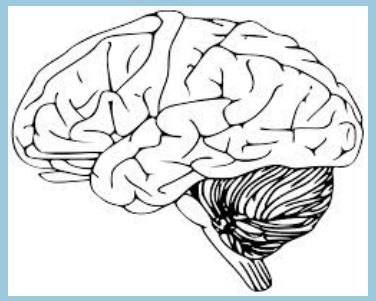
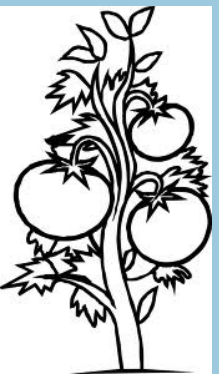


Summer Assignment: Living Systems, Part 1

In the AP Biology curriculum, this topic includes human body systems, as well as a comparison to the body systems of other animals. It even includes mechanisms used by plants, some protists and bacteria. This self-study will give you a good overview of the main ideas related to living systems.

Read through the material and look at the pictures in this presentation. Wherever you see the ? icon, there is a question to answer. You are welcome to look up information online to help you with the questions. Write your answers on the question sheet posted with the summer assignment (Word document). You do not need to print this powerpoint. There are 25 questions. The summer assignment is due during the week of Sept. 18th – exact date TBA.



The Importance of Feedback Mechanisms

- Organisms use feedback mechanisms to maintain their internal environments and respond to external environmental changes.

  1. What is it called when organisms maintain a steady or stable internal environment (such as maintaining a relatively constant body temperature)?

- In biology, there are two types of feedback:

  negative feedback and positive feedback

- What's the difference?
  - In **negative feedback**, a change in a condition triggers a control mechanism that stops the change from continuing.

  - In **positive feedback**, a change in a condition triggers a control mechanism that continues or amplifies the change

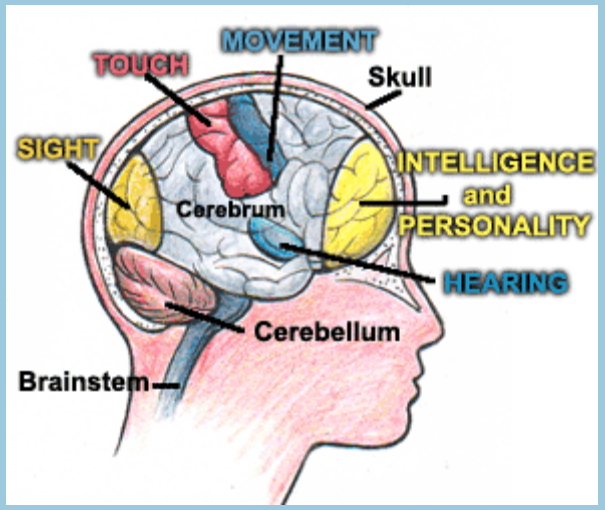
Feedback – A Mechanism for Maintaining Homeostasis

2. Your eyes are an example of a _____. Your muscles are an example of an _____. (Use terms from the diagram.)

Receptor
(Detects stimulus)

Response
(Change in condition)

Effector
(Part of body that can respond)



