to muscle	Myoblast
myc(o)-	fungus	Onychomycosis
myel(o)-	Of or relating to bone marrow or spinal cord	Myeloblast
myl(o)-	Of or relating to molar teeth or lower jaw	Mylohyoid nerve
myring(o)-	eardrum	Myringotomy
myx(o)-	mucus	Мухота

N: PREFIX/ SUFFIX	Greek and/or Latin Meaning	Example(s)
narc(o)-	numb, sleep	narcolepsy
nas(o)-	Of or pertaining to the nose	nasal
necr(o)-	death	Necrosis, necrotizing fasciitis
neo-	new	Neoplasm
nephr(o)-	Of or pertaining to the kidney	Nephrology
neur(i)-, neur(o)-	Of or pertaining to nerves and the nervous system	Neurofibromatosis

<b>O: PREFIX/ SUFFIX</b>	Greek and/or Latin Meaning	Example(s)
ocul(o)-	Of or pertaining to the eye	Oculist
odont(o)-	Of or pertaining to teeth	orthodontist
odyn(o)-	pain	stomatodynia
-oid	resemblance to	Sarcoidosis
ole	small or little	arteriole
om(o)-	shoulder	Omohyoid muscle
-oma (singular), - omata(plural)	tumor, mass, fluid collection	Sarcoma, teratoma, Mesothelioma
omphal(o)-	Of or pertaining to the navel, the umbilicus	Omphalotomy
onco-	tumor, bulk, volume	Oncology
onych(o)-	Of or pertaining to the nail (of a finger or toe)	Onychophagy
00-	Of or pertaining to an (egg), a woman's egg, the ovum	Oogenesis
oophor(o)-	Of or pertaining to the woman's (ovary)	Oophorectomy
ophthalm(o)-	Of or pertaining to the (eye)	Ophthalmology
-opsy	Examination or inspection	Biopsy, autopsy
optic(o)-	Of or relating to chemical properties of the eye	Opticochemical, biopsy
or(o)-	Of or pertaining to the mouth	Oral
orchi(o)-, orchid(o)-, orch(o)-	testis	Orchiectomy, orchidectomy
orth(o)-	Denoting something as straight or correct	Orthodontist
-osis	a condition, disease or increase	Harlequin type ichthyosis, psychosis, osteoporosis
osse-, ossi-	bony, bone	Osseous, ossifification
ost(e)-, oste(o)-	bone	[[Osteoporosis], Osteoarthritis
ot(o)-	Of or pertaining to the ear	Otology
-ous	pertaining to	porous
ovari(o)-	Of or pertaining to the ovaries	Ovariectomy
ovo-, ovi-, ov-	Of or pertaining to the eggs, the ovum	Ovogenesis
oxy-	sharp, acid, acute, oxygen	Oxytocin, oxygenated, oxycodone

P: PREFIX/ SUFFIX	Greek and/or Latin Meaning	Examples
pan-, pant(o)-	Denoting something as 'complete' or containing 'everything'	pandemic
papill-	Of or pertaining to the nipple (of the chest/breast)	papillitis
papul(o)-	Indicates papulosity, a small elevation or swelling in the skin, a pimple, swelling	papulation
para-	alongside of	paracyesis
-paresis	slight paralysis	hemiparesis
parvo-	small	Parvovirus
path(o)-	disease	Pathology
-pathy	Denotes (with a negative sense) a disease, or disorder	sociopathy, neuropathy
pauci-	Few	Pauci-immune
pector-	breast or chest	pectoralgia, pectoriloquy, pectorophony
ped-, -ped-, -pes	Of or pertaining to the foot; -footed	Pedoscope
ped-, pedo-	Of or pertaining to the child	pediatrics. pedophilia
pelv(i)-, pelv(o)-	hip bone	Pelvis
-penia	deficiency	osteopenia
peo-	Of or pertaining to the penis	Peotomy
-pepsia	Denotes something relating to digestion, or the digestive tract.	Dyspepsia
per-	through	percutaneous
peri-	Denoting something with a position 'surrounding' or 'around' another	Periodontal
-реху	fixation	Orchiopexy
phaco-	lens-shaped	phacolysis, phacometer, phacoscotoma
-phage, -phagia	Forms terms denoting conditions relating to eating or ingestion	Dysphagia
-phago-	eating, devouring	phagocyte
phagist-	Forms nouns that denote a person who 'feeds on' the first element or part of the word	Lotophagi
-phagy	Forms nouns that denotes 'feeding on' the first element or part of the word	hematophagy
phall-	phallus	Aphallia
pharmac-	drug, medication	pharmacology
pharyng-	Of or pertaining to the pharynx, the upper throat cavity	pharyngitis, pharyngoscopy
-phil(ia)	attraction for	hemophilia
phleb-	Of or pertaining to the (blood) veins, a vein	phlebography, phlebotomy
-phobia	exaggerated fear, sensitivity, aversion	arachnophobia

