Form & Function : Homeostasis, Neurophysiology, and Sensory Physiology

Animal Structure and Function:

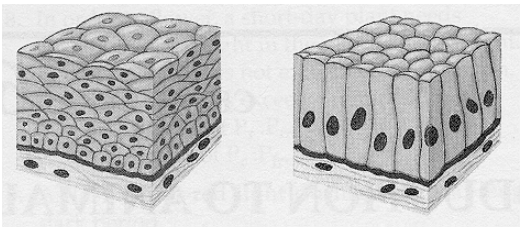
The body structures of an animal include organs that are composed of specialized cells grouped into the four basic tissues: epithelial, connective, muscle, and nerves. Organs function together in organ systems. Structure correlates with function in these hierarchical levels of organization, and the functions of an animal are powered by chemical energy derived from food. Metabolic rate determines the amount of energy needed and is higher for endothermic animals and inversely related to body size. Body proportions and posture are related to size.

All cells must be bathed in an aqueous solution. Compact animal bodies have highly folded exchange surfaces and a circulatory system that distributes materials throughout the body. The internal environment is carefully regulated by the process of **HOMEOSTASIS**.

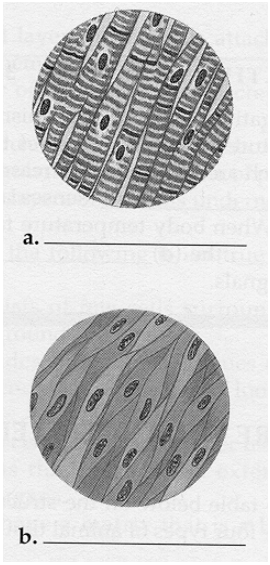
1. Have a member of your Learning Community Define the term **HOMEOSTASIS...**

A comparative physiology study of animals illustrates three general themes: the correlation of structure and function, the capacity of organisms to adapt to their environments, both by short-term physiological adjustments and long-term evolutionary changes, along with bioenergetics, as the basis for understanding animal physiology. As was mentioned in the early lectures of the class, hierarchical levels of organization characterize ***life***. Life emerges at the level of the cell. Multicellular organisms have specialized cells grouped into tissues, which may be combined into organs. Various organs may function together in organ systems.

Tissues are collections of cells with a common structure and function, held together by a sticky extracellular matrix or fibers. **Epithelial tissue** lines the outer and inner surfaces of the body in protective sheets of tightly packed cells. Cells at the base of an epithelium are attached to a **basement membrane,** a dense layer of extracellular matrix. A **simple epithelium** has one layer, whereas a **stratified epithelium** has multiple layers of cells. The shape of cells at the free surface may be **squamous** (flat), **cuboidal** (boxlike), or **columnar** (pillar-like).



2. Name the 2 types of epithelia illustrated in the figures to the right. One of these forms the outer skin and the other lines the digestive tract. Explain why each would be found at its location? A. _____ B. _____



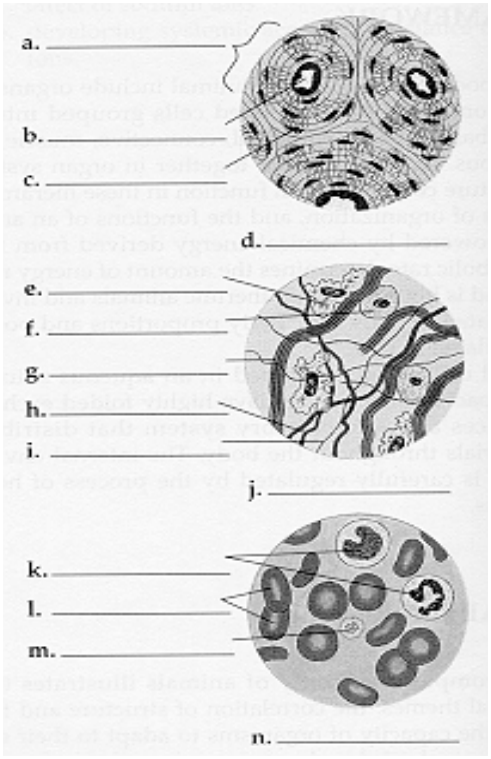
Muscle tissue consists of long, contractile cells that are packed with microfilaments of actin and myosin. **Skeletal muscle-also** called **striated muscle** because it looks striped due to the arrangement of overlapping filaments-is responsible for voluntary body movements. **Cardiac muscle,** forming the wall of the heart, is also striated, but its cells are branched, joined at their ends by intercalated discs that relay signals to synchronize the heartbeat. **Smooth muscle** is composed of spindle-shaped cells lacking striations. It is found in the walls of the digestive tract, arteries, and other internal organs. Unlike voluntary skeletal muscle, smooth muscle is often called involuntary because it is not generally under conscious control.

3. Identify the types of vertebrate muscle cells depicted in figures on the left. A. _____
B. _____

What are the dark bands in fig. a, and what is their function?

