Animal

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Lecture outline

- Animal forms and function
  - Structure
  - Physiology
- Animal behavior
  - Communication
  - Learning
  - Animal cognition

Hierarchical Organization of Body Plans

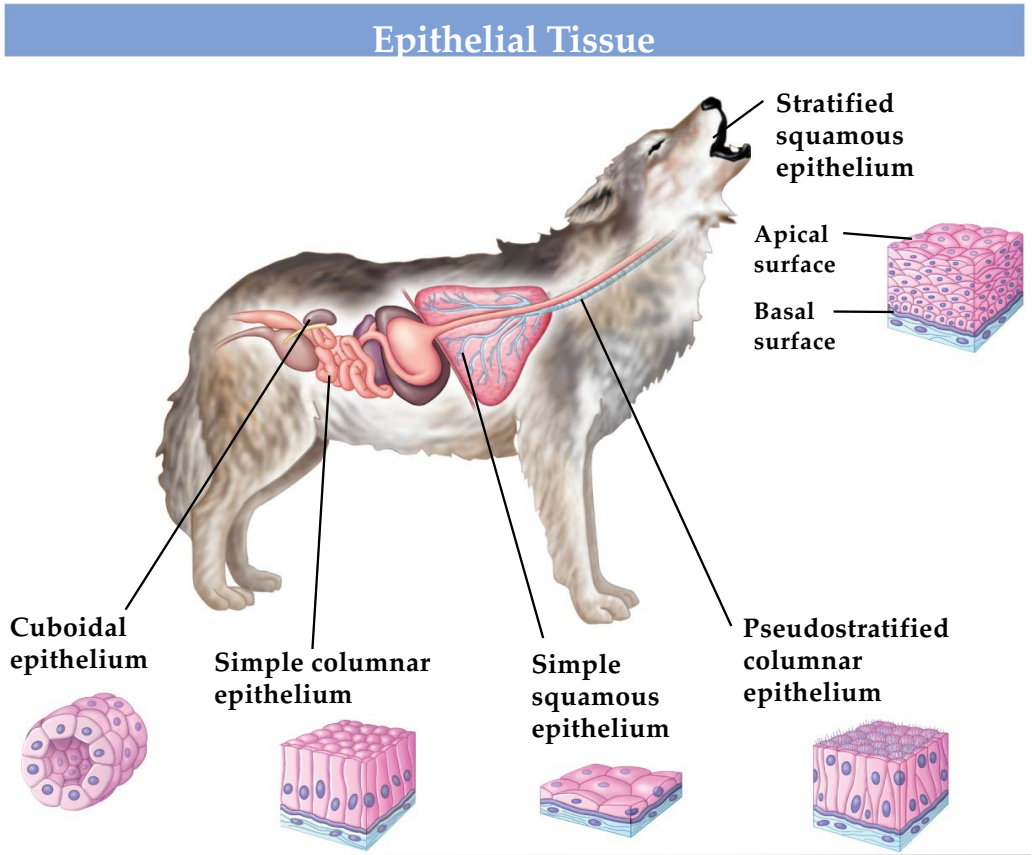
- Most animals are composed of specialized **cells** 细胞 organized into **tissues** 组织 that have different functions
- Tissues make up **organs** 器官, which together make up **organ systems** 器官系统
- **Pancreas** 胰脏 belong to two systems
- **Skin** 皮肤 is the largest organ

Structure and Function in Animal Tissues

- Tissues are classified into four main categories:
  - Epithelial 上皮组织
  - Connective 结缔组织
  - Muscle 肌肉组织
  - Nervous 神经组织