phren-, phrenic-	the mind	phrenic nerve, schizophrenia
phyt-	to grow	hydrophyte
pia-	soft	pia mater
piri-	Pear	Piriformis muscle
-plasia	formation, development	Achondroplasia
-plasty	surgical repair, reconstruction	Mammoplasty
-plegia	paralysis	paraplegia
pleio-	more, excessive, multiple	pleiomorphism
pleur-	Of or pertaining to the ribs	Pleurogenous
-plexy	stroke or seizure	Cataplexy
pne-, pneum-	air, breath, lung	apnea, pneumatology, pneumonocyte, pneumonia
pod-, -pod-, -pus	Of or pertaining to the foot, -footed	podiatry
-poiesis	production	hematopoiesis
polio-	Denoting a grey color	poliomyelitis
poly-	Denotes a 'plurality' of something	polymyositis
por-	pore, porous	pore
porphyr-	Denotes a purple color	porphyroblast
post-	Denotes something as 'after' or 'behind' another	postoperation, postmortem
pre-	Denotes something as 'before' another (in [physical] position or time)	premature birth
presby-	old age	presbyopia,
prim-	Denotes something as 'first' or 'most- important'	primary
pro-	Denotes something as 'before' another (in [physical] position or time)	procephalic
proct-	anus, rectum	proctology
prosop-	face	prosopagnosia
prot-	Denotes something as 'first' or 'most important'	protoneuron
pseud-	Denotes something false or fake	pseudoephedrine
psor-	Itching	psoriasis
psych-	Of or pertaining to the mind	psychology, psychiatry
pterygo-	Pertaining to a wing	lateral pterygoid plate
-ptosis	falling, drooping, downward placement, prolapse	apoptosis, nephroptosis
-ptysis	spitting	hemoptysis, the spitting of blood derived from the lungs or bronchial tubes
pulmon- <i>,</i> pulmo-	Of or relating to the lungs	pulmonary
ру-	pus	pyometra
pyel-	pelvis	pyelonephritis
pykno-	to thicken (as the nucleus does in early stages of cell death)	pyknosis
pylor-	gate	pyloric sphincter

pyr- fever antipyretic
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Q: PREFIX/ SUFFIX	Greek and/or Latin Meaning	Example(s)
quadr(i)-	four	quadriceps

R: PREFIX/ SUFFIX	Greek and/or Latin Meaning	Example(s)
radic-	referring to the beginning, or the root, of a structure, usually a nerve or a vein	radiculopathy
re-	again, back	relapse
rect-	rectum	rectal, rectum
ren-	Of or pertaining to the kidney	renal
reticul(o)-	net	reticulocyte
retro-	backward, behind	retroversion, retroverted
rhabd(o)-	rod shaped, striated	rhabdomyolysis
rhachi(o)-	spine	rachial, rachialgia, rachidian, rachiopathy
rhin(o)-	Of or pertaining to the nose	rhinoceros, rhinoplasty
rhod(o)-	Denoting a rose-red color	rhodophyte
-rrhage	burst forth	Hemorrhage
-rrhagia	rapid flow of blood	menorrhagia
-rrhaphy	surgical suturing	neurorrhaphy
(a)rrhea	profuse flow, or outflow	diarrhea, amenorrhea
-rrhexis	rupture	Karyorrhexis
rubr(o)-	Of or pertaining to the red nucleus of the brain	Rubrospinal
-rupt	Break or burst	Erupt, Interrupt

