Anatomy & Physiology

Division B/C

Georgia Tech Event Workshop Series
2024-25

Science Olympiad at Georgia Tech®

01 RULES SHEET

02 DIFFICULT TOPICS

03 COMMON QUESTIONS

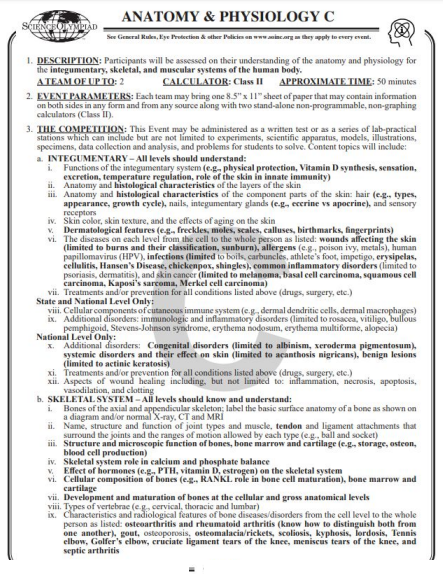
04 TIPS FROM A VETERAN

05 OTHER FREE RESOURCES

https://www.facebook.com/AnatomyEducation/photos/a.281228008578 34/1098311303530163/?_rdr

The Rules Sheet

- 1 page front and back
- 2 calculators
- Bold shows changes
- 3 systems
  - Integ, Skel, and Musc
- At least 20 MCQ for each system
- At least one labelling for each system
- Points are somewhat equal across each system
- Labeling > MCQ > FRQ in terms of simplicity
  - Labeling should be free from memory/notes | mcq is usually basic knowledge



ANATOMY & PHYSIOLOGY C

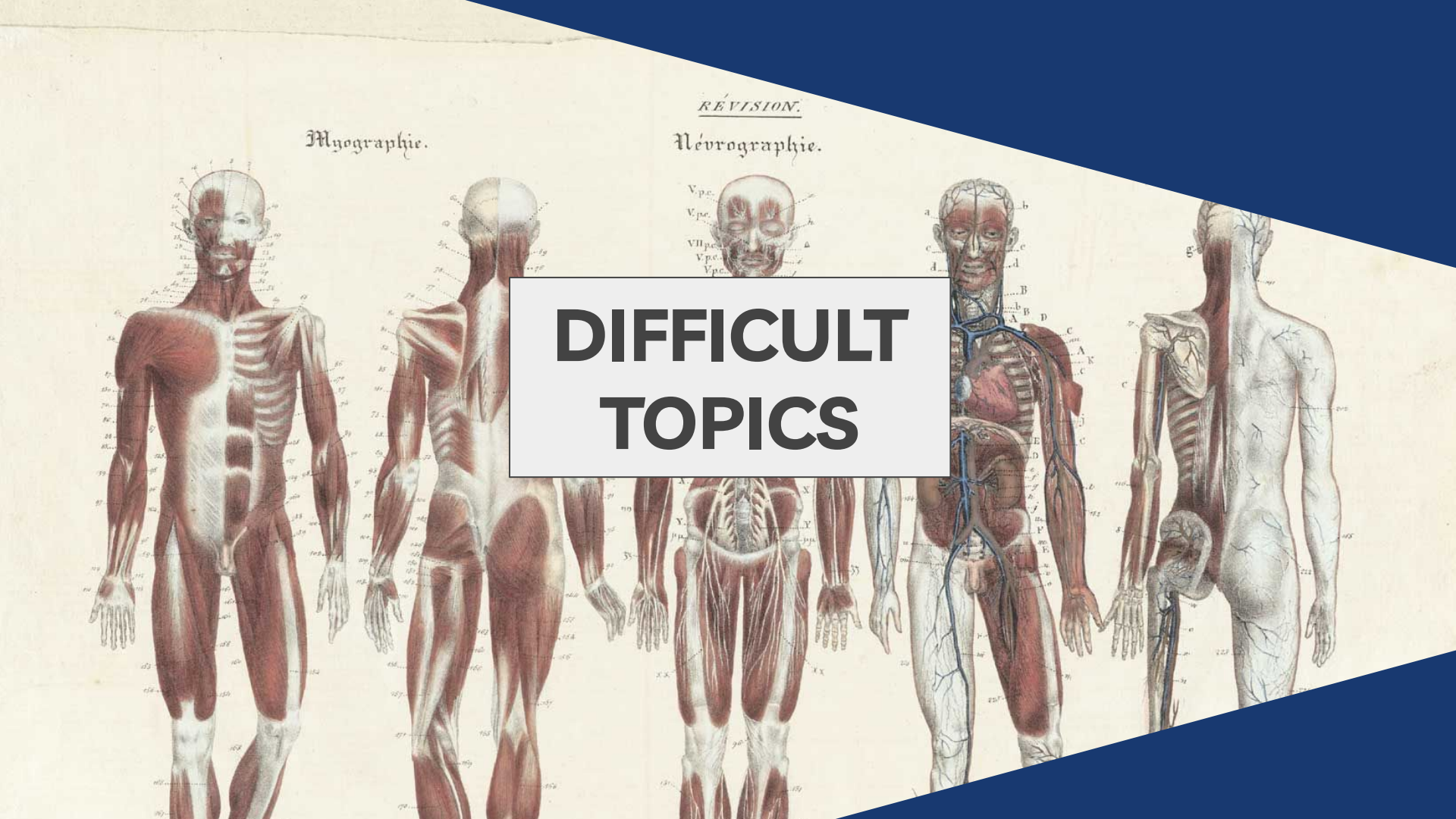
See General Rules, Eye Protection & other Policies on www.soinc.org as they apply to every event.