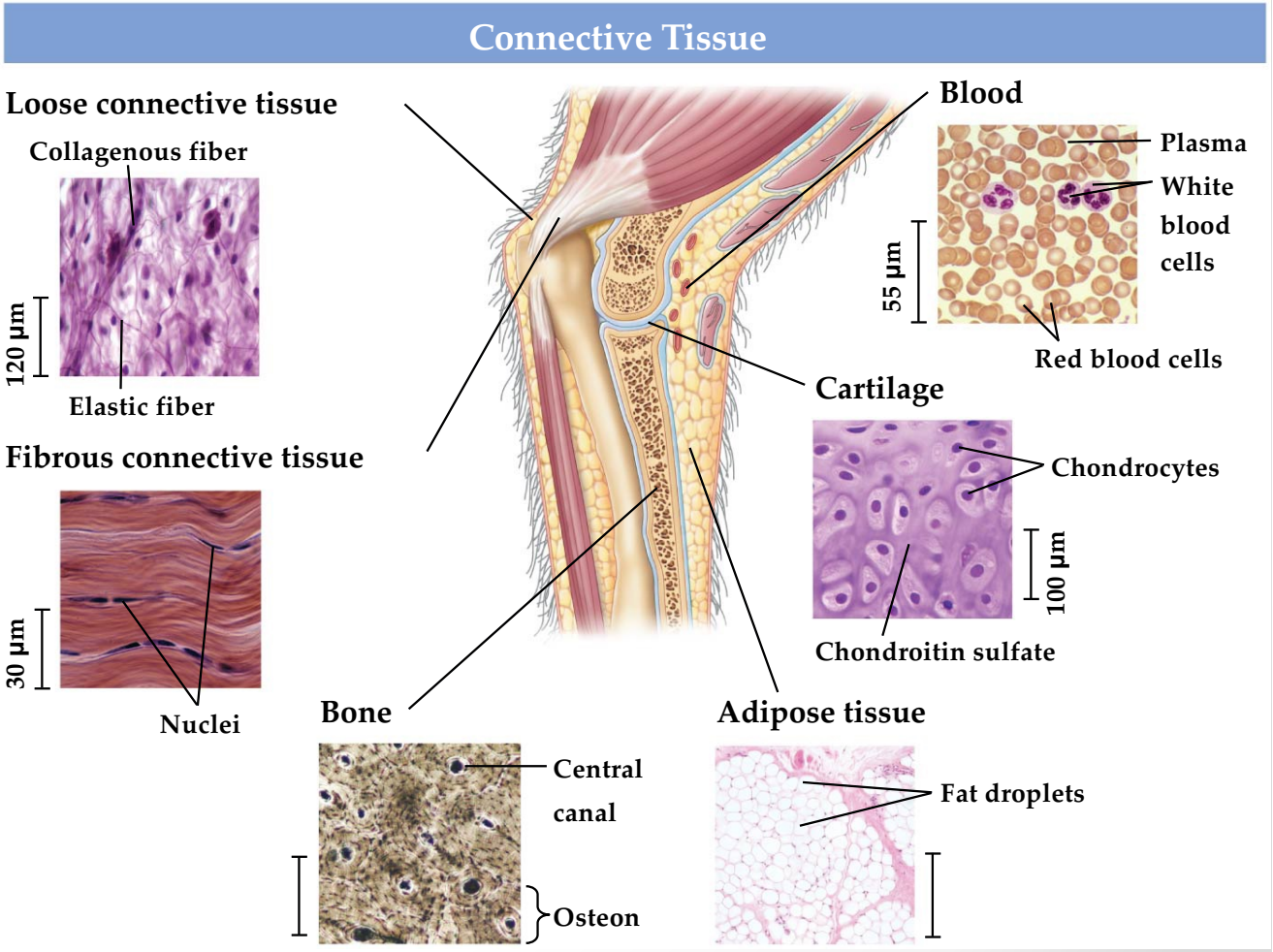
Epithelial Tissue

- Covers the **outside** of the body and lines the organs and cavities **within** the body
- Contains cells that are **closely joined**
- The arrangement of epithelial cells may be **simple** (single cell layer), **stratified** 分层 (multiple tiers of cells), or **pseudostratified** 伪分层(a single layer of cells of varying length)