S: PREFIX/ SUFFIX	Greek and/or Latin Meaning	Example(s)
salping(o)-	Of or pertaining to tubes e.g. fallopian tubes	Salpingectomy, salpingopharyngeus muscle
sangui-, sanguine-	Of or pertaining to blood	Sanguine
sarco-	muscular, fleshlike	sarcoma, sarcoidosis
schist(o)-	split, cleft	schistocyte
schiz(o)-	Denoting something 'split' or 'double-sided'	Schizophrenia
scler(o)-	hard	Scleroderma
-sclerosis	hardening	Atherosclerosis, multiple sclerosis
scoli(o)-	twisted	scoliosis
-scope	instrument for viewing	stethoscope
-scopy	use of instrument for viewing	endoscopy
scoto-	darkness	scotopic vision
semi-	one-half, partly	semiconscious
sigmoid(o)-	sigmoid, S-shaped curvature	sigmoid colon

sinus-	Of or pertaining to the sinus	Sinusitis
sito-	food, grain	Sitophobia
somat(o)-, somatico-	body, bodily	somatic
-spadias	slit, fissure	hypospadias, epispadias
spasmo-	spasm	Spasmodic dysphonia
sperma-, spermo-, spermato-	semen, spermatozoa	Spermatogenesis
splanchn(i)- <i>,</i> splanchn(o)-	viscera	splanchnology
splen(o)-	spleen	Splenectomy
spondyl(o)-	Of or pertaining to the spine, the vertebra	Spondylitis
squamos(o)-	Denoting something as 'full of scales' or 'scaly'	Squamous cell
-stalsis	contraction	Peristalsis
-stasis	stopping, standing	Cytostasis, homeostasis
sten(o)-	Denoting something as 'narrow in shape' or pertaining to narrowness	Stenography
-stenosis	abnormal narrowing in a blood vessel or other tubular organ or structure	restenosis, stenosis
steth-	Of or pertaining to the upper chest, chest, the area above the breast and under the neck	stethoscope
stom-, stomat-	Of or pertaining to the mouth; an artificially created opening	stomatogastric, stomatognathic system
-stomy	creation of an opening	colostomy
sub-	beneath, under	subcutaneous tissue
super-	in excess, above, superior	superior vena cava
supra-	above, excessive	supraorbital vein
sy, syl-, sym-, syn-, sys-	Indicates similarity, likeness, or being together	symptom, synalgia, synesthesia, syssarcosis

T: PREFIX/ SUFFIX	Greek and/or Latin Meaning	Example(s)
tachy-	Denoting something as fast, irregularly fast	tachycardia
-tension, - tensive	pressure	Hypertension
terato-	Monster	teratoma, teratogen
tetan-	rigid, tense	tetanus
thec-	case, sheath	Intrathecal
thel-	Of or pertaining to a nipple ( <i>uncommon as a prefix</i> )	Theleplasty, thelarche
therap-	treatment	hydrotherapy, therapeutic
therm(o)-, - therm	heat	hypothermia

thorac(i)-,	Of or pertaining to the upper chest, chest;		
thorac(o)-,	the area above the breast and under the	thoracic, thorax	
thoracico-	neck		
thromb(o)-	Of or relating to a blood clot, clotting of	Thrombus, thrombocytopenia	
	blood		
thyr(o)-	thyroid		
thym-	emotions	dysthymia	
-tome	cutting instrument	Osteotome	
-tomy	act of cutting; incising, incision	Gastrotomy	
top(o)-	place, topical	Topical anesthetic	
tort(i)-	twisted	Testicular Torsion, Torticollis	
tox(i)-, tox(o)-,	toxin, poison	Toxoplasmosis	
toxic(o)-			
trache(a)-	trachea Tracheotomy		
trachel(o)-	Of or pertaining to the neck	tracheloplasty	
trans-Denoting something as moving or situated across or throughTransfusion		Transfusion	
tri-	three	triangle, triceps	
trich(i)-, trichia,	Of or pertaining to hair, hair-like structure	Trichocyst	
trich(o)-			
-tripsy	crushing	Lithotripsy	
-trophy	nourishment, development	Pseudohypertrophy	
tympan(o)-	eardrum	Tympanic Nerve	

