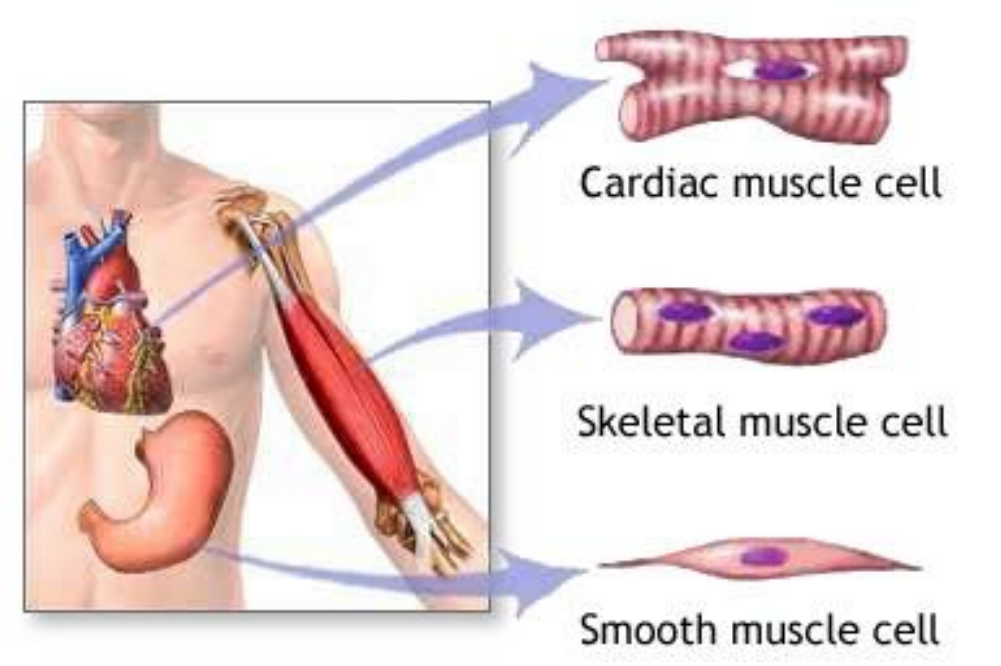
Form and Function



Form and function reflect biology's major themes

- The study of animal form and function is integrated by the common set of problems that all animals must solve.
  - These include how to extract oxygen from the environment, how to nourish themselves, how to excrete waste products, and how to move.
- Animals of diverse evolutionary histories and varying complexities must solve these general challenges of life.

- Animals provide vivid examples of biology's overarching theme of evolution.
- The adaptations observed in a comparative study of animals evolved by natural selection.

  – For example, the long, tongue-like proboscis of a hawkmoth is a structural adaptation for feeding.
    - Recoiled when not in use, the proboscis extends as a straw through which the moth can suck nectar from deep within tube-shaped flowers.

- While natural selection provides a mechanism for long-term adaptation, organisms also have the capacity to adjust to environmental change over the short term by physiological responses.
  - For example, while most insects are inactive when cold, the hawkmoth, *Manduca sexta*, can forage for nectar when air temperatures are as low as 5^{o}C.
  - The moth uses a shivering-like mechanism for preflight warm up of its flight muscles.
  - Once in flight, the waste heat of metabolic activity in the flight muscles and other adaptations maintain a muscle temperature of 30^{o}C, even when the external environment is close to freezing.

- Searching for food, generating body heat and regulating internal temperature, sensing and responding to environmental stimuli, and all other animal activities require fuel in the form of chemical energy.

- The concepts of bioenergetics - how organisms obtain, process, and use their energy resources - is another connecting theme in the comparative study of animals.

- Animals also show a correlation between structure and function.
  - Form fits function at all the levels of life, from molecules to organisms.
  - Knowledge of a structure provides insight into what it does and how its works.
  - Conversely, knowing the function of a structure provides insight about its construction.