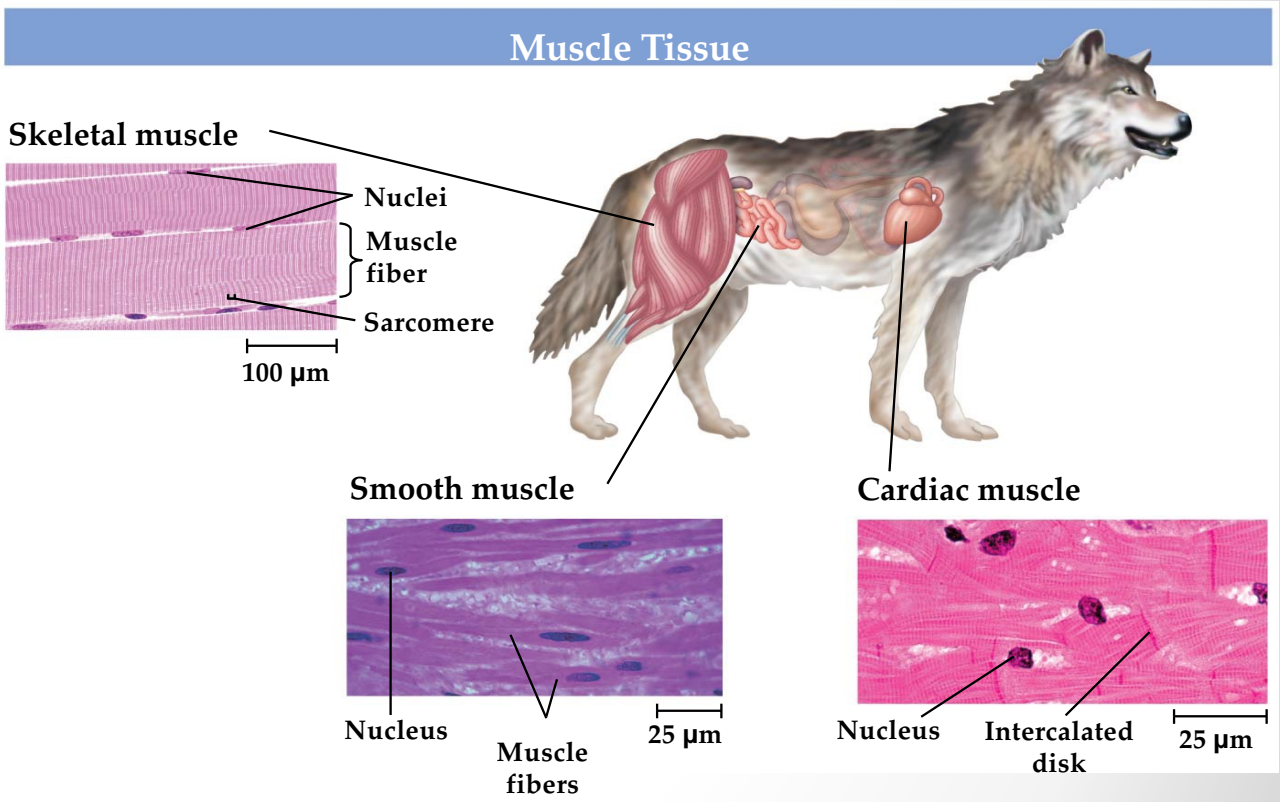
Connective Tissue

- Binds and supports other tissues
- **Loose connective tissue** binds epithelia to underlying tissues and holds organs in place
- Fibrous 纤维 connective tissue is found in **tendons** 肌腱, which attach muscles to bones, and **ligaments** 韧带, which connect bones at joints
- **Bone** is mineralized and forms the skeleton
- **Adipose**脂肪 tissue stores fat for insulation and fuel
- **Blood** is composed of blood cells and cell fragments in blood plasma
- **Cartilage**软骨 is a strong and flexible support material



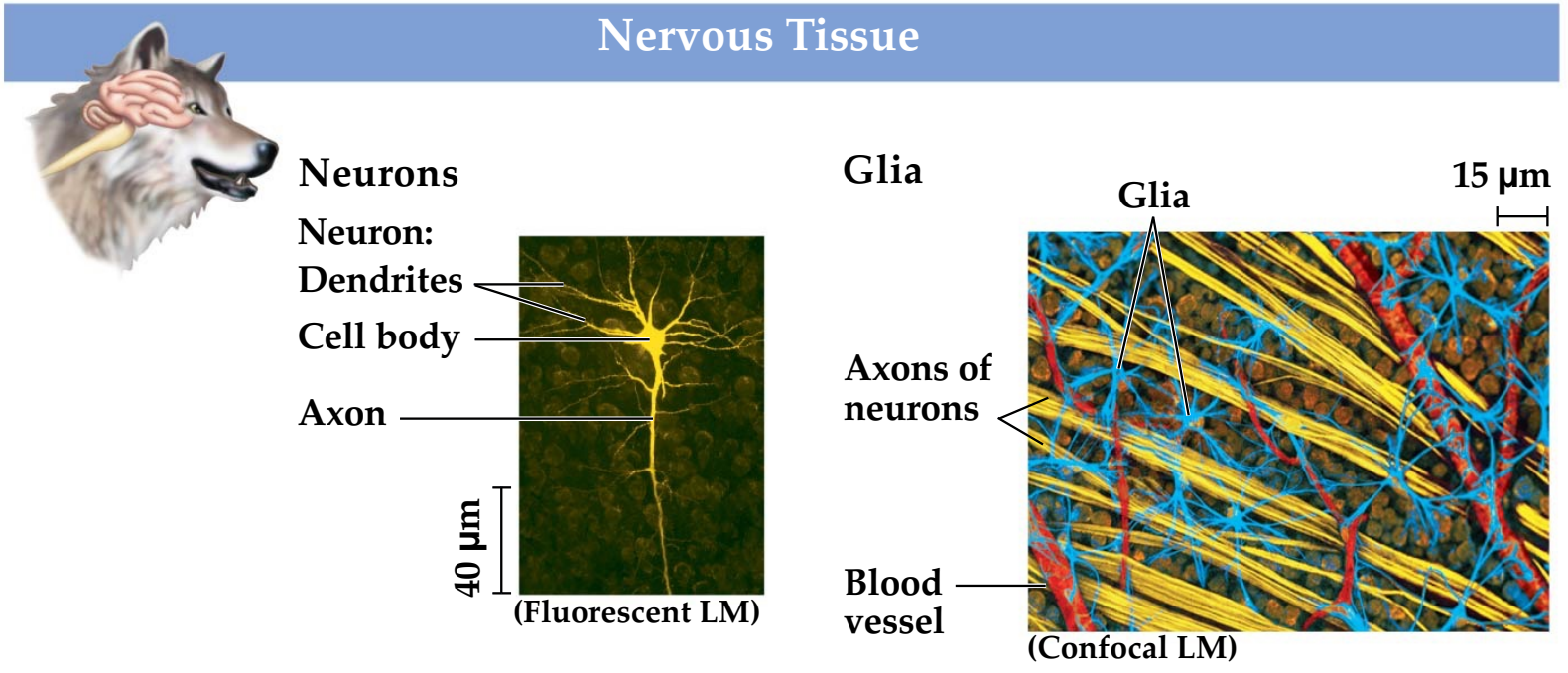
Muscle Tissue

- Muscle cells consist of filaments of the proteins **actin**肌动蛋白 and **myosin** 肌球蛋白
- It is divided in the vertebrate body into three types
  - **Skeletal muscle** 骨骼肌 voluntary movement
  - **Smooth muscle** 平滑肌 involuntary body activities
  - **Cardiac muscle** 心肌 contraction of the heart