U: PREFIX/ SUFFIX	Greek and/or Latin Meaning	Example(s)	
-ula, -ule	small	Nodule	
ultra-	beyond, excessive	Ultrasound, ultraviolet	
umbilic-	Of or pertaining to the navel, the umbilicus Umbilical		
ungui-	Of or pertaining to the nail, a claw	Unguiform, Ungual	
un(i)-	one	Unilateral hearing loss	
ur-	Of or pertaining to urine, the urinary system	antidiuretic, diuresis, diuretic, dysuria, enuresis, polyurea, polyuria, uraemia/uremia, uremic, ureter, urethra, urology	
urin-	Of or pertaining to urine, the urinary system	Uriniferous	
uter(o)-	Of or pertaining to the uterus or womb	Uterus	

V: PREFIX/ SUFFIX	Greek and/or Latin Meaning	Examples
vagin-	Of or pertaining to the vagina	Vagina
varic(o)-	swollen or twisted vein	varicose
vas(o)-	duct, blood vessel	vasoconstriction
vasculo-	blood vessel	vascular surgery

ven-	Of or pertaining to the veins, venous blood, and the vascular system	Venule, Venospasm	
ventr(o)-	Of or pertaining to the belly; the stomach cavities	stomach Ventrodorsal	
ventricul(o)-	ventricul(o)-Of or pertaining to the ventricles; any hollow region inside an organCardiac ventriculography		
-version	turning	anteversion, retroversion	
vesic(o)-	Of or pertaining to the bladder	vesical arteries	
viscer(o)-	Of or pertaining to the internal organs, the viscera	Viscera	

X: PREFIX/ SUFFIX	Greek and/or Latin Meaning	Example(s)	
xanth(o)-	Denoting a yellow color, an abnormally yellow color	Xanthopathy	
xen(o)-	Foreign, different	Xenograft	
xer(o)-	dry, desert-like	Xerostomia, xeroderma	
xiph-	sword	xiphisternum, xiphoid,	

Z: PREFIX/ SUFFIX	Greek and/or Latin Meaning	Example(s)
zo(o)-	animal, animal life	zoology
zym(o)-	fermentation	enzyme, lysozyme

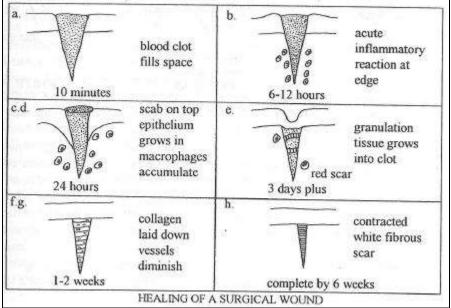
Source: https://en.wikipedia.org/wiki/List\_of\_medical\_roots,\_suffixes\_and\_prefixes, accessed 10/1/17, 3:30pm

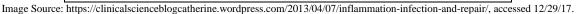
# **Appendix II: SUPPLEMENTAL INFORMATION**