Negative Feedback

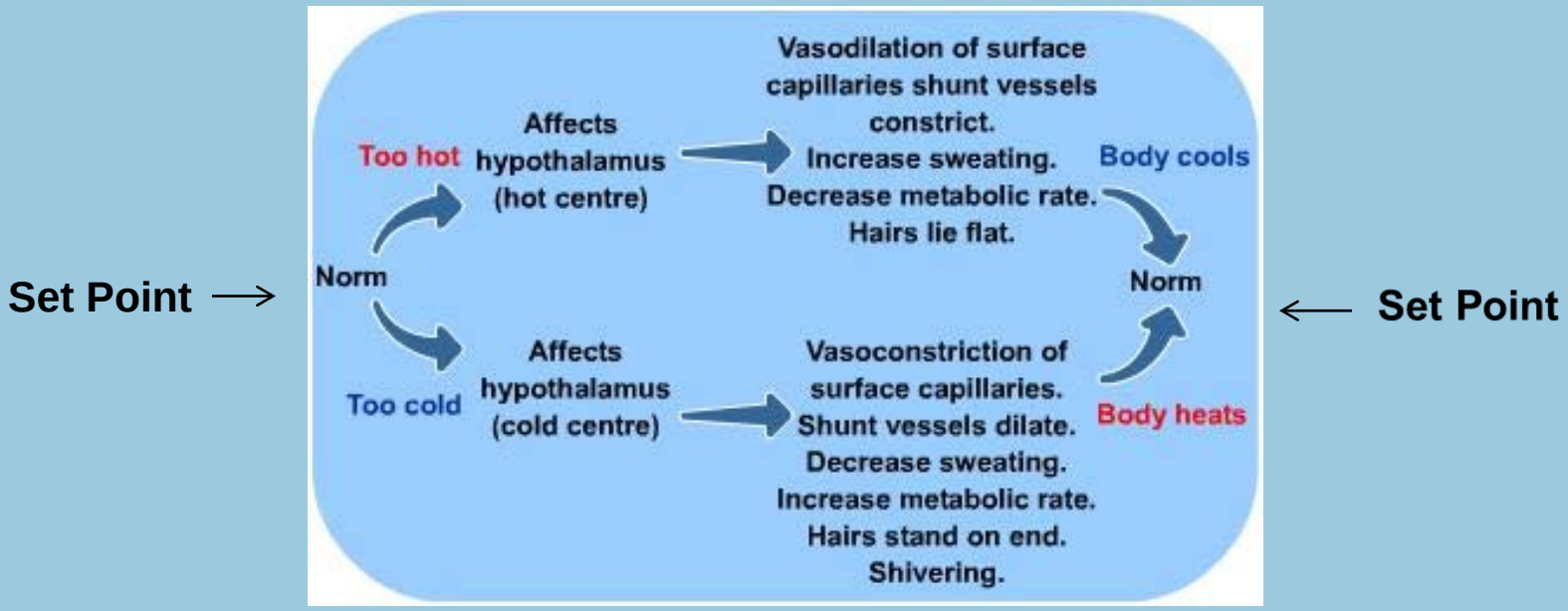
- Negative feedback mechanisms maintain dynamic homeostasis for a particular condition (variable) by regulating physiological processes, returning the changing condition back to its target set point.

- Examples of negative feedback include:
  - **Temperature regulation** in animals
    - See the next slide
  - Plant responses to **water limitations**
    - For example, if water is scarce, plants may grow deeper roots to access more water in the soil. As the drought comes to an end, the plants' roots might not continue to grow.
  - **Operons** in gene regulation
    - You will learn about more about operons in our DNA unit. For an introduction, go to: http://bioscience.jbpub.com/cells/MBIO3103.aspx and http://www.biology-pages.info/L/LacOperon.html

3. What is an operon?

4. How is the trp operon an example of negative feedback? The genes of the trp operon control the production of the amino acid _____.

An Example of Negative Feedback: Temperature Regulation



- In this example, humans start with a normal body temperature range; this is sometimes called the norm or set point. If their body temperature varies from the set point, various responses will take place. These responses then cause the body temperature to return to the norm. So if the body is too hot, it will cool down. If it is too cold, it will warm up. That is negative feedback.

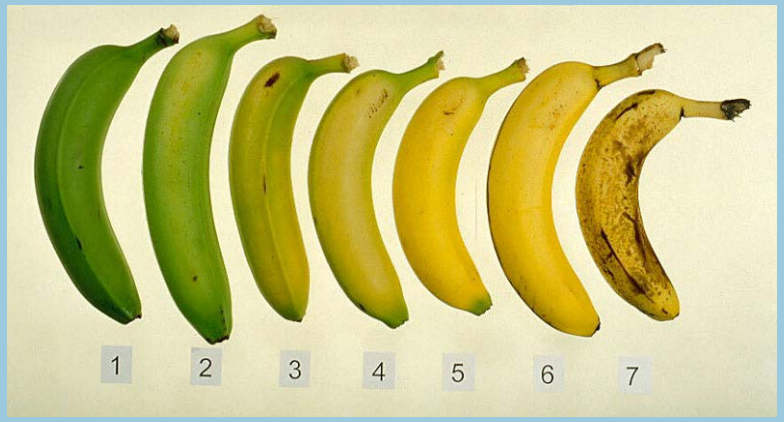
5. True or False: If body temperature was regulated by positive feedback, then as the body temperature increased, it would continue to increase even more. But, of course, body temperature is regulated by negative feedback.