4. **Connective tissue** connects and supports other tissues and is characterized by having relatively few cells suspended in an extracellular matrix of fibers, which may be embedded in a liquid, jellylike or solid ground substance.

Identify the types of Connective Tissue and their components in the 3 figures to the right.



5. There are 11 organ systems in mammals.
How many of them can your Learning Community name?
Have each member name at least one.
Define the parts of that organ system
and give a function of the system.

6. Histologists, biologists who study tissues-classify tissues into four categories. Have one member each, in turn, fill-in the table below of the four major types of vertebrate animal tissues.

Tissue	Structural Characteristics	General Functions	Specific Examples

Bioenergetics is fundamental to all animal functions

Animals exchange energy with the environment by taking in food, from which they harvest ATP for cellular work and chemical energy, and carbon skeletons for biosynthesis, and returning heat to the environment. The total energy an animal uses in a unit of time is its **metabolic rate.** Energy is measured in **calories** (cal) or **kilocalories** (kcal). The **basal metabolic rate (BMR)** for an endotherm is described as the number of kcal needed per hour when totally at rest, fasting, and non-stressed. The **standard metabolic rate (SMR)** is the metabolic rate of a resting, fasting ectotherm determined at a specific temperature.

7. (a) Which animal, a rabbit or a bear, would have a higher BMR?

(b) Which animal would have a higher SMR? a frog or a rabbit?

(c) Which animal, a rabbit or a bear, would consume the most cal/gm of body weight?, and

(d) which animal, rabbit, bear, or frog would consume the most total calories?

Homeostatic Mechanisms and Water Balance

Animals are able to survive large fluctuations in their external environment by maintaining a relatively constant internal environment. The physiological adjustments that maintain homeostasis, such as osmoregulation, enable organisms to cope with short-term environmental changes. These mechanisms developed by natural selection as populations evolved in specific environments. Homeostatic mechanisms temper changes in the internal body fluid that bathes the cells, either hemolymph in animals with open circulatory systems or interstitial fluid serviced by blood in those with closed circulatory systems.

Osmoconformers and Osmoregulators. **Osmoconformers** are isosmotic with their aqueous surroundings and do not regulate their osmolarity. **Osmoregulators** must get rid of excess water if they live in a hypoosmotic medium or take in water to offset osmotic loss if they inhabit a hyperosmotic environment. Osmoregulation is energetically costly because animals must actively transport solutes in order to maintain osmotic gradients needed to gain or lose water.

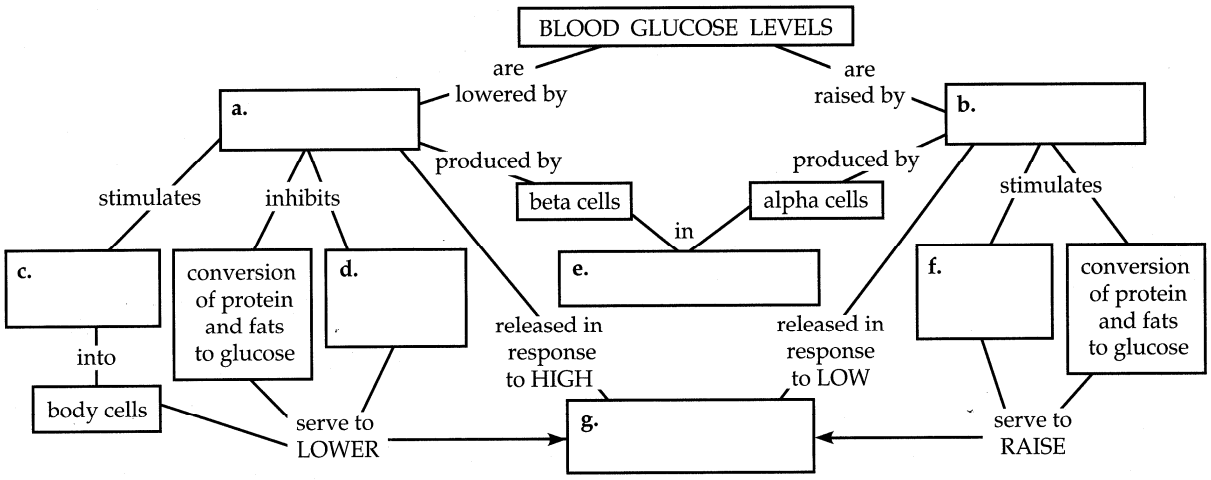
8. Indicate whether the following are **osmoregulators** or **osmoconformers**, and whether they are **isosmotic**, **hyperosmotic**, or **hypoosmotic** to their environment

Animal	**Osmoregulator or Osmosconformer ?**	**Osmotic Relation to Environment**
marine invertebrates		
sharks		
marine fish		
freshwater fish		
freshwater protozoan		
terrestrial animal		

Vertebrate Endocrine Systems and Homeostasis:

The Pancreas Scattered within the exocrine tissue of the **pancreas** are clusters of endocrine cells known as the **islets of Langerhans.** Within each islet are cells that secrete the hormone **glucagon** and **cells** that secrete the hormone **insulin.** These antagonistic hormones regulate glucose concentration in the blood, and negative feedback controls their secretion.