# A. WOUND CLASSIFICATION and HEALING

Wound Class	Definition	Examples	Reminders	
Class I Clean	<ul> <li>Operative wound clean</li> <li>Non-traumatic, with no inflammation encountered</li> <li>No break in technique</li> <li>Respiratory, gastrointestinal and genitor-urinary tracts not entered</li> <li>Caesarean Section, elective, no pre-rupture of membranes or trial of labor</li> </ul>	<ul> <li>Vascular Procedures</li> <li>Neurological procedures (inflamed II, infected III)</li> <li>Endocrine procedures</li> <li>Eye surgery (inflamed II, foreign body III, infected III)</li> <li>Orthopedic procedures (unless: trauma III, old wound IV, amputation II)</li> <li>Penile prosthesis</li> <li>Skin (mastectomy, lumpectomy, lesions, lipoma, cosmetic, 18D IV, old wounds III, inflamed III, infected IV)</li> <li>Exploratory Lap (no bowel involvement II)</li> <li>Miscellaneous procedures (lymph node excision/Bx unless inflamed III or infected IV, splenectomy, tenckhoff cath unless replacement II)</li> </ul>		
Class II Clean - contaminated	<ul> <li>Operative wound clean-contaminated</li> <li>Non-traumatic wound with minor break in technique</li> <li>Gastrointestinal, respiratory or genitor-urinary tracts entered without significant spillage</li> <li>Includes:         <ul> <li>Transection of appendix or cholecystic duct in the absence of infected bile or urine</li> <li>Hysterectomy</li> <li>Caesarean Section, emergency involving pre-rupture of membranes and / or trial of labor</li> </ul> </li> </ul>	<ul> <li>Thoracic procedures (except mediastinoscopy I, inflammation III, infected IV, foreign body III)</li> <li>GI procedures (including: laparoscopy, colonoscopy, gastroscopy) (gross spillage III, acute inflammation III, fresh accidental wound III) (itis III, Lithiasis II)</li> <li>GU procedures (infected III)</li> <li>Ear surgery (infected III)</li> <li>Nose/Oropharynx procedures (infected IV)</li> <li>GYN procedures (Oophorectomy I, inflamed III, infected IV)</li> </ul>	<ul> <li>Any wound open for drainage II (except total hip / knee)</li> <li>Removing old implants (wires, pins, etc)</li> <li>Re-operation at the same site</li> </ul>	
Class III contaminated	<ul> <li>Operative wound contaminated</li> <li>Fresh traumatic wound from clean source</li> <li>Operative wound with a major break in technique</li> <li>Gross spillage from the gastrointestinal tract</li> <li>Entrance into the genito-urinary or billary tracts</li> <li>When infected urine or bile is present</li> <li>Indision encountering acute non-purulent inflammation.</li> </ul>	<ul> <li>Inflammation</li> <li>Gross spillage</li> <li>Fresh accidental wound</li> </ul>	<ul> <li>Foreign bodies in a wound (bullets, etc)</li> </ul>	
Class IV	Operative wound dirty	<ul> <li>Infected</li> </ul>		
Dirty - infected	<ul> <li>Traumatic wound from dirty source</li> <li>Traumatic wound with delayed treatment</li> <li>Fecal contamination</li> <li>Foreign body</li> <li>Retained devitalized tissue</li> <li>Operative wound w/ acute bacterial inflammation or perforated viscus</li> <li>Operative wound where clean tissue is transected to gain access to a collection of pus</li> </ul>	<ul> <li>I&amp;D abscess</li> <li>Wound debridement</li> </ul>		
Unclassified	When unable to classify accurately an operative wound		<ul> <li>Communicable disease (aids, hepatitis, TB) is not classified the surgical wound is what is being classified</li> </ul>	

Source: https://zencaesar.files.wordpress.com/2012/08/surgical-wound-classification.png, accessed 12/27/17.





### **B. BLOOD CLOTTING**

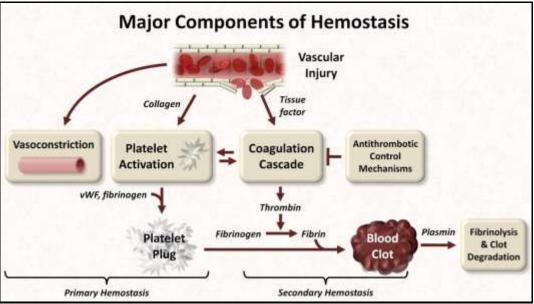


Image source: https://www.youtube.com/watch?v=5GPPt0kftfE, accessed 12/29/17

### **C. LAB VALUES**

LABORATORY TESTS	NORMAL VALUES	
HEMATOLOGY		
*Red Blood Cell Values		
RBC (Male)	4.2 - 5.6 M/μL	
RBC (Female)	3.8 - 5.1 M/µL	
*White Blood Cell Values		
WBC (Male)	3.8 - 11.0 K / mm cubed	
WBC (Female)	3.8 - 11.0 K / mm cubed	
*Hemoglobin Values		
Hgb (Male)	14 - 18 g/dL	
Hgb (Female)	11 - 16 g/dL	
Hgb (child)	10 - 14 g/dL	
Hgb (Newborn)	15 - 25 g/dL	
*Hematocrit Values		
Hct (Male)	39 - 54%	
Hct (Female)	34 - 47%	
MCV	78 - 98 fL	
MCH	27 - 35 pg	
MCHC	31 - 37%	
Neutrophils	50 - 81%	
Bands	1 - 5%	
Lymphocytes	14 - 44%	
Monocytes	2 - 6%	
Eosînophils	1 - 5%	
Basophils	0 - 1%	