1. **DESCRIPTION:** Participants will be assessed on their understanding of the anatomy and physiology for the **integumentary, skeletal, and muscular systems of the human body.**
   A TEAM OF UP TO: 2 **CALCULATOR: Class II APPROXIMATE TIME:** 50 minutes
2. **EVENT PARAMETERS:** Each team may bring one 8.5" x 11" sheet of paper that may contain information on both sides in any form and from any source along with two stand-alone non-programmable, non-graphing calculators (Class II).
3. **THE COMPETITION:** This Event may be administered as a written test or as a series of lab-practical stations which can include but are not limited to experiments, scientific apparatus, models, illustrations, specimens, data collection and analysis, and problems for students to solve. Content topics will include:
   a. **INTEGUMENTARY – All levels should understand:**
      i. Functions of the integumentary system **(e.g., physical protection, Vitamin D synthesis, sensation, excretion, temperature regulation, role of the skin in innate immunity)**
      ii. Anatomy and **histological characteristics** of the layers of the skin
      iii. Anatomy and **histological characteristics** of the component parts of the skin: hair **(e.g., types, appearance, growth cycle),** nails, integumentary glands **(e.g., eccrine vs apocrine),** and sensory receptors
      iv. Skin color, skin texture, and the effects of aging on the skin
      v. **Dermatological features (e.g., freckles, moles, scales, calluses, birthmarks, fingerprints)**
      vi. The diseases on each level from the cell to the whole person as listed: **wounds affecting the skin (limited to burns and their classification, sunburn), allergens** (e.g., poison ivy, metals), human papillomavirus (HPV), **infections (limited** to boils, carbuncles, athlete's foot, impetigo, **erysipelas, cellulitis, Hansen's Disease, chickenpox, shingles), common inflammatory disorders** (limited to psoriasis, dermatitis), and skin cancer **(limited to melanoma, basal cell carcinoma, squamous cell carcinoma, Kaposi's sarcoma, Merkel cell carcinoma)**
      vii. Treatments and/or prevention for all conditions listed above (drugs, surgery, etc.)

   State and National Level Only:
      viii. Cellular components of cutaneous immune system (e.g., dermal dendritic cells, dermal macrophages)
      ix. Additional disorders: immunologic and inflammatory disorders (limited to rosacea, vitiligo, bullous pemphigoid, Stevens-Johnson syndrome, erythema nodosum, erythema multiforme, alopecia)

   National Level Only:
      x. Additional disorders: **Congenital disorders (limited to albinism, xeroderma pigmentosum), systemic disorders and their effect on skin (limited to acanthosis nigricans), benign lesions (limited to actinic keratosis)**
      xi. Treatments and/or prevention for all conditions listed above (drugs, surgery, etc.)
      xii. Aspects of wound healing including, but not limited to: inflammation, necrosis, apoptosis, vasodilation, and clotting
   b. **SKELETAL SYSTEM – All levels should know and understand:**
      i. Bones of the axial and appendicular skeleton; label the basic surface anatomy of a bone as shown on a diagram and/or normal X-ray, CT and MRI
      ii. Name, structure and function of joint types and muscle, **tendon** and ligament attachments that surround the joints and the ranges of motion allowed by each type (e.g., ball and socket)
      iii. **Structure and microscopic function of bones, bone marrow and cartilage (e.g., storage, osteon, blood cell production)**
      iv. **Skeletal system role in calcium and phosphate balance**
      v. **Effect of hormones (e.g., PTH, vitamin D, estrogen) on the skeletal system**
      vi. **Cellular composition of bones (e.g., RANKL role in bone cell maturation), bone marrow and cartilage**
      vii. **Development and maturation of bones at the cellular and gross anatomical levels**
      viii. Types of vertebrae (e.g., cervical, thoracic and lumbar)
      ix. Characteristics and radiological features of bone diseases/disorders from the cell level to the whole person as listed: **osteoarthritis and rheumatoid arthritis (know how to distinguish both from one another), gout,** osteoporosis, **osteomalacia/rickets, scoliosis, kyphosis, lordosis, Tennis elbow, Golfer's elbow, cruciate ligament tears of the knee, meniscus tears of the knee, and septic arthritis**

Div B **Div C**



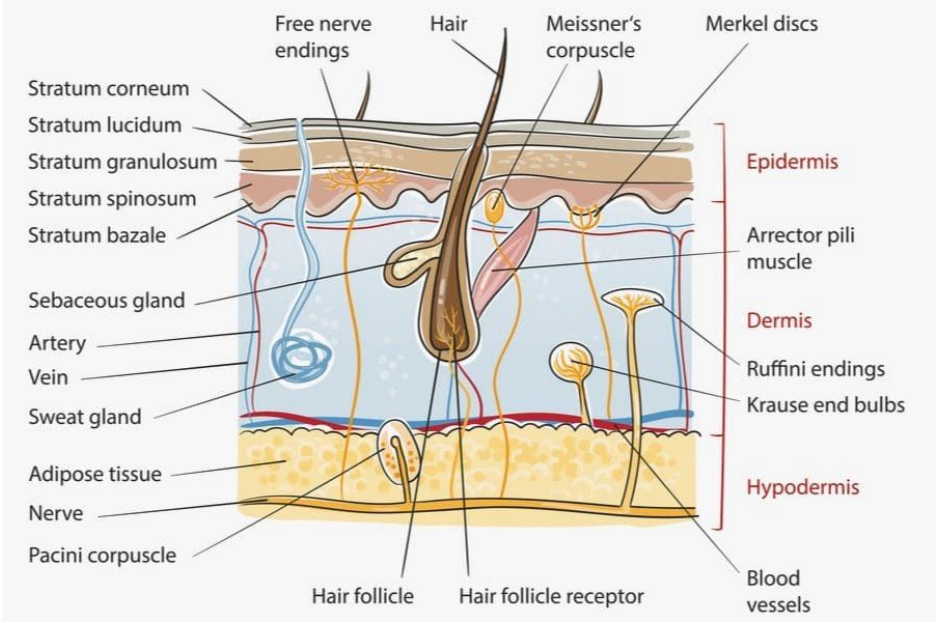
DIFFICULT TOPICS

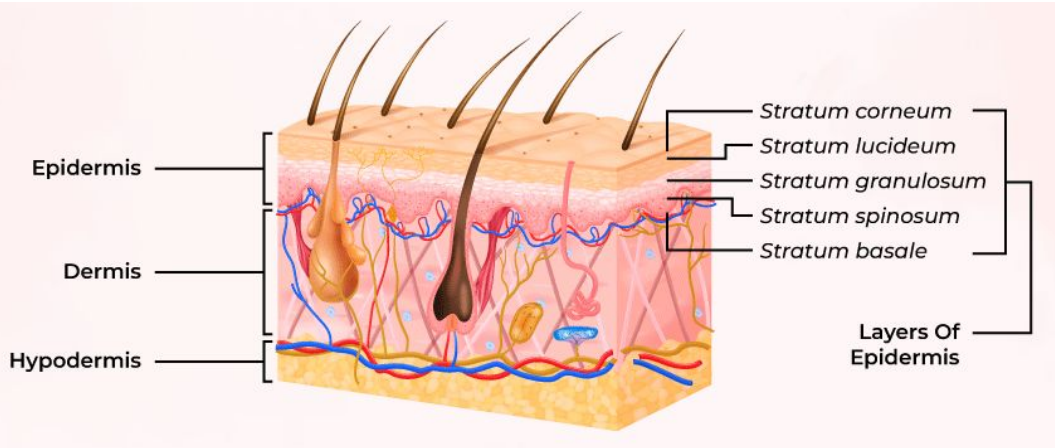
Topic 1: Detailed Anatomy and Histology of the Integumentary System