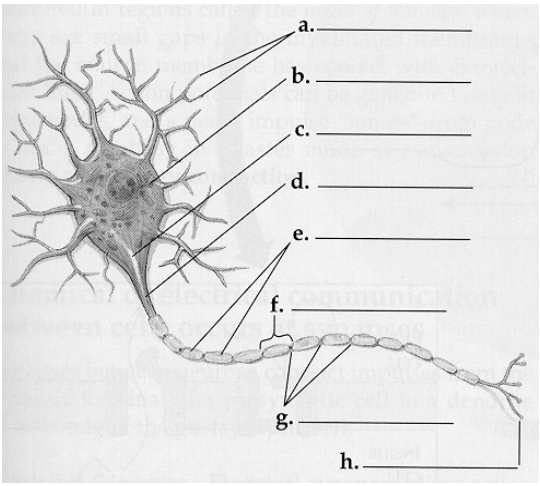
9. Complete the concept map below on the regulation of blood glucose levels.

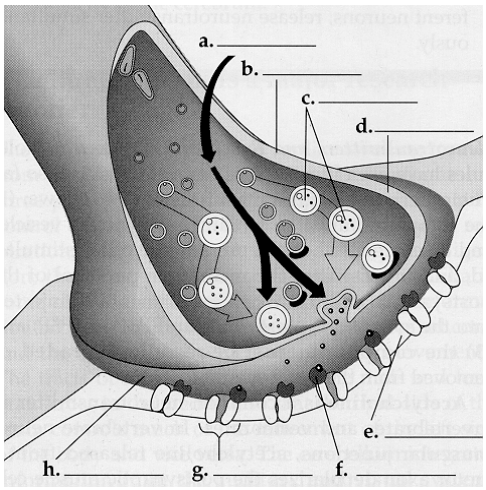


Neurophysiology...

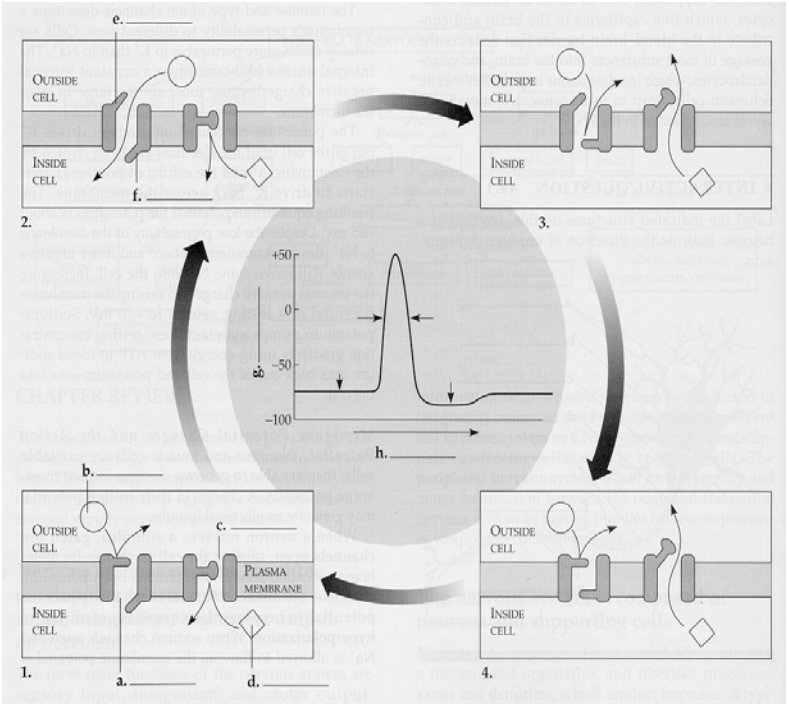
The 3 main functions of a vertebrate nervous system are sensory input, integration, and motor output. Motor output sends signals to effector cells, muscle, or gland cells. Neurons and muscle cells are electrically excitable cells, i.e., they are able to generate changes in their membrane potentials in response to stimuli. An action potential is a local depolarization of a membrane potential having defined properties and characteristics. Synapses are functional connections between neurons, which conduct an electrical impulse from the synaptic terminal of a presynaptic cells to the membranes of a postsynaptic receptor cell.

10. Have one member, each in turn, identify the labels in the following 3 diagrams (10 a, b, and c).





10-A.	10-B.
a.	**a.**
b.	**b.**
c.	**c.**
d.	**d.**
e.	**e.**
f.	**f.**
g.	**g.**
h.	**h.**



10-C.

a.
b.
c.
d.
e.
f.
g.
h.