Positive Feedback

- Positive feedback mechanisms amplify responses and processes in biological organisms. The variable initiating the response is moved farther away from the initial set-point. **Amplification** occurs when the stimulus is further activated which, in turn, initiates an additional response that produces system change.

- Examples of positive feedback include:
  - Lactation in mammals
    - When a baby nurses, the stimulation leads to secretion of the hormones **oxytocin & prolactin**. These hormones then cause milk to be let down into the breast. They also cause the brain to stimulate further hormone secretion, which in turn leads to more lactation.
    - This is a positive feedback system as the product (milk) causes the infant to increase nursing and the mother to produce more hormones.
  - Onset of labor in childbirth
    - In order for a baby to be delivered, powerful contractions must take place in the uterus. In early labor, the contractions are less powerful and gradually intensify. During labor, **oxytocin** is released. This hormone intensifies and speeds up contractions. The increase in contractions causes more oxytocin to be released and the cycle goes on until the baby is born. The birth ends the release of oxytocin and ends the positive feedback mechanism.
  - Ripening of fruit
    - See the next slide

An Example of Positive Feedback: Fruit Ripening



- The ripening process in fruits involves the **hormone ethylene** and it is an example of a positive feedback mechanism.

6. Explain what you think happens during ripening to make it an example of positive feedback:

(Hint: Look at the examples on the previous slide or feel free to look it up.)

Why are Feedback Mechanisms So Important?

- Alteration in the mechanisms of feedback often results in deleterious (harmful) consequences.
- Examples include:
  - Diabetes mellitus in response to decreased insulin
    - Normally, after a meal, the levels of glucose in the blood rise past a certain set point. Glucose sensors detect this increase and stimulate the pancreas to produce and secrete the hormone **insulin.**
    - The presence of insulin in the bloodstream stimulates cells in the liver to store glucose in the form of **glycogen** and stimulates other cells and tissues to **take in glucose,** which they can use as an energy source.
    - When this process is not working properly, the pancreas might not be stimulated to secrete insulin when the glucose level is past the set point. This could result in **excess glucose remaining in the bloodstream**, which is a symptom of diabetes.
  - Dehydration in response to decreased **antidiuretic hormone (ADH)**
  - Graves' disease
  - Blood clotting