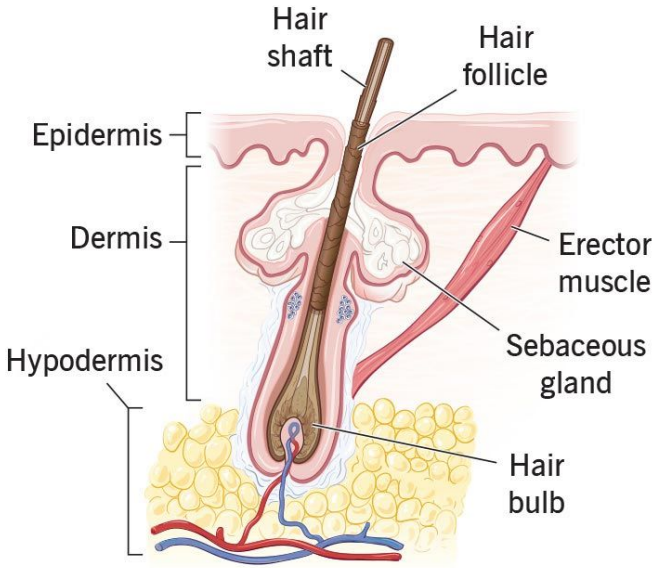
Challenge: Mastering the microscopic and gross anatomy of the skin's layers, glands, and receptors, along with understanding diseases at the cellular level.

Advice:

- Start by creating detailed diagrams of the skin layers, glands, and sensory receptors to visualize how each part is structured.
- Use color-coded flashcards to match specific diseases with their histological features and treatments.
- Practice connecting the structure of each component to its function in protection, sensation, and immunity, and learn how conditions like burns and infections affect each layer differently.





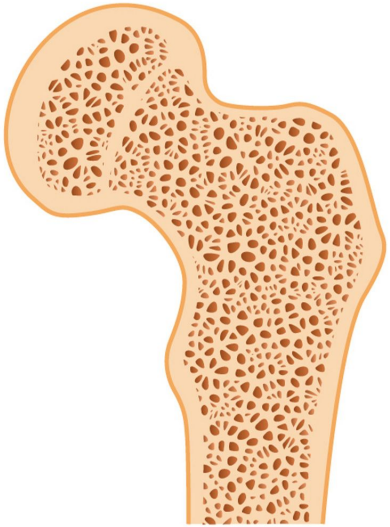


Topic 2: Bone Diseases and Disorders, Including Radiological Features

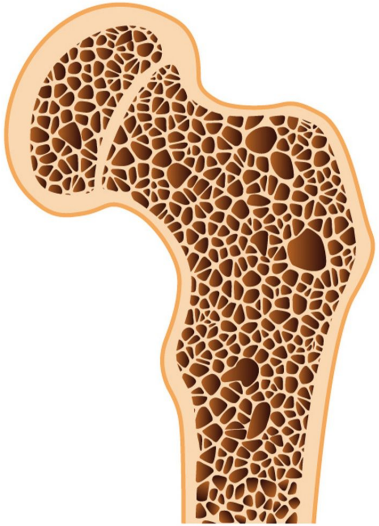
Challenge: This topic includes understanding a range of skeletal diseases (e.g., osteoarthritis, osteoporosis) and how they present in radiographs, CT, and MRI images.

Advice:

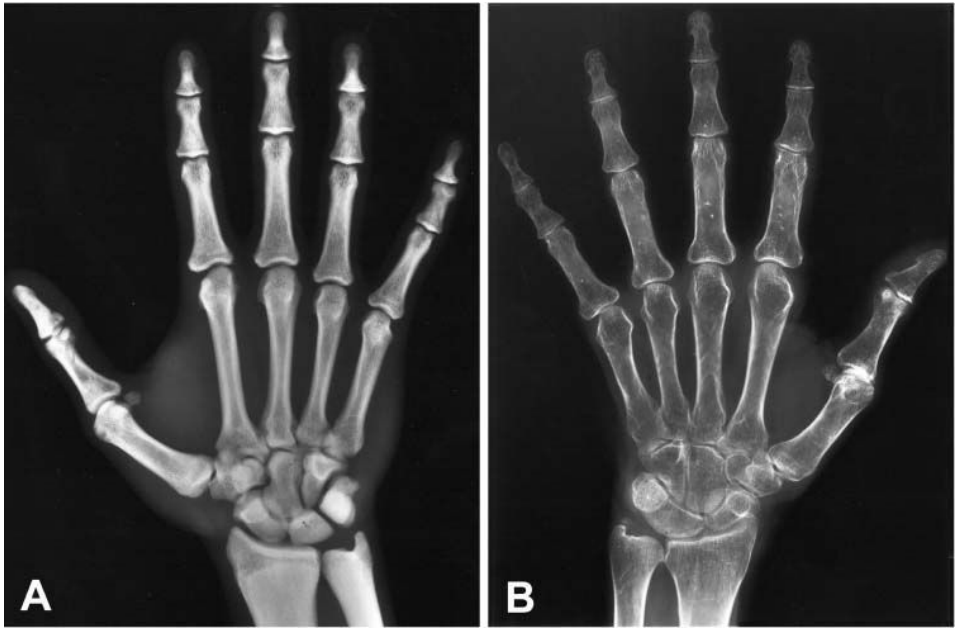
- Focus on the basic visual patterns associated with different disorders by studying sample images of X-rays, CT scans, and MRIs for each condition.
  - Identify key features, such as bone density changes in osteoporosis or joint space narrowing in arthritis.
- Practice with diagrams to learn bone structure, then expand to radiographs and MRI interpretations for a full understanding of disease progression and characteristics.