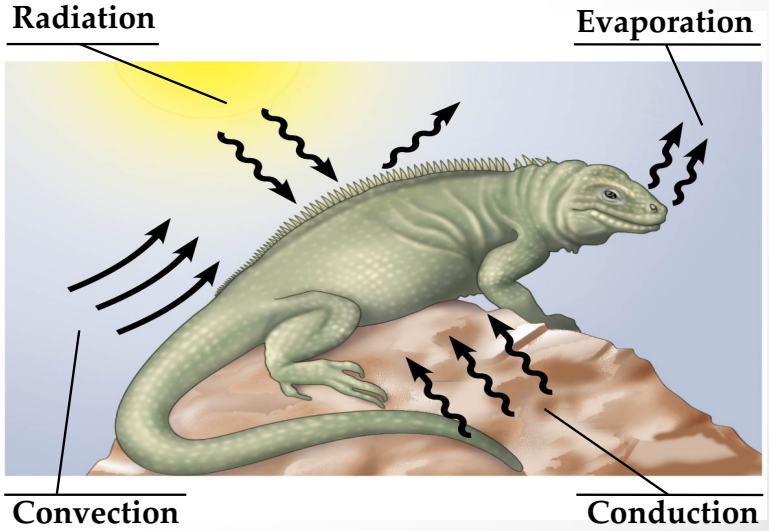
Nervous Tissue

- Nervous tissue contains
  - **Neurons**, or nerve cells：transmit nerve impulses
  - **Glial cells**, or **glia**： support cells



Thermoregulation 体温控制

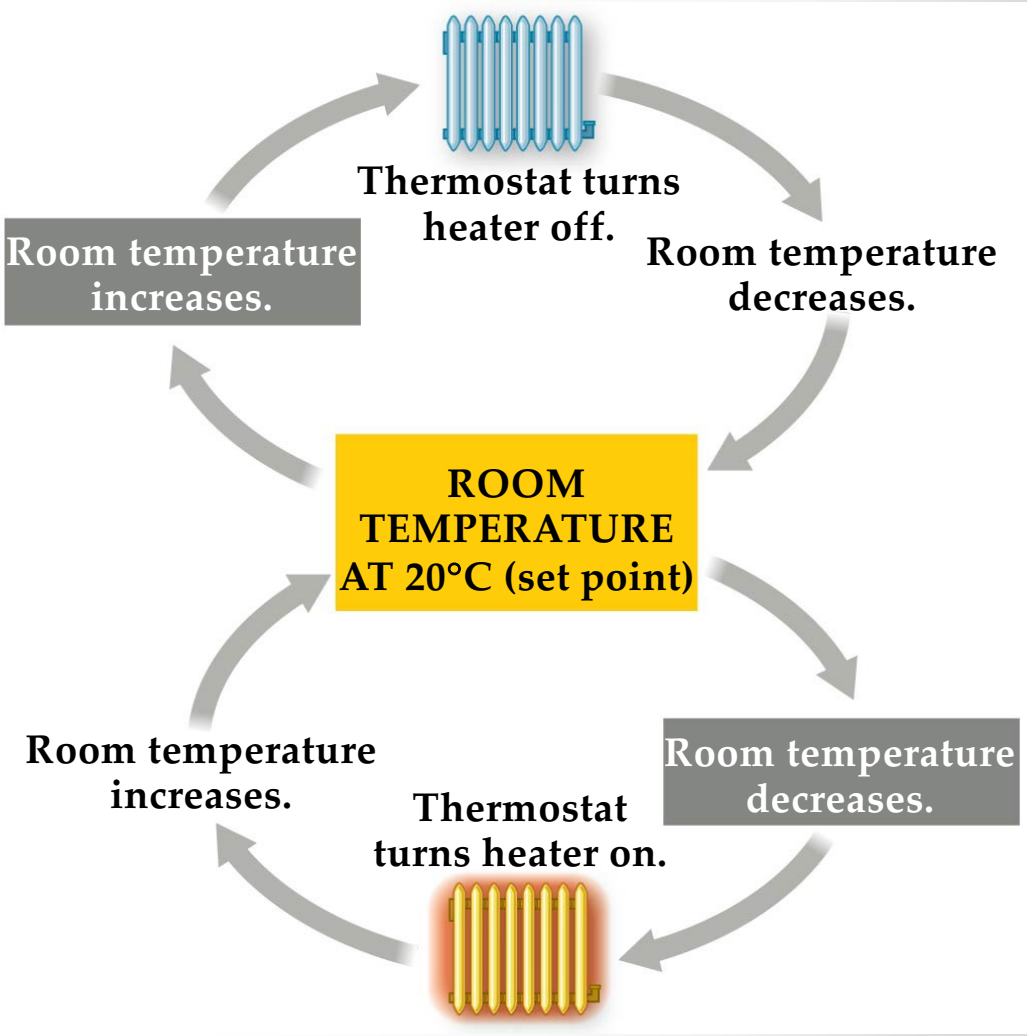
- Thermoregulation involves **form**, **function**, and **behavior** of animals
- **Ectothermic** animals变温动物/冷血动物 gain heat from external sources
- **Endothermic** animals 恒温动物/温血动物 generate heat by metabolism (energetically more expensive)
- Organisms exchange heat by four physical processes: radiation 辐射, evaporation 蒸发, convection 对流, and conduction 传导