CARDIAC MARKERS	
Troponin I	Less than 0.3 micrograms per liter (mcg/L)
Troponin T	Less than 0.2 mcg/L
Creatinine Kinase-MB (CK-MB)	0-3 micrograms per liter (mcg/L)
Total CPK (creatinine phosphokinase)	0-120 micrograms per liter (mcg/L)
LIPID PANEL (ADULT)	
Cholesterol (total)	Less than 200 mg/dL desirable
Cholesterol (HDL)	30 - 75 mg/dL
Cholesterol (LDL)	Less than 130 mg/dL desirable
Triglycerides (Male)	Greater than 40 - 170 mg/dL
Triglycerides (Female)	Greater than 35 - 135 mg/dL
SERUM ELECTROLYTE PROFILE	
Serum sodium	135 -145 mEq
Serum chloride	96 – 106 mEq/L
Serum phosphorus	2.4 - 4.1 mg/dl
Serum calcium	8.5 – 10.2 mg/dl
THYROID FUNCTION TEST	
T3	100-200 ng/dl
T4	4.5-11.2 mcg/dl
TSH	0.4 - 4.0 mIU/
COAGULATION TEST	
APTT	21 - 35 seconds
Platelets	140,000 - 450,000 / ml
Plasminogen	62 - 130%
PT	10 - 14 seconds
PTT	32 - 45 seconds
Fibrinogen	160 - 450 mg/dL
Bleeding time	3 - 7 minutes
Thrombin time	11 - 15 seconds
LIVER FUNCTION TEST	
•Serum albumin	3.4-5.4 g/dl
•Alanine transaminase(ALT)	10-34 IU/L
<ul> <li>Aspartate aminotransferase(AST)</li> </ul>	10-34 IU/L
•Gamma glutamyl transpeptidase(GGT)	0-51 IU/L
•Alkaline phosphatase(ALP)	44 -147 IU/L
Prothrombin time	11 – 13.5 seconds
Serum Bilirubin	
1. Direct bilirubin	0 - 0.3 mg/dl
2. Total bilirubin	0.3 - 1.9 mg/dl

BLOOD GASES	
* Arterial	
рН	7.35 - 7.45
PaCO2	35 - 45 mm Hg
нсоз	22 - 26 mEq/L
O2 sat	96 - 100%
PaO2	85 - 100 mm Hg
BE	-2 to +2 mmol/L
* Venous	
pН	7.31 - 7.41
PaCO2	41 - 51 mm Hg
нсоз	22 - 29 mEq/L
O2 sat	60 - 85%
PaO2	30 - 40 mm Hg
BE	0 to +4 mmol/L
KIDNEY FUNCTION TEST	
BUN (Blood Urea Nitrogen)	7 - 18 mg/dl
Creatinine, serum	0.6 - 1.2 mg/dl
Uric Acid Serum	3.0 - 8.2 mg/dL

Image Source: http://rn-post.com/study-guide-3/, accessed 12/28/17.

## **D.ANESTHETIC AGENTS**

#### a. I.V. agents

Drug	Induction and Recovery	Main Unwanted Effects	Notes
thiopental	Fast onset (accumulation occurs, giving slow recovery) Hangover	Cardiovascular and respiratory depression	Used as induction agent declining. ↓ CBF and O2 consumption Injection pain
etomidate	Fast onset, fairly fast recovery	Excitatory effects during induction Adrenocortical suppression	Less cvs and resp depression than with thiopental, Injection site pair
propofol	Fast onset, very fast recovery	cvs and resp depression Pain at injection site.	Most common induction agent. Rapidly metabolized; possible to use as continuous infusion. Injection pain. Antiemetic
ketamine	Slow onset, after- effects common during recovery	Psychotomimetic effects following recovery, Postop nausea, vomiting, salivation	Produces good <b>analgesia</b> and amnesia. No injection site pain
midazolam	Slower onset than other agents	Minimal CV and resp effects.	Little resp or cvs depression. No pain. Good amnesia. 38

Image source: https://www.slideshare.net/Pharmacologist/2014-general-anesthetics, accessed 12/29/17.