Healthy bone



Osteoporosis



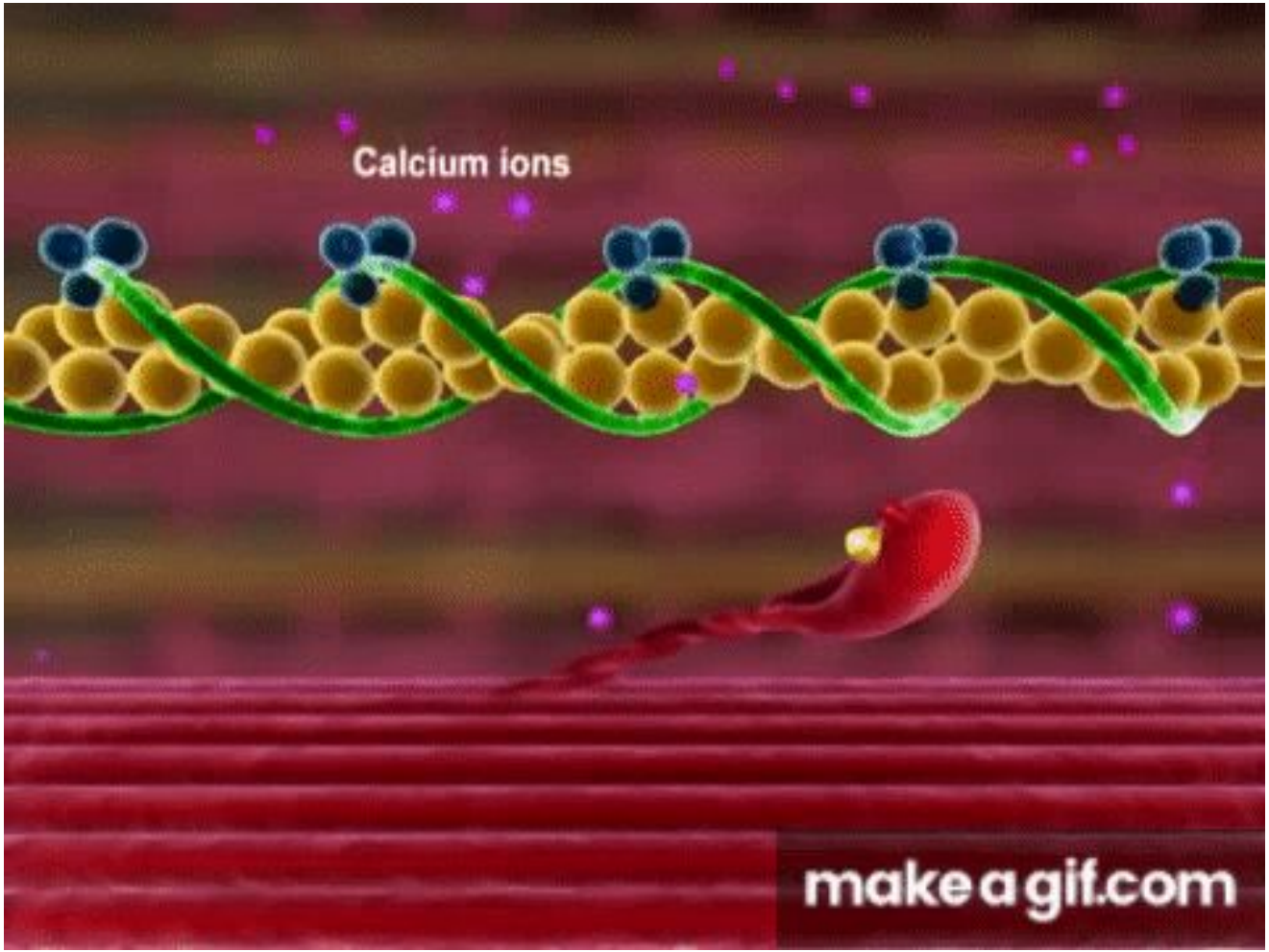
Topic 3: Physiology of Muscle Contraction and Muscle Metabolism

Challenge: Understanding the complex process of muscle contraction (neuromuscular junction, cross-bridge cycling) and energy metabolism (phosphocreatine system, glycogen usage).

Advice:

- Break down each step of the muscle contraction process into small, memorable stages (e.g., signal transmission, sarcomere shortening, relaxation).
- Create flowcharts to visualize each phase of muscle metabolism and how energy sources are used during different types of exercise.
- Practicing case studies of exercise physiology can help reinforce these pathways, showing how different energy systems are used based on exercise intensity and duration.

Cross-bridge cycling is a sequence of molecular events that underlies the sliding filament theory. A cross-bridge is a myosin projection, consisting of two myosin heads, that extends from the thick filaments.[1] Each myosin head has two binding sites: one for adenosine triphosphate (ATP) and another for actin. The binding of ATP to a myosin head detaches myosin from actin, thereby allowing myosin to bind to another actin molecule. Once attached, the ATP is hydrolyzed by myosin, which uses the released energy to move into the "cocked position" whereby it binds weakly to a part of the actin binding site. The remainder of the actin binding site is blocked by tropomyosin.[26] With the ATP hydrolyzed, the cocked myosin head now contains adenosine diphosphate (ADP) + Pi. Two Ca^{2+} ions bind to troponin C on the actin filaments. The troponin-Ca^{2+} complex causes tropomyosin to slide over and unblock the remainder of the actin binding site. Unblocking the rest of the actin binding sites allows the two myosin heads to close and myosin to bind strongly to actin.[26] The myosin head then releases the inorganic phosphate and initiates a power stroke, which generates a force of 2 pN. The power stroke moves the actin filament inwards, thereby shortening the sarcomere. Myosin then releases ADP but still remains tightly bound to actin. At the end of the power stroke, ADP is released from the myosin head, leaving myosin attached to actin in a rigor state until another ATP binds to myosin. A lack of ATP would result in the rigor state characteristic of rigor mortis. Once another ATP binds to myosin, the myosin head will again detach from actin and another cross-bridge cycle occurs.