Thermoregulation (Feedback control)

- **Thermoregulation in mammals** is controlled by a region of the brain called the **hypothalamus** 下丘脑, which triggers heat loss or heat generating mechanisms

- **Fever**, a response to some infections, reflects an increase in the normal range for the biological thermostat



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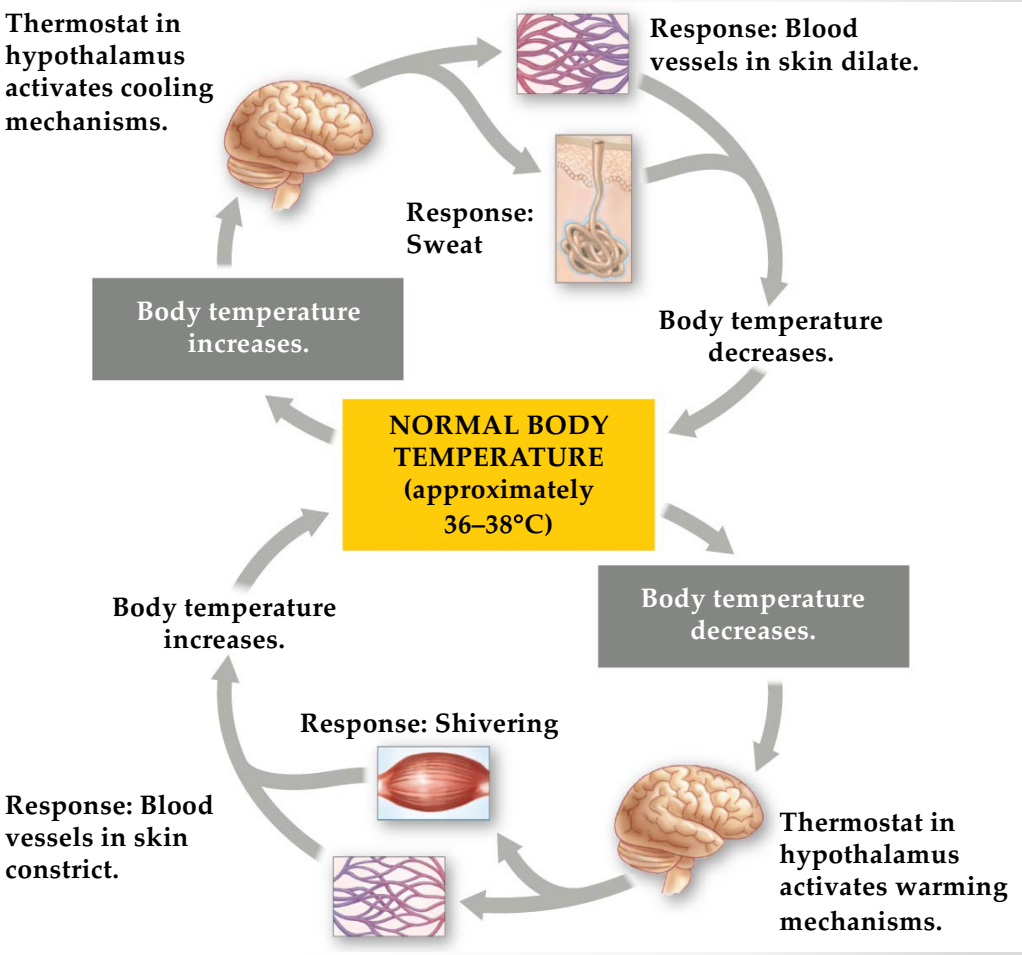