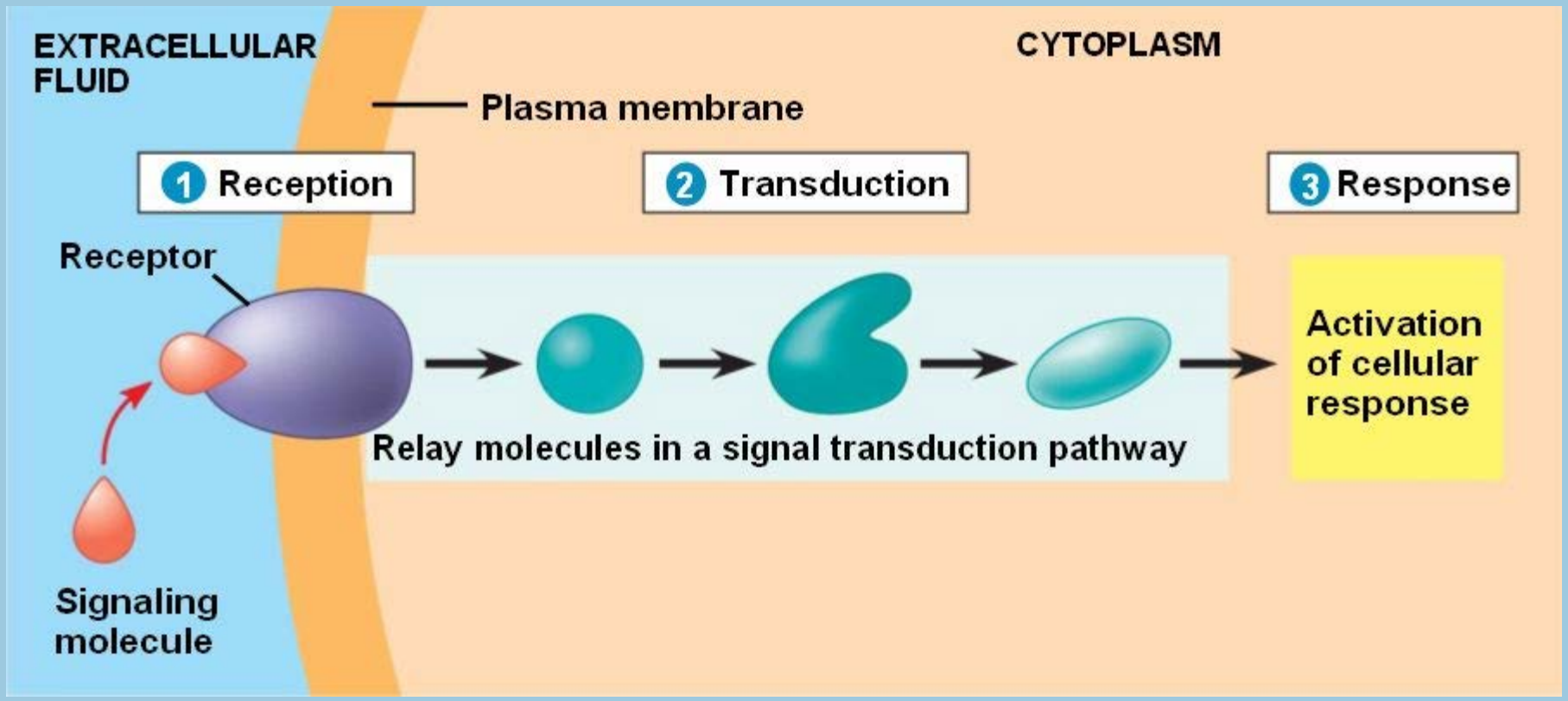
7. Diabetes was explained here. Choose one of the other 3 examples given and explain how they are caused by a