Calcium ions
makeagif.com

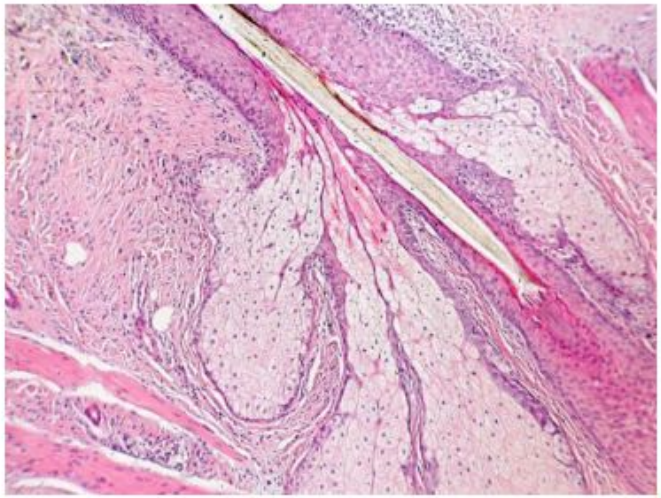
COMMON QUESTIONS

All of the following questions have been pulled from past YJI exams (which can be found on our website) or the Text Exchange on SciOly Wiki

Question 1

For questions 22 through 24, identify the sweat gland based on the image.

22. (1.00 pts)



Questions 34-36:
Jan, who is 24 years old, has developed a dry rash with white scales across her skin. She notices that the condition worsens in the winter and during times of stress.

34. (2.00 pts) What condition does Jan have?

35. (2.00 pts) What is the cause of this condition? What cell type does it involve?

36. (1.00 pts) Name one other condition that Jan's condition has been associated with.

Question 1

Questions 34-36:

Jan, who is 24 years old, has developed a dry rash with white scales across her skin. She notices that the condition worsens in the winter and during times of stress.

34. (2.00 pts) What condition does Jan have?

Psoriasis

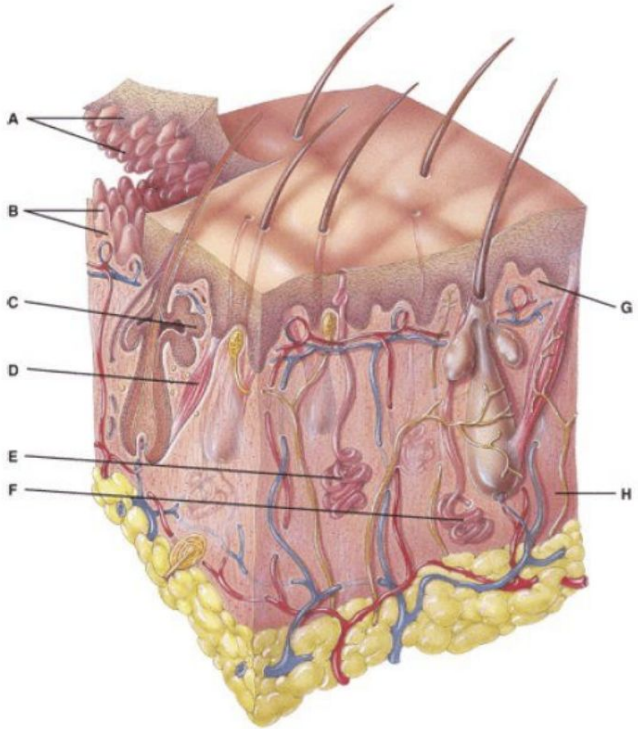
35. (2.00 pts) What is the cause of this condition? What cell type does it involve?

Auto-immune disease causing excessive growth of the epidermis due to premature proliferation of keratinocytes

36. (1.00 pts) Name one other condition that Jan's condition has been associated with.

Ex. obesity, diabetes, hypertension, heart disease, etc

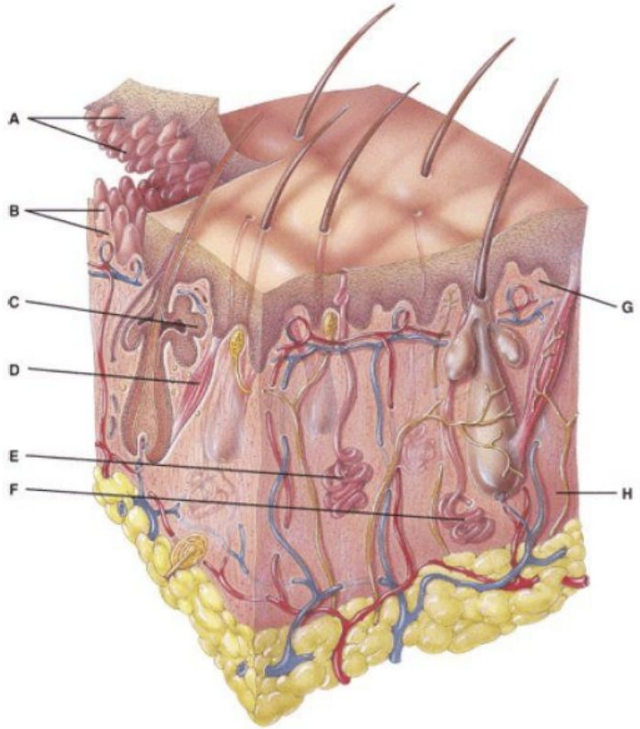
Question 2



For questions 1-8, correctly match each structure with its corresponding letter in the above diagram [7 points, 1 point each]

1) Epidermal Ridges	A.
2) Eccrine Sweat Gland	B.
3) Papillary Layer	C.
4) Reticular Layer	D.
5) Dermal Papillae	E.
6) Sebaceous (Oil) Gland	G.
7) Arrector Pili Muscle	H.

Question 2



1) A [1] Epidermal Ridges
2) E [1] Eccrine Sweat Gland
3) G [1] Papillary Layer
4) H [1] Reticular Layer
5) B [1] Dermal Papillae
6) C [1] Sebaceous (Oil) Gland
7) D [1] Arrector Pili Muscle

Question 3

18) A patient's posterior torso, posterior left leg and entire left arm was burned while attempting to put out a fire. What percentage of his body is burned?

a) 18%
b) 27%
c) 31.5%
d) 36%

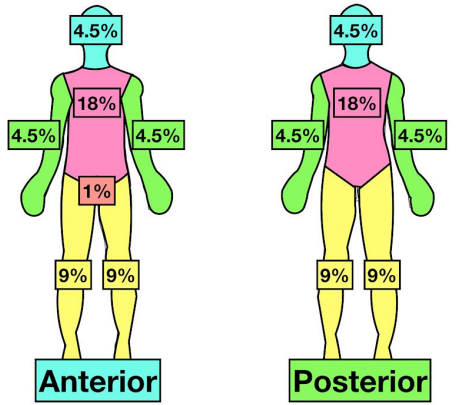
Question 3

18) A patient's posterior torso, posterior left leg and entire left arm was burned while attempting to put out a fire. What percentage of his body is burned?