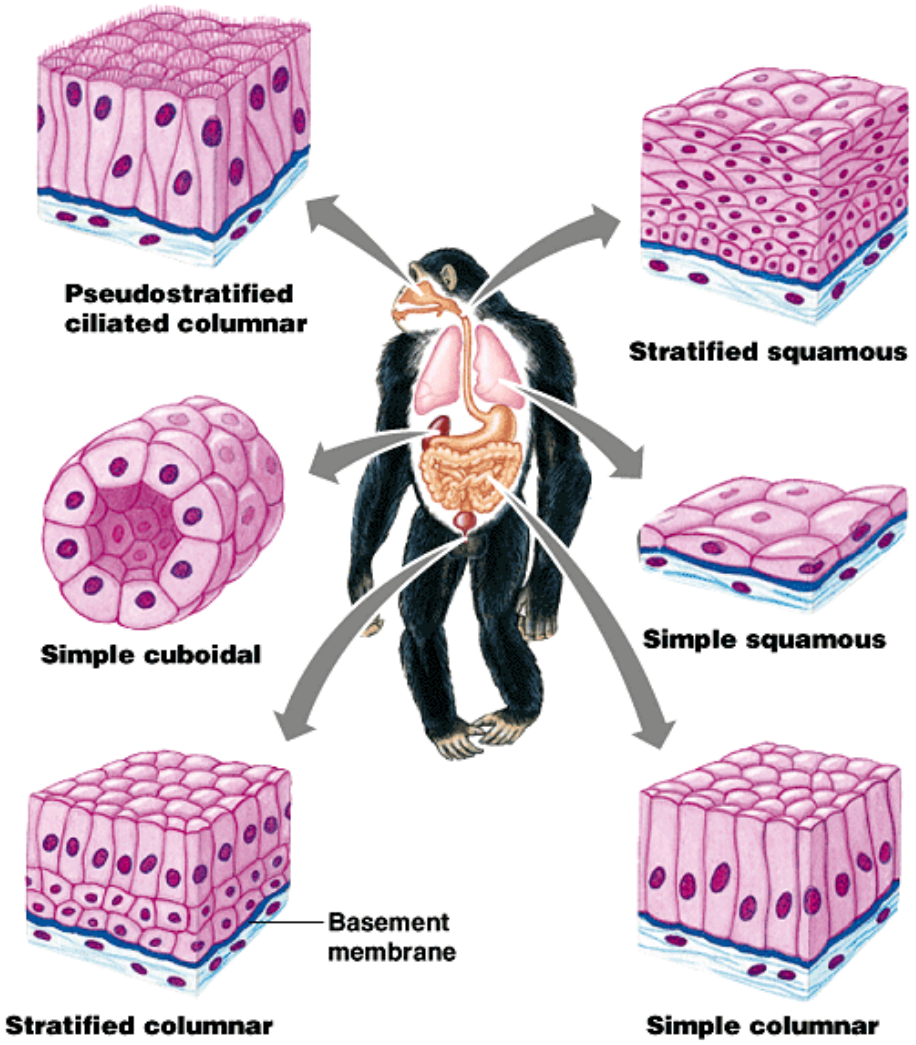
- **Anatomy** is the study of the *structure* of an organism.
- **Physiology** is the study of the *functions* an organism performs.
- The distinction blurs when we apply the structure-function theme, and “anatomy-and-physiology” rolls off the tongue as though it were one big compound noun.
  - The form-function principle is just another extension of biology’s central theme of evolution.

Function correlates with structure in the tissues of organisms

- Life is characterized by hierarchical levels of organization, each with emergent properties.
- Animals are multicellular organisms with their specialized cells grouped into tissues.
- In most animals, combinations of various tissues make up functional units called organs, and groups of organs that work together form organ systems.
  - For example, the human digestive system consists of a stomach, small intestine, large intestine, and several other organs, each a composite of different tissues.