#### **b.** Local agents

Esters	Max Dose (mg/kg)	Duration (h)
Chloroprocaine	12	0.5 - 1
Procaine	12	0.5 - 1
Cocaine	3	0.5 - 1
Tetracaine	3	1.5 - 6
Amides	Max Dose (mg/kg)	Duration (h)
Lidocaine	4.5/(7 with epi)	0.75 - 1.5
Mepivacaine	4.5/(7 with epi)	1-2
Prilocaine	8	0.5 - 1
Bupivacaine	3	1.5 - 8
Ropivacaine	3	1.5 - 8

Image source: https://www.openanesthesia.org/local\_anesthetics\_systemic\_toxicity/, accessed 12/29/17.

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### **APPENDIX IV: ANSWERS TO SAMPLE QUESTIONS**

SAMPLE QUESTION 1.1: Thumb inferior, then back to superior

SAMPLE QUESTION 1.2: Superficial to its corresponding ventral roots

**SAMPLE QUESTION 1.3: Duodenum and common bile duct** 

SAMPLE QUESTION 1.4: Proximal and anterior to the pes anserinus, medial to the patellar ligament.

SAMPLE QUESTION 1.5: Into the space between the spinal canal and the dura mater covering the nerve roots.

**SAMPLE QUESTION 2.1: Patellar Ligament** 

SAMPLE QUESTION 2.2: Calcaneus, navicular, tibia, and calcaneus

SAMPLE QUESTION 2.3: Pubis, ischium, and ilium.

SAMPLE QUESTION 2.5: Pancreas

SAMPLE QUESTION 2.6: Internal iliac artery

SAMPLE QUESTION 2.7: More than about 10%

SAMPLE QUESTION 2.8: Increasing blood flow to the brain

**SAMPLE QUESTION 2.9: Cardiac Tamponade** 

SAMPLE QUESTION 2.10: Lower than normal hemoglobin

SAMPLE QUESTION 2.11: Bradycardia

**SAMPLE QUESTION 2.12: Peroneal** 

**SAMPLE QUESTION 2.13: Vagus Nerve** 

SAMPLE QUESTION 2.14: Calot's triangle

**SAMPLE QUESTION 2.15: The Splenic Flexure of the colon** 

**SAMPLE QUESTION 2.16: Splenic Artery** 

SAMPLE QUESTION 2.17: The open approach generally utilizes a low transverse collar incision

SAMPLE QUESTION 2.18: Rapid blood pressure change.

SAMPLE QUESTION 2.19: All of the above are true statements.

SAMPLE QUESTION 2.20: Broad ligament.

SAMPLE QUESTION 2.21: Pudendal nerve and its branches

SAMPLE QUESTION 2.22: Bowman's capsule, collecting ducts, renal calyx, renal pelvis, and ureter

SAMPLE QUESTION 2.23: Hypoventilation lengthens the time taken to exhale the anesthetic agent and delays recovery.

SAMPLE QUESTION 2.24: Optimized cardiac output

SAMPLE QUESTION 2.25: Removal and biopsy of successive lymph nodes starting at the known tumor site along the lymphatic pathway until a "negative" node is discovered.

SAMPLE QUESTION 3.1: Vagus nerve.

**SAMPLE QUESTION 3.2: The carotid triangle** 

SAMPLE QUESTION 3.3: Absence of branches in the neck, superior to the common carotid bifurcation

SAMPLE QUESTION 3.4: Maxillary branch of CN V (Trigeminal)

SAMPLE QUESTION 3.5: Subclavian vein and artery, and brachial plexus.