a) 18%
b) 27%
c) 31.5%
d) 36%

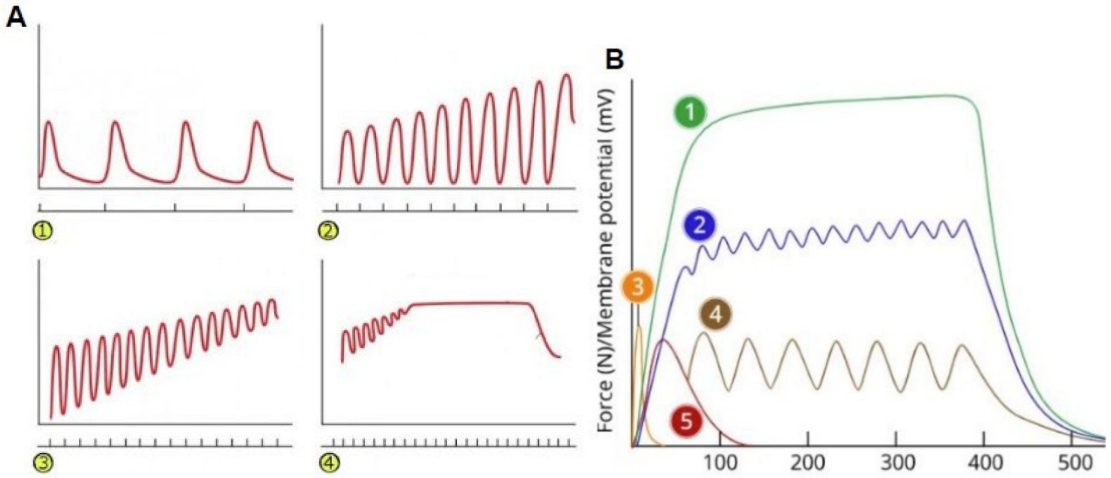
Rule of Nines for Burns

Body Part	Body Surface Area
Entire Head & Neck	9%
Entire Right Arm	9%
Entire Left Arm	9%
Entire Trunk	36%
Groin	1%
Entire Right Leg	18%
Entire Left Leg	18%



https://www.ezmedlearning.com/blog/rule-of-nines-burn-chart-child-adult

Question 4

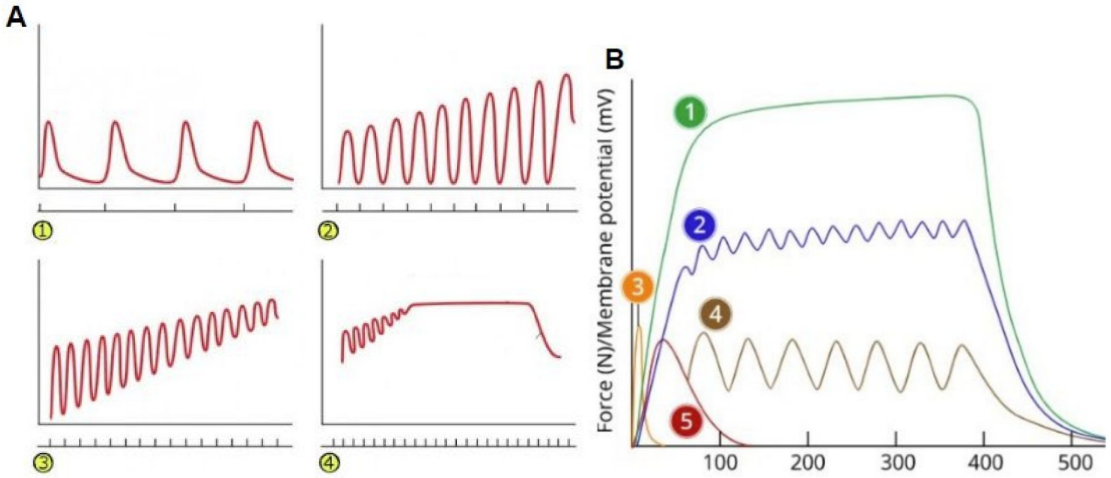


What type of muscle contraction do each of the images in Figure A show?

Which number represents the action potential in Figure B?

At about how many milliseconds (shown on the x axis) does the relaxation phase for line 1 begin?

Question 4



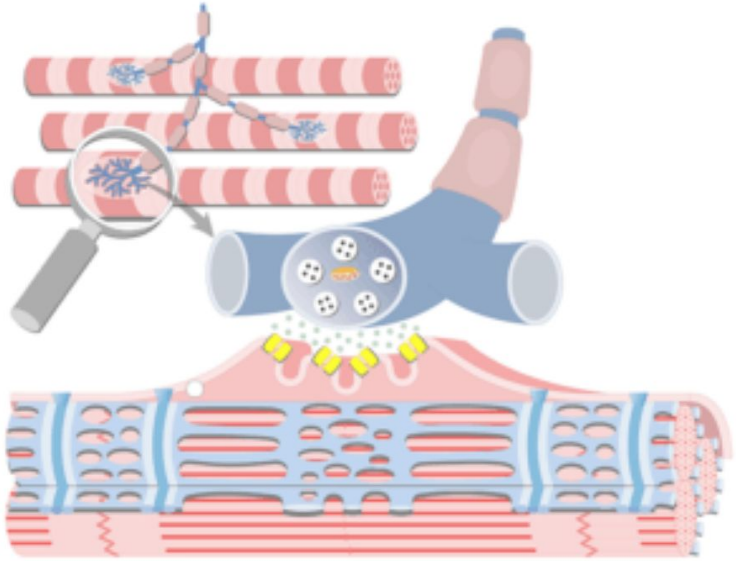
What type of muscle contraction do each of the images in Figure A show?
Twitch, Treppe, Incomplete tetanus, Tetanus

Which number represents the action potential in Figure B?
3

At about how many milliseconds (shown on the x axis) does the relaxation phase for line 1 begin?
400 ms