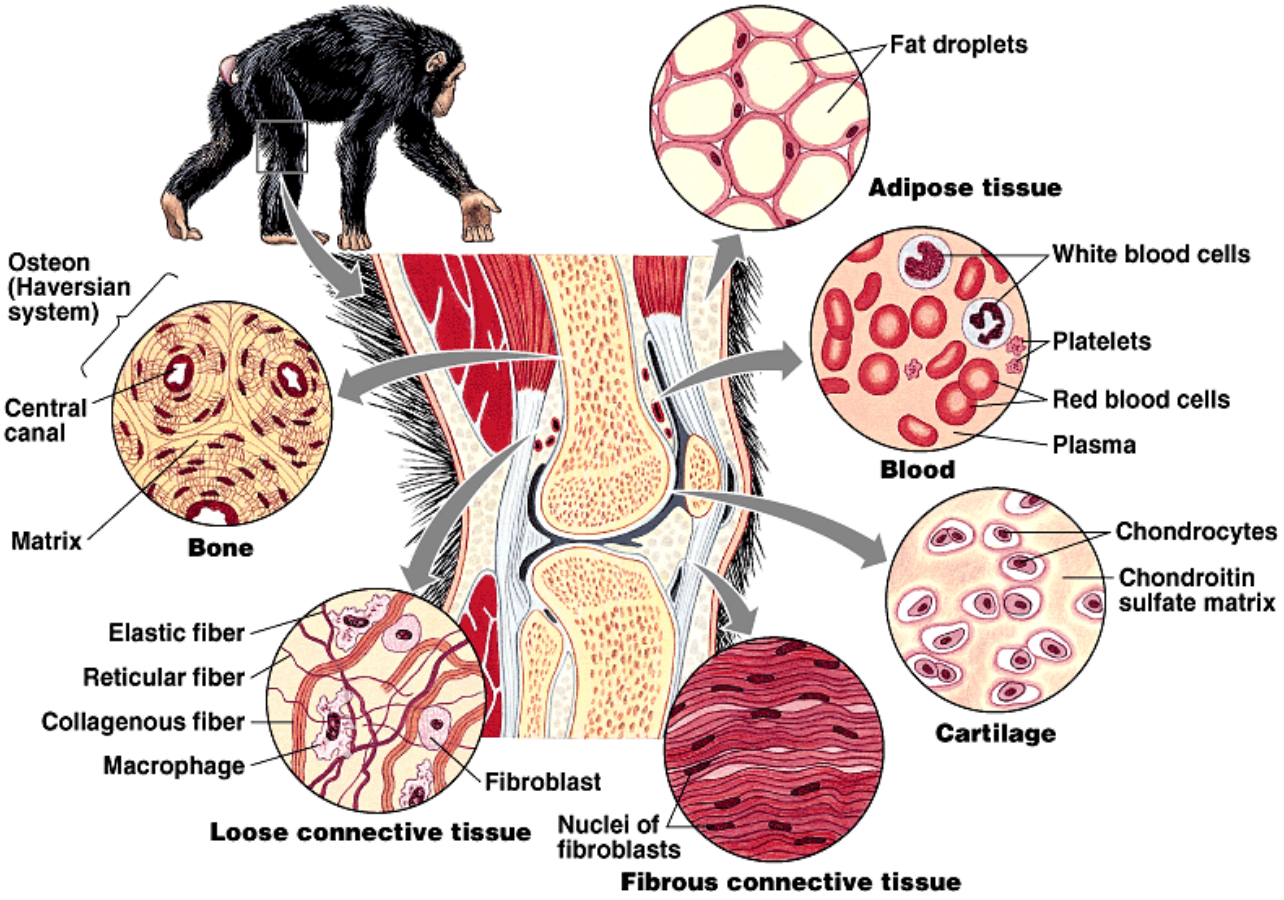
- **Tissues** are groups of cell with a common structure and function.
  - Different types of tissues have different structures that are especially suited to their functions.
  - A tissue may be held together by a sticky extracellular matrix that coats the cells or weaves them together in a fabric of fibers.
  - The term *tissue* is from a Latin word meaning “weave.”
- Tissues are classified into four main categories: **epithelial** tissue, **connective** tissue, **nervous** tissue, and **muscle** tissue.

- **Epithelia** are classified by the number of cell layers and the shape of the cells on the free surface.
- A **simple epithelium** has a single layer of cells, and a **stratified epithelium** has multiple tiers of cells.
- The shapes of cells may be **cuboidal** (like dice), **columnar** (like bricks on end), or **squamous** (flat like floor tiles).