disruption to a feedback mechanism. (You can look up info.)

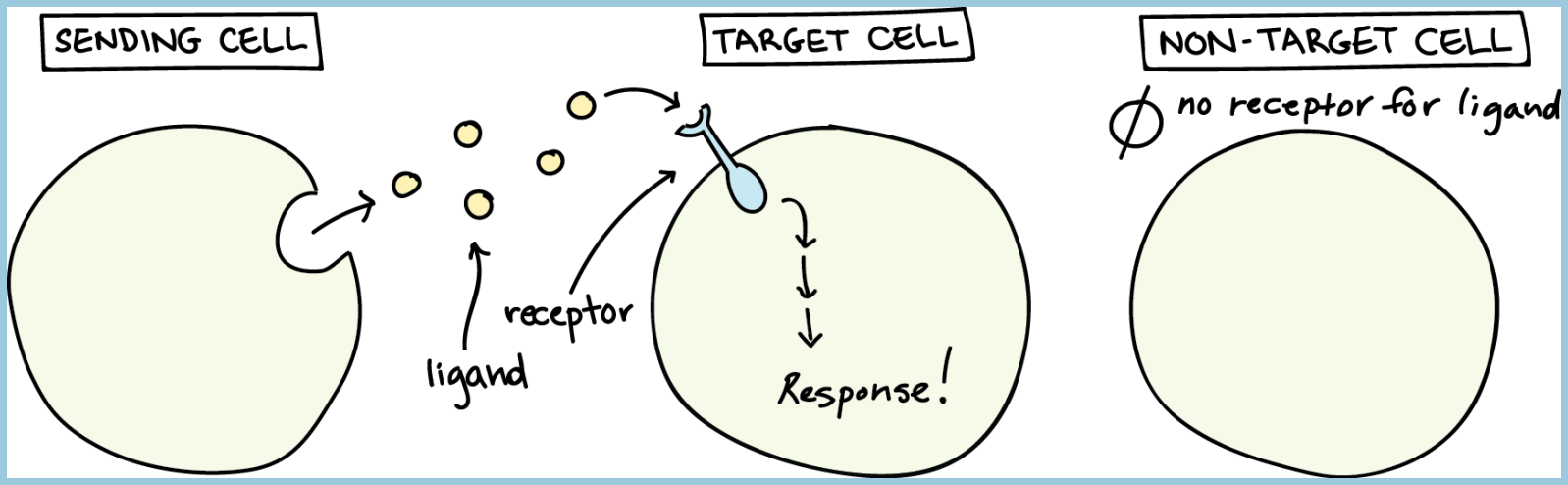
How Do Biological Mechanisms Relate to Evolution?