**SAMPLE QUESTION 3.6:** The right atrium and the right ventricle

SAMPLE QUESTION 3.7: Subclavian artery/s

SAMPLE QUESTION 3.8: 5

- SAMPLE QUESTION 3.9: 3
- SAMPLE QUESTION 3.10: 2
- SAMPLE QUESTION 3.11: Transverse colon
- **SAMPLE QUESTION 3.12: Marginal artery**
- SAMPLE QUESTION 3.13: Right hepatic artery
- SAMPLE QUESTION 3.14: 45
- SAMPLE QUESTION 3.15: Quadrate Lobe
- SAMPLE QUESTION 3.16: Any of the above
- SAMPLE QUESTION 3.17: Medial to the internal inguinal ring
- SAMPLE QUESTION 3.18: Femoral triangle
- SAMPLE QUESTION 3.19: Sciatic nerve
- SAMPLE QUESTION 3.20: Central spinal stenosis
- SAMPLE QUESTION 3.21: Omohyoid muscle
- SAMPLE QUESTION 3.22: Median nerve
- SAMPLE QUESTION 3.23: Deep and superficial volar
- SAMPLE QUESTION 3.24: Long head of the biceps
- SAMPLE QUESTION 3.25: Coracoacromial ligament
- SAMPLE QUESTION 3.26: Tibial nerve
- SAMPLE QUESTION 3.27: Popliteal artery

SAMPLE QUESTION 3.28: Its opening marks the location for the distal anastomosis during in femoral-popliteal bypass.

#### SAMPLE QUESTION 4.1: X and XII

SAMPLE QUESTION 4.2: Internal carotid artery.

SAMPLE QUESTION 4.3: Prevent sinus bradycardia

**SAMPLE QUESTION 4.4: Reversibly arrest the heart beat** 

**SAMPLE QUESTION 4.5:** Anterior to the medial malleolus

SAMPLE QUESTION 4.6: Scarpa's fascia, obliques, transversus abdominus, transversalis fascia.

**SAMPLE QUESTION 4.7: Class IV: Dirty Infected** 

SAMPLE QUESTION 4.8: Through a small umbilical incision, elevating the anterior fascia with Kocher clamps and penetrating the abdominal wall with slow downward pressure with a Veress needle, followed by confirmation of negative intra-abdominal pressure with a syringe and saline, then insufflation to a desired pressure through the Veress needle.

**SAMPLE QUESTION 4.9: Hydrops** 

SAMPLE QUESTION 4.10: Gallbladder retracted superiorly, and the redundant infundibular laterally

SAMPLE QUESTION 4.11: Ilio-inguinal and ileo-hypogastric

SAMPLE QUESTION 4.12: Within Hasselbach's triangle outside the cord structure and internal inguinal ring.

SAMPLE QUESTION 4.13: Post-op seroma

SAMPLE QUESTION 4.14: Decrease skin perforation and/or thermal damage from cautery. SAMPLE QUESTION 4.15: Paralysis of the serratus anterior

SAMPLE QUESTION 4.16: Sigmoid Colectomy

**SAMPLE QUESTION 4.17:** Superior Mesenteric Artery

SAMPLE QUESTION 4.18: Taenia Coli

SAMPLE QUESTION 4.19: The Connell stitch penetrates the mucosal layer, while the Cushing does not.

SAMPLE QUESTION 4.20: Ligamentum flavum

**SAMPLE QUESTION 4.21: Frazier suction tip** 

SAMPLE QUESTION 4.22: Arachnoid mater and dura mater.

**SAMPLE QUESTION 4.23: Internal fixation** 

SAMPLE QUESTION 4.24 Threaded screw heads facilitate mechanical coupling to the plate for angular screw stability.

SAMPLE QUESTION 4.25: Contraindicated in pediatric surgery.

SAMPLE QUESTION 4.26: Patellar ligament

SAMPLE QUESTION 4.27: Medial distal insertion

SAMPLE QUESTION 4.28: Anterior

**SAMPLE QUESTION 4.29: Gluteus medias** 

SAMPLE QUESTION 5.1: Microsurgery

**SAMPLE QUESTION 5.2:** Bipolar cautery forceps

**SAMPLE QUESTION 5.3:** The suture should exit the jaw of the clamp at the very tip.

SAMPLE QUESTION 5.4: The number your surgeon wants plus one.

SAMPLE QUESTION 5.5: Poor relative knot security compared with braided material.

SAMPLE QUESTION 5.6: Turn the skin edges up, that is, line up the dermal margins.