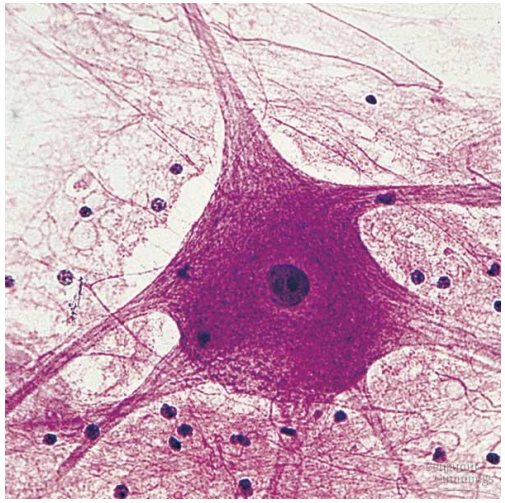


- **Connective** tissue functions mainly to bind and support other tissues.
  - Connective tissues have a sparse population of cells scattered through an extracellular matrix.
  - The matrix generally consists of a web of fibers embedding in a uniform foundation that may be liquid, jellylike, or solid.
  - In most cases, the connective tissue cells secrete the matrix.

- The major types of connective tissues in vertebrates are loose connective tissue, adipose tissue, fibrous connective tissue, cartilage, bone, and blood.
  - Each has a structure correlated with its specialized function.

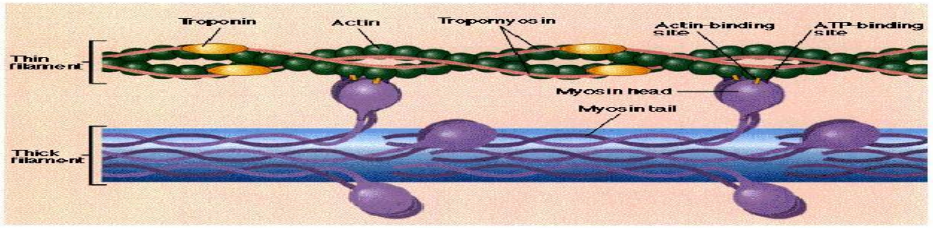


- **Nervous tissue** senses stimuli and transmits signals from one part of the animal to another.
  - The functional unit of nervous tissue is the **neuron**, or nerve cell.
  - It consists of a cell body and two or more extensions, called dendrites and axons.
  - Dendrites transmit nerve impulses from their tips toward the rest of the neuron.
  - Axons transmit impulses toward another neuron or toward an effector, such as a muscle cell.