Heat regulation

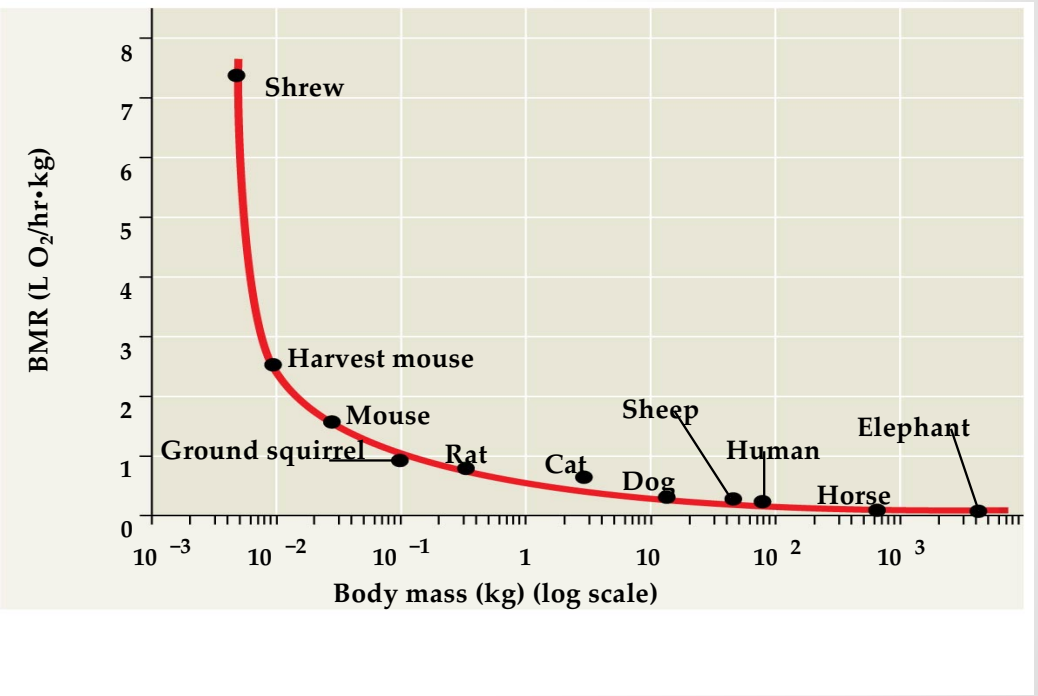
- Five adaptations help thermoregulation
  - Insulation (fur, fat)
  - Circulatory adaptations (blood vessels constricting/dilating)
  - Cooling by evaporative heat loss (sweating)
  - Behavioral responses (dragon fly pointing its tail to the sun)
  - Adjusting metabolic heat production (shivering)

Quantifying Energy Use

- **Metabolic rate** is the amount of energy an animal uses in a unit of time
- Metabolic rate can be determined by
  - An animal's heat loss
  - The amount of oxygen consumed or carbon dioxide produced
  - Measuring energy content of food consumed and energy lost in waste products
- Basal metabolic rate (**BMR**) is the metabolic rate of an endotherm at rest at a "comfortable" temperature
- Ectotherms have much lower metabolic rates than endotherms of a comparable size