Tips from a Veteran

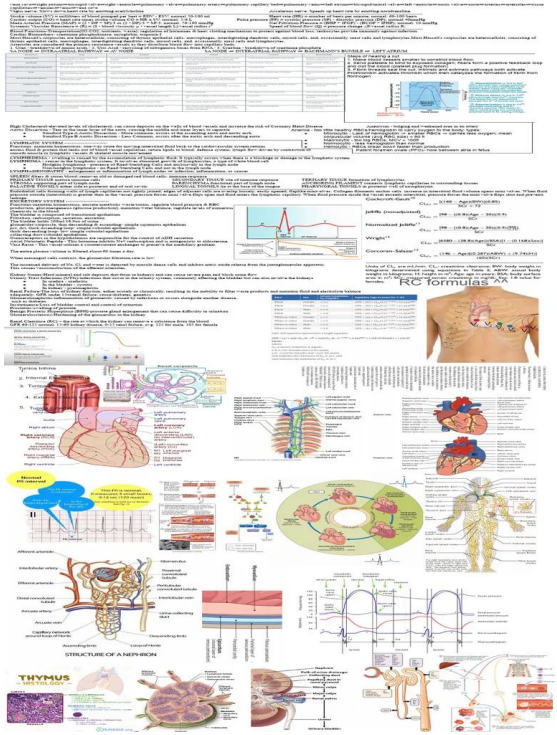
- **Prep:**
  - Study the content; don't just rely on your reference sheet!
  - Know the basics for all 3 systems; become an expert in just 1-2 (split with your partner)
  - Verbalize concepts
  - Lots and lots of practice tests



https://www.getbodysmart.com/muscle-physiology/

Tips from a Veteran

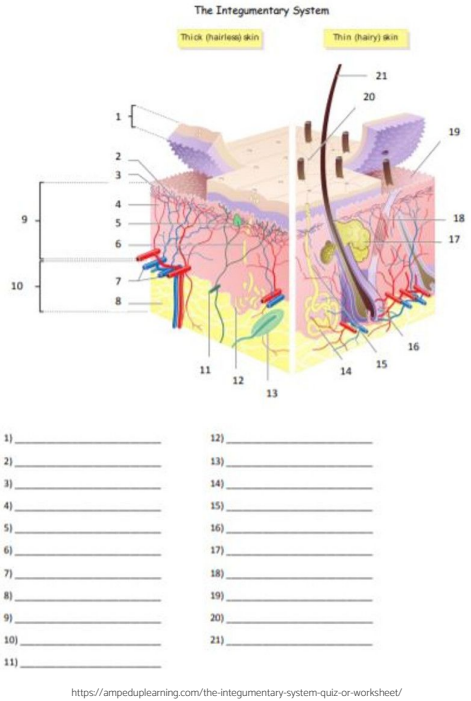
- **Reference sheet:**
  - Color code
  - Diagrams
  - Know where everything is!
  - Be “organized”
  - Memorize what you can



https://www.scribd.com/document/709686871/Anatomy-and-Physiology-Science-Olympiad-2024-Cheat-Sheet

Tips from a Veteran

- **Test:**
  - Split it up (tests are long)
  - If you're in a time crunch, focus on easy points and questions worth most point values (usually diagrams and mcq)
  - Guess if you have to; don't leave anything blank



Additional Resources

Visible Body
Anatomy Learn Site

OpenStax A&P

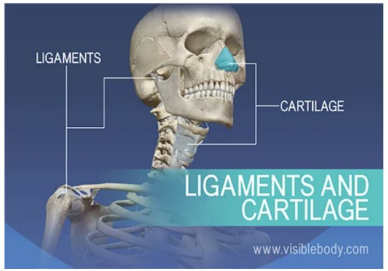
GetBodySmart
Interactive A&P

AnatomyTOOL

Visible Body

SKELETAL MUSCULAR CIRCULATORY RESPIRATORY DIGESTIVE LYMPHATIC URINARY REPRODUCTIVE NERVOUS ENDOCRINE

Skeletal



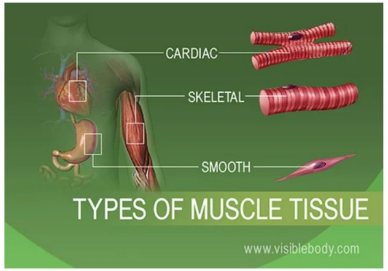
Bones Come Together: Types of Joints in the Human Body

Joints hold the skeleton together and support movement. There are two

Skeletal System Pathologies: Common Disorders and Conditions

The skeletal system, which includes bones, ligaments, and cartilage, gives

Muscular



Describing Skeletal Muscles: A Review of Muscle Attachments And Actions

There are over 600 muscles in the human body.

Muscle Contractions: How Neurotransmitters And Chemical Reactions Move Muscles And Bones

How do the bones of the human skeleton move?

Quadriceps femoris muscle

When the muscles of the quadriceps femoris group contract, they extend the knee joint, straightening the leg.

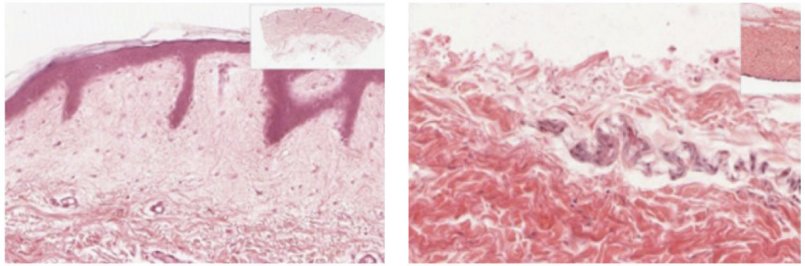
OpenStax

Contents
Highlights
Table of contents
Critical Thinking Questions
2 The Chemical Level of Organization
3 The Cellular Level of Organization
4 The Tissue Level of Organization
Support and Movement
5 The Integumentary System
Introduction
5.1 Layers of the Skin
5.2 Accessory Structures of the Skin
5.3 Functions of the Integumentary System
5.4 Diseases, Disorders, and Injuries of the Integumentary System
Key Terms
Chapter Review
Interactive Link Questions
Review Questions
Critical Thinking Questions

Search this book

The Epidermis

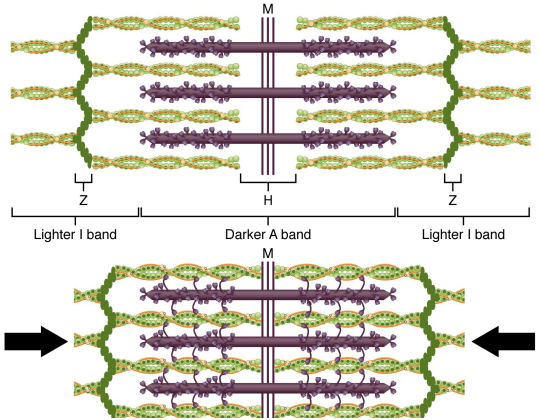
The **epidermis** is composed of keratinized, stratified squamous epithelium. It is made of four or five layers of epithelial cells, depending on its location in the body. It does not have any blood vessels within it (i.e., it is avascular). Skin that has four layers of cells is referred to as "thin skin." From deep to superficial, these layers are the stratum basale, stratum spinosum, stratum granulosum, and stratum corneum. Most of the skin can be classified as thin skin. "Thick skin" is found only on the palms of the hands and the soles of the feet. It has a fifth layer, called the stratum lucidum, located between the stratum corneum and the stratum granulosum (Figure 5.3).