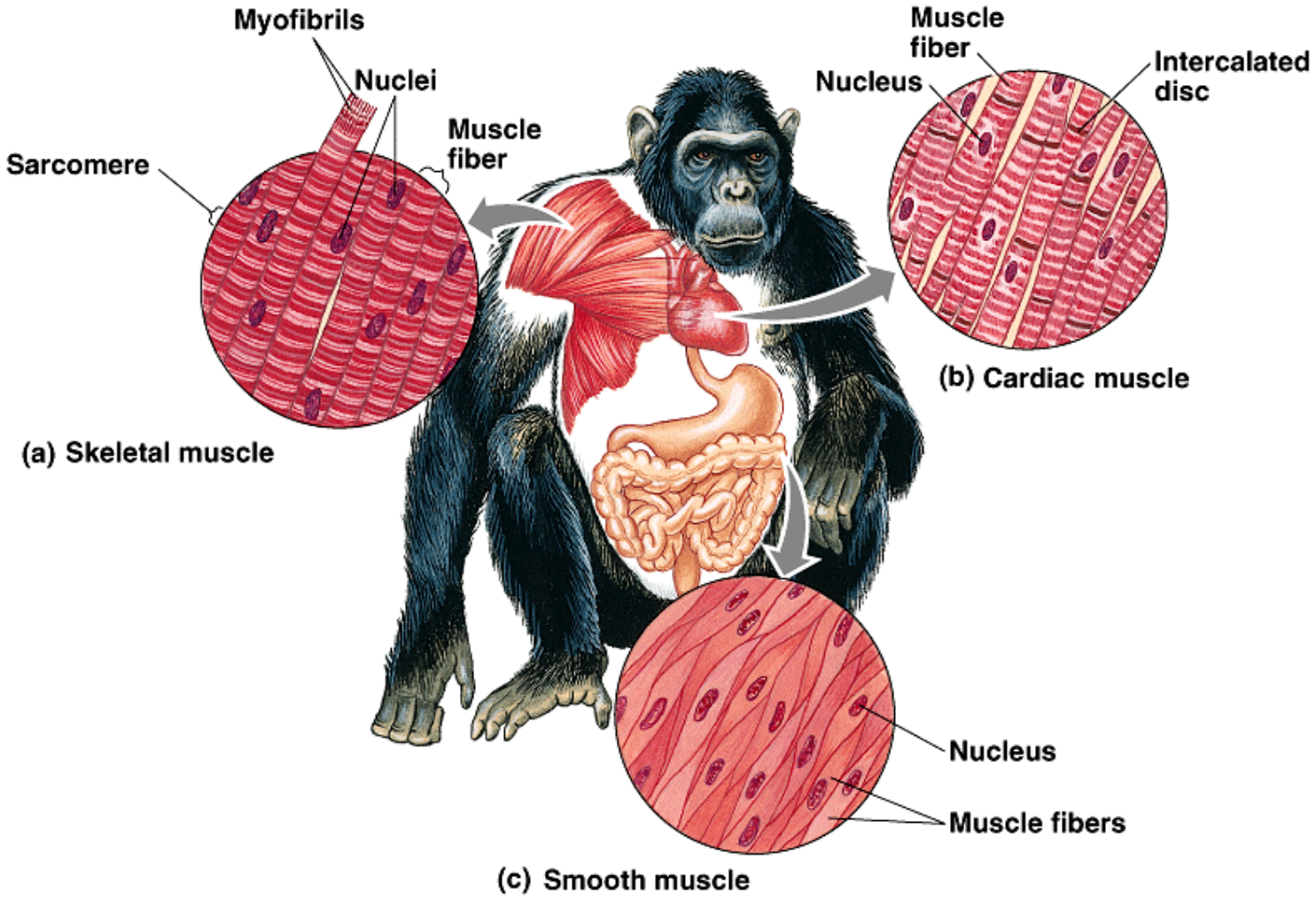


- **Muscle tissue** is composed of long cells called muscle fibers that are capable of contracting when stimulated by nerve impulses.
  - Arranged in parallel within the cytoplasm of muscle fibers are large numbers of myofibrils made of the contractile proteins actin and myosin.
  - Muscle is the most abundant tissue in most animals, and muscle contraction accounts for most of the energy-consuming cellular work in active animals.

Myosin & the Thick Filament



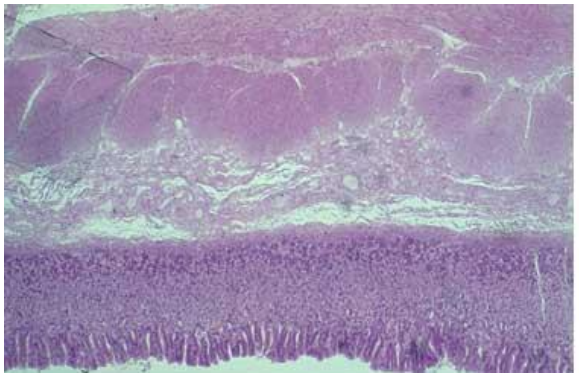
- There are three types of muscle tissue in the vertebrate body: skeletal muscle, cardiac muscle, and smooth muscle.

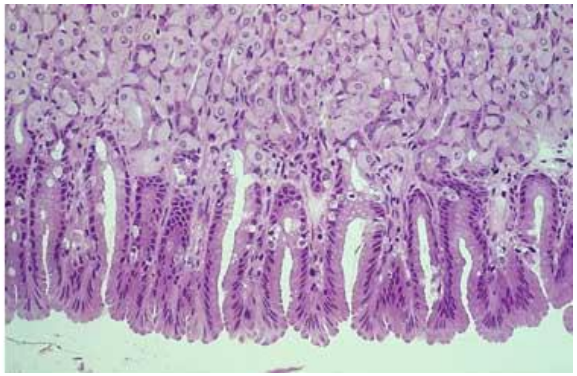


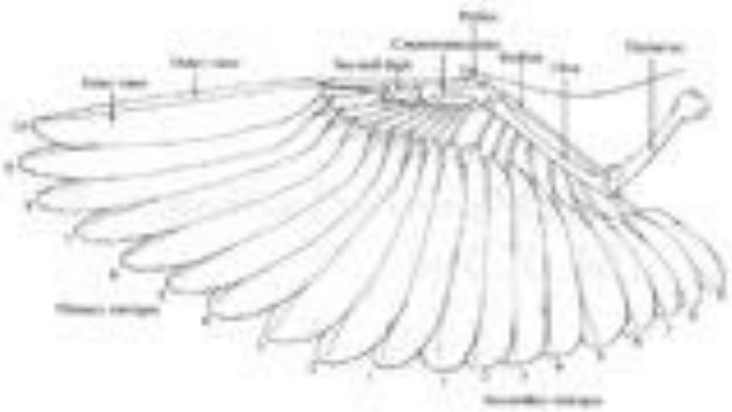
The organ systems of animals are interdependent