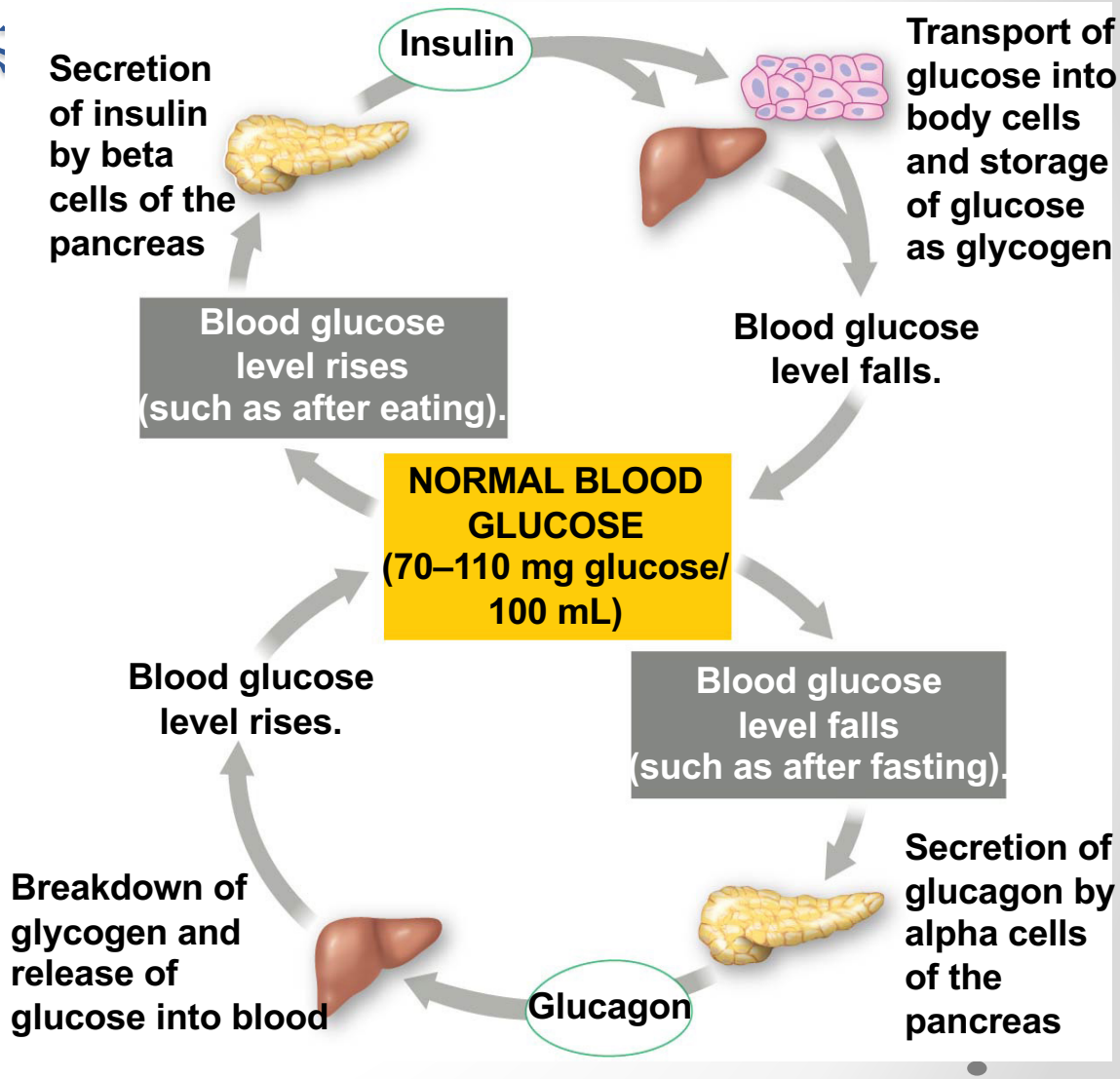
Influences on Metabolic Rate

- Key factors: **age, sex, size, activity, temperature, and nutrition**
- Metabolic rate is proportional to (body mass)$^{3/4}$
- Smaller animals have **higher metabolic rates per gram**
- The higher metabolic rate of smaller animals leads to a **higher breathing rate and heart rate**

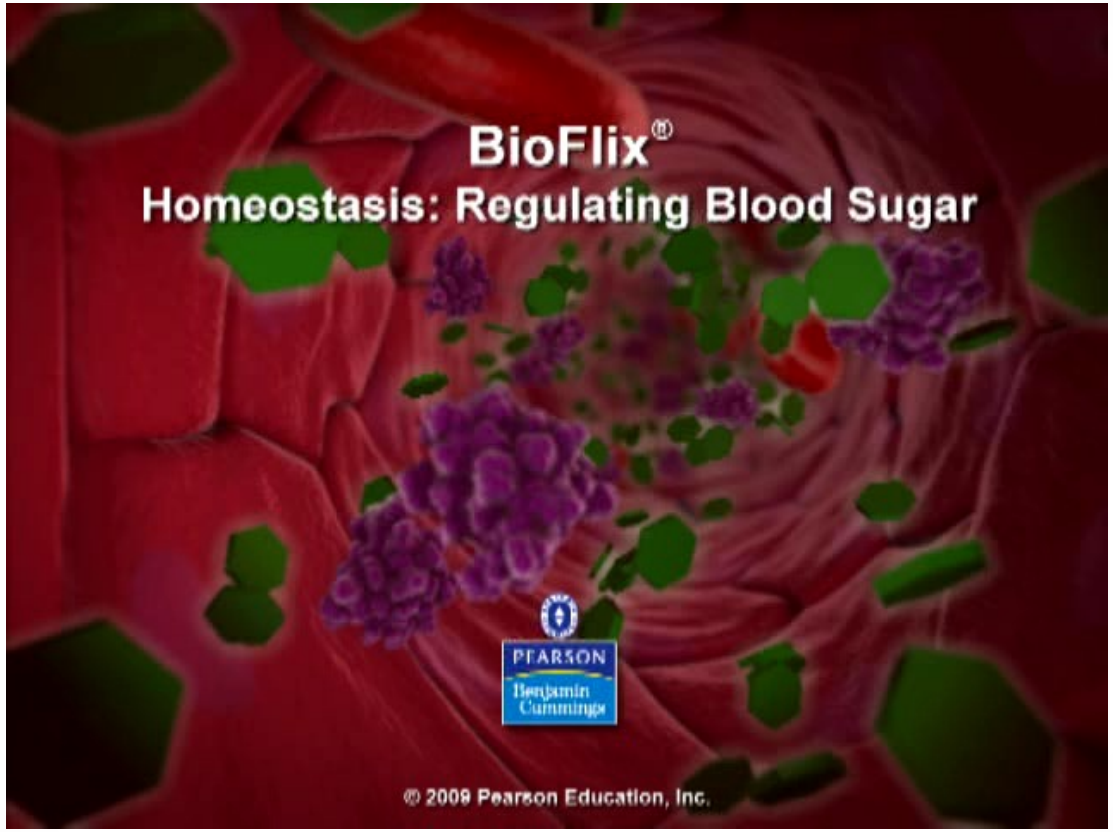


Glucose Homeostasis 血糖稳态

- **Glucose** 葡萄糖 is a major fuel for cellular respiration
- The hormones **insulin** 胰岛素 and **glucagon** 胰高血糖素 regulate the breakdown of glycogen 糖原 into glucose
- The **liver** is the site for glucose homeostasis
  - Food containing carbohydrate raises **insulin** levels, which triggers the **synthesis of glycogen**
  - Low blood sugar causes **glucagon** to stimulate the breakdown of glycogen and **release glucose**



Homeostasis: Regulating Blood Sugar



Animal Behavior

- Do you believe humans are the most intelligent animal species on planet earth?

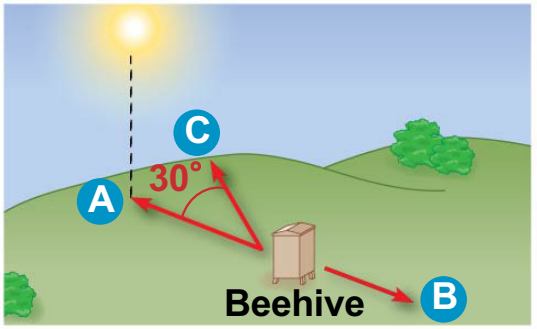
- How do we define intelligence?