- Homeostatic mechanisms reflect both common ancestry **and** divergence due to adaptation in different environments.
  - **Common Ancestry:** Some biological mechanisms or processes developed early in our evolutionary history and are still present today. These processes are said to be "conserved."
    - Comparing how many processes 2 species share can provide some information about how closely related the species are.
    - A shared process or trait can indicate that the organisms evolved from a common ancestor.

- Continuity of homeostatic mechanisms reflects common ancestry, while *changes may occur in response to different environmental conditions.*
  - Continuity ex - When we studied **cell signaling**, we learned that **signal transduction pathways** in microbes and mammals are similar. This indicates an early origin of these pathways.

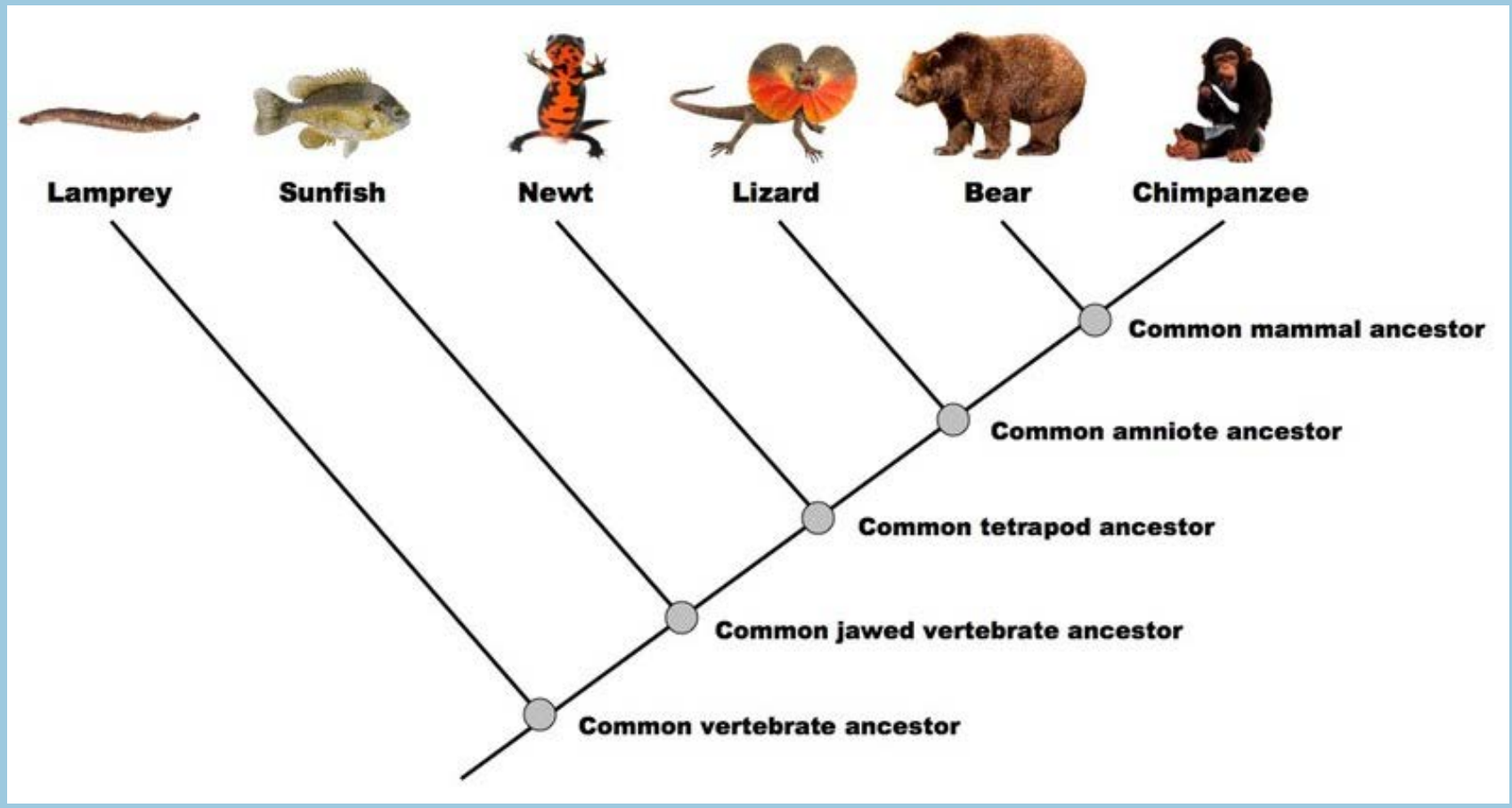
8. See the cell signaling diagrams on the next slide. What is the relationship between a signal (ligand) & receptor?