(a) (b)

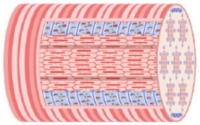
The Sliding Filament Model of Contraction

When signaled by a motor neuron, a skeletal muscle fiber contracts as the thin filaments are pulled and then slide past the thick filaments within the fiber's sarcomeres. This process is known as the sliding filament model of muscle contraction (Figure 10.10). The sliding can only occur when myosin-binding sites on the actin filaments are exposed by a series of steps that begins with Ca^{++} entry into the sarcoplasm.



GetBodySmart

Muscle Physiology



The muscular system is an organ system composed of the muscle tissue. There are three types of muscle tissue:

- **Cardiac muscle**, which comprises the myocardium of the heart
- **Smooth muscle**, which is found in the walls of the hollow organs and blood vessels
- **Skeletal muscle**, which composes the skeletal muscles

All three types share a characteristic in common - the ability to **contract**. Only skeletal muscles contract voluntarily, enabling us to move the parts of our body. Cardiac and smooth muscles contract involuntarily, as they are under control of the autonomic nervous system.

Muscle physiology is a branch of physiology that studies the mechanism behind muscle contraction.

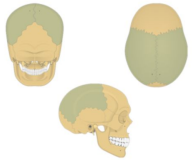
Muscle contraction is shortening of the muscle fibers initiated by action potentials in motor neurons which cause the release of neurotransmitters from synaptic vesicles.

Put simply, the neuronal stimulus (action potential) causes the neuron to release a chemical messenger (neurotransmitter) which excites the membrane of the muscle cell and causes it to contract.

On the molecular level, the contraction is a result of an interaction cascade between **myosin** and **actin filaments** inside a muscle fiber (muscle cell).

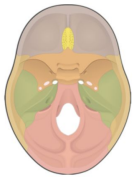
When enough skeletal muscle cells are excited and contract, that translates into a movement.

Learn the anatomy and functions of muscle fibers and their contraction with the interactive animations and diagrams in the topics below.



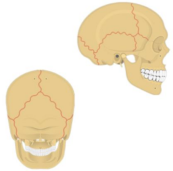
Parietal Bone Anatomy

The parietal bone is a large, thin, four-sided cranial bone that makes up much of the top and sides of the cranium. Learn about the different markings of the parietal bone.



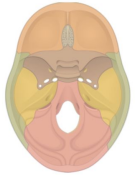
Bones at the base of the skull

The base of the skull is the inferior part of the [...]



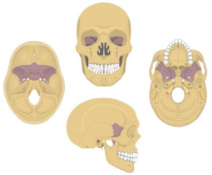
Major Sutures of the Skull

Sutures are junctions between adjacent bones of the skull which are rigidly held together by fibrous connective tissue.



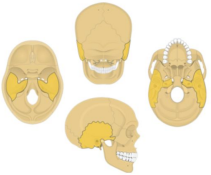
Fissures, foramina and markings of the base of the skull

The cranial floor bones support the inferior part of skull. Learn about the anterior markings of the tibia and fibula bones and test yourself.



Sphenoid Bone

The Sphenoid bone is a butterfly-shaped cranial bone that is located in the middle of the skull between the frontal and temporal bones.



Temporal Bone Anatomy

The temporal bones are facial bones which located at the sides and base of the skull, and lateral to the temporal lobes of the cerebral cortex.

AnatomyTOOL

ANATOMYTOOL Best Open Anatomy Learning Resources

Texts/ textual tutorials	Video Tutorials/ lectures	Interactive modules/ e-learning	Questions/ quizzes	Illustrations	3D models	Dissection photo's/video's	Clinical Anatomy
-OpenStax Anatomy&Physiology -Minnesota Atlas Human Cardiac Anatomy -El Paso Texas Tech Gross Anatomy -Virginia Digital Histology -AnatomyTOOL	-U.Br.Columbia Clinical Anatomy (incl. embryology) -3D Anatomy Lyon -Leiden MOOC - Anatomy of the Abdomen and Pelvis -Michigan BlueLink -Morton Noted Anatomist -U.Br.Columbia Neuroanatomy -Utah Neuroanatomy Video Lab -Utah Neurologic Exam -AnatomyTOOL	-U.Br.Columbia Clinical Anatomy -El Paso Texas Tech Gross Anatomy -U.Br.Columbia Neuroanatomy	-Michigan BlueLink -El Paso Texas Tech Gross Anatomy -Utah Neurologic Exam -Virginia Digital Histology (H5P-questions) -Radiopaedia -AnatomyTOOL quizzes, questions (log-in required to browse) (H5P-questions)	-U.Br.Columbia Clinical Anatomy -Michigan BlueLink -Wikimedia Commons -AnatomyTOOL	-U.Br.Columbia Clinical Anatomy -Michigan BlueLink -U.Br.Columbia Neuroanatomy -Amsterdam 3D embryo atlas -AnatomyTOOL	-U.Br.Columbia Clinical Anatomy -Leiden Visual Dissection Manuals -Michigan BlueLink -El Paso dissection videos -U.Br.Columbia Neuroanatomy -AnatomyTOOL	-U.Br.Columbia Clinical Anatomy -Michigan BlueLink -El Paso Texas Tech Gross Anatomy -U.Br.Columbia Neuroanatomy -Utah Neurologic Exam -Radiopaedia -MedPix -AnatomyTOOL

THANKS!

Cheat Sheets

The one showed on the presentation:
https://docs.google.com/document/d/14K1vdRYZ22wrAPBrUnnrMII-7cG13QkWU_ETLs84cuo/edit?usp=sharing