- In all but the simplest animals (sponges and some cnidarians) different tissues are organized into **organs**.
  - Many vertebrate organs are suspended by sheets of connective tissues called **mesenteries** in body cavities moistened or filled with fluid.
  - Mammals have a **thoracic cavity** housing the lungs and heart that is separated from the lower **abdominal cavity** by a sheet of muscle called the diaphragm.

- In some organs the tissues are arranged in layers.
- For example, the vertebrate stomach has four major tissues layers.
  - A thick epithelium lines the lumen and secretes mucus and digestive juices into it.
  - Outside this layer is a zone of connective tissue, surrounded by a thick layer of smooth muscle.
  - Another layer of connective tissue encapsulates the entire stomach.







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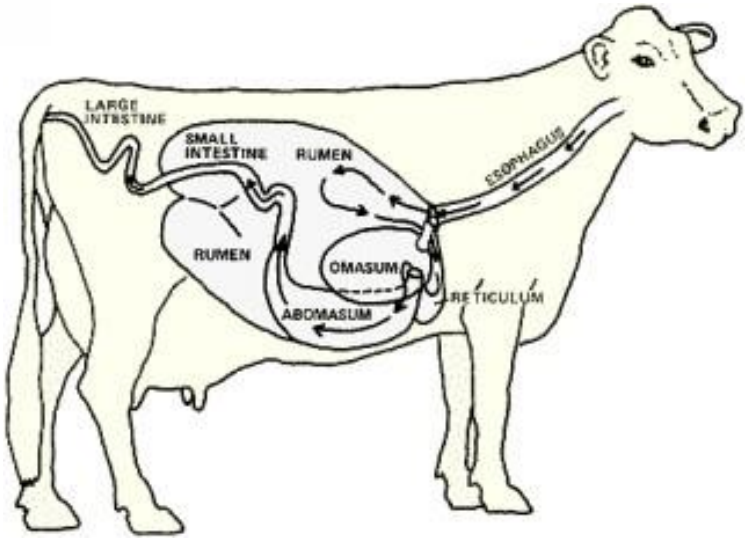
LARGE INTESTINE
SMALL INTESTINE
RUMEN
ESOPHAGUS
RUMEN
OMASUM
RETICULUM
ABOMASUM

- **Organ systems** carry out the major body functions of most animals.
  - Each organ system consists of several organs and has specific functions.

There are 11 organ systems……

can you list them and explain their function?

Table 40.1 Organ Systems: Their Main Components and Functions in Mammals

Organ System	Main Components	Main Functions
Digestive	Mouth, pharynx, esophagus, stomach, intestines, liver, pancreas, anus	Food processing (ingestion, digestion, absorption, elimination)
Circulatory	Heart, blood vessels, blood	Internal distribution of materials
Respiratory	Lungs, trachea, other breathing tubes	Gas exchange (uptake of oxygen; disposal of carbon dioxide)
Immune and Lymphatic	Bone marrow, lymph nodes, thymus, spleen, lymph vessels, white blood cells	Body defense (fighting infections and cancer)
Excretory	Kidneys, ureters, urinary bladder, urethra	Disposal of metabolic wastes; regulation of osmotic balance of blood
Endocrine	Pituitary, thyroid, pancreas, other hormone-secreting glands	Coordination of body activities (e.g., digestion, metabolism)
Reproductive	Ovaries, testes, and associated organs	Reproduction
Nervous	Brain, spinal cord, nerves, sensory organs	Coordination of body activities; detection of stimuli and formulation of responses to them
Integumentary	Skin and its derivatives (e.g., hair, claws, skin glands)	Protection against mechanical injury, infection, drying out
Skeletal	Skeleton (bones, tendons, ligaments, cartilage)	Body support, protection of internal organs
Muscular	Skeletal muscles	Movement, locomotion


1995
I'll get him for this.
Ooo
http://go.to/funpic