EXTRACELLULAR FLUID
CYTOPLASM
Plasma membrane
1 Reception
2 Transduction
3 Response
Receptor
Activation of cellular response
Relay molecules in a signal transduction pathway
Signaling molecule


SENDING CELL
TARGET CELL
NON-TARGET CELL
no receptor for ligand
receptor
ligand
Response!

Phylogenetic Tree

9. The lizard, bear and chimpanzee all share a common ancestor that produced amniotic eggs. What trait is shared by a common ancestor of the sunfish, newt, lizard, bear and chimpanzee?



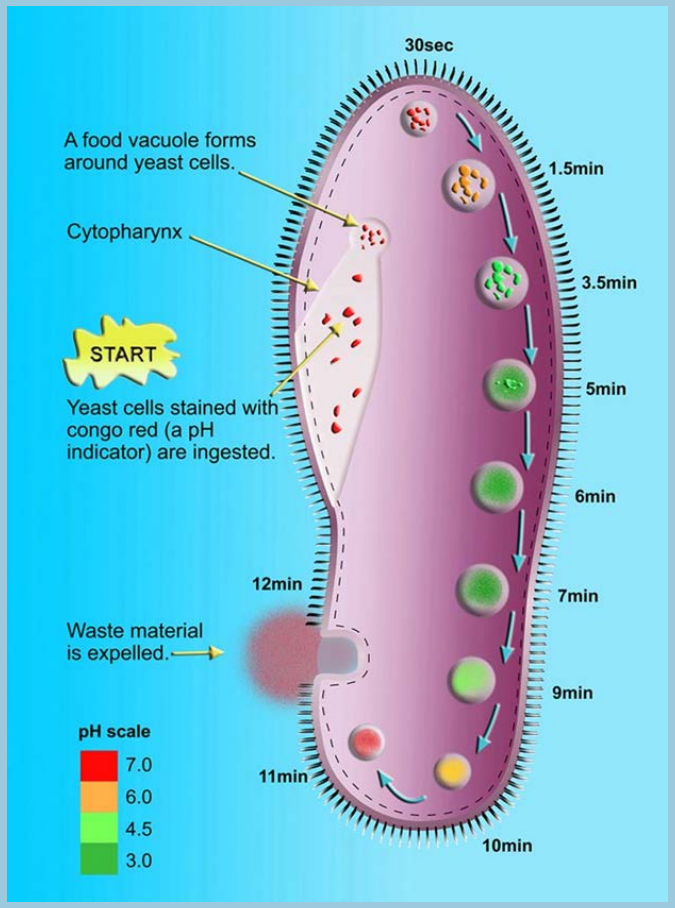
Divergence Due to Adaptations

- **Divergence:** On the other hand, species evolved from a common ancestor may eventually develop different mechanisms and traits depending on their environment.
- For example, organisms have various mechanisms for obtaining nutrients and eliminating wastes. These mechanisms reflect the environments in which they live. Processes related to nutrition and waste removal include:
  - **Digestive mechanisms** and **Respiratory systems**
  - **Nitrogenous waste production and elimination**
  - **Gas exchange** in aquatic and terrestrial plants
    - Stomata provide a way for both types of plants to exchange gases. They can take in and release oxygen and carbon dioxide through the stomata. Through the process of transpiration, water evaporates and exits the plants through the stomata. If the plant needs to conserve water, then it keeps its stomata closed some of the time.

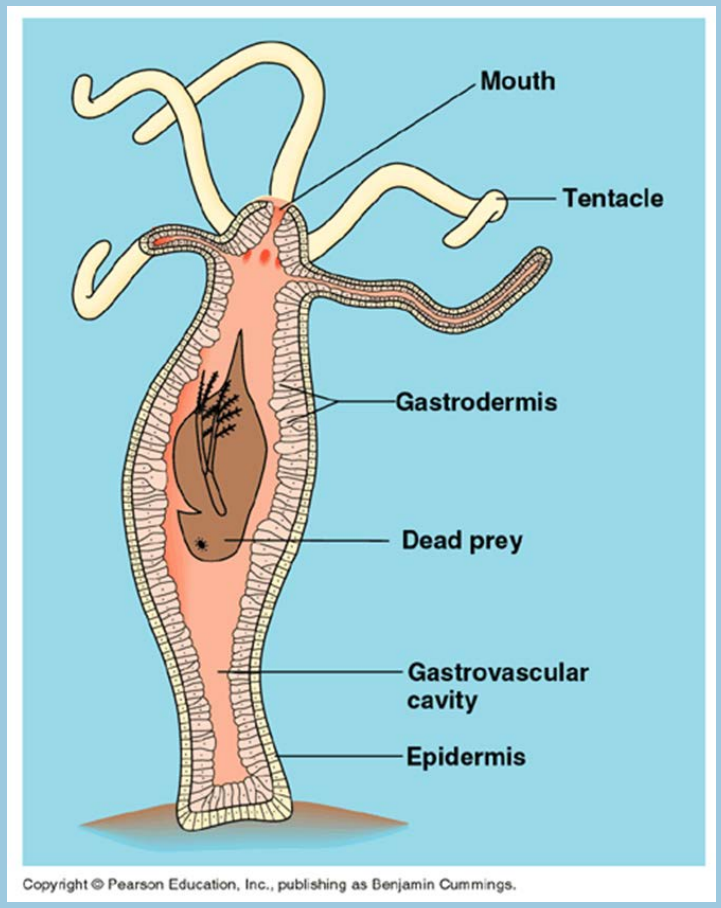
10. Which would have this trait (of keeping the stomata closed sometimes) – aquatic or terrestrial plants? Why?

Digestive Mechanisms

- Digestive mechanisms in animals such as food vacuoles, gastrovascular cavities, one-way digestive systems