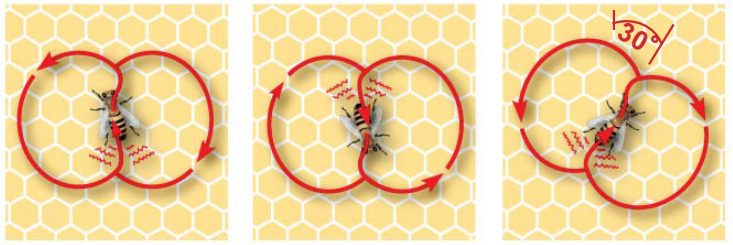
Animal Communication

- **Communication** is the transmission and reception of signals
- Honeybees show complex communication with symbolic language
- A bee returning from the field performs a dance to communicate information about the distance and direction of a food source

(a) Worker bees

(b) Round dance (food near)



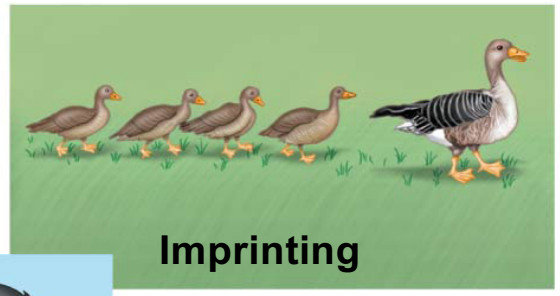


(c) Waggle dance (food distant)

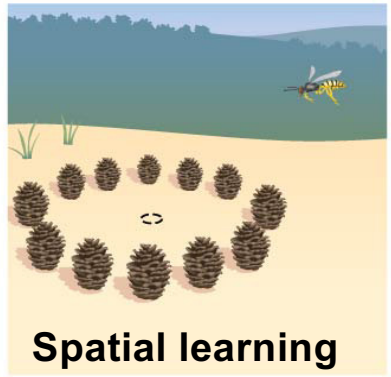
Learning

- **Learning** is the modification of behavior based on specific experiences

- The contributions of *both* **nature** and **nurture** in shaping learning



Forms of learning and problem solving

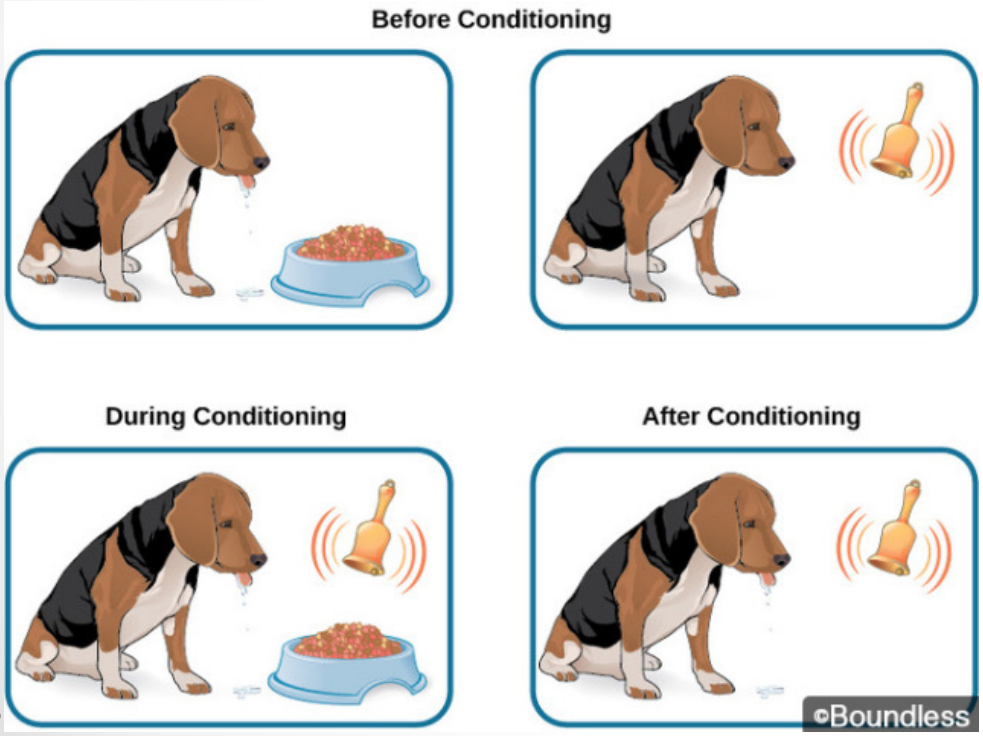


Imprinting

- **Imprinting** is the establishment of a long-lasting behavioral response to a particular individual or object
- Imprinting includes learning and innate components
- It is distinguished from other learning by a **sensitive period**

Associative Learning

- **Classical conditioning** is a type of associative learning in which an arbitrary stimulus is associated with a reward or punishment



Cognition and Problem Solving

- **Cognition** is a process of knowing that may include awareness, reasoning, recollection, and judgment
- **Problem solving** is the process of devising a strategy to overcome an obstacle