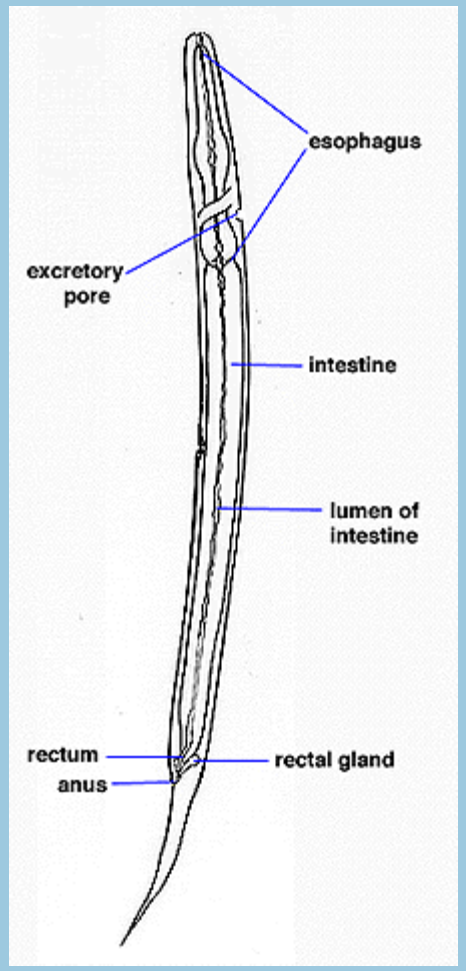
Paramecium digests food in vacuoles

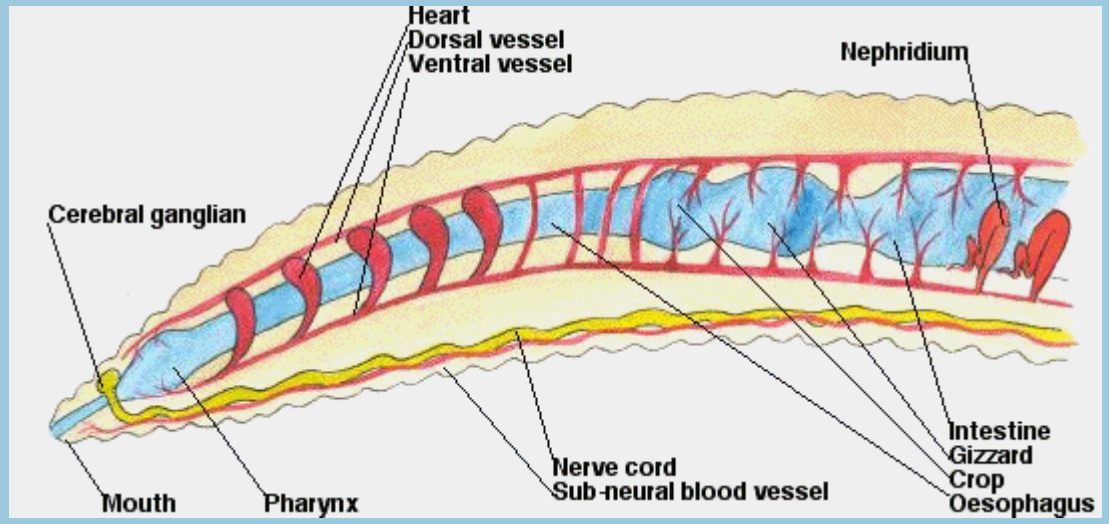


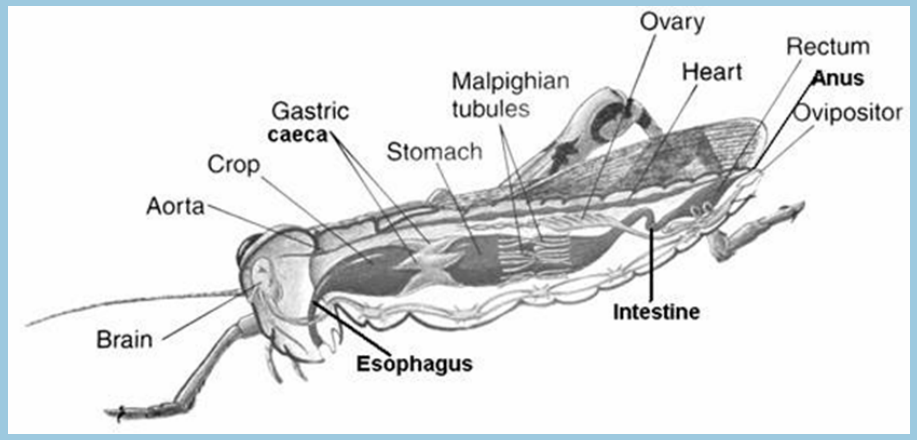
Hydra digests food inside a body cavity

11. Which organism is an example of extracellular digestion and which is an example of intracellular digestion?

A Complete Digestive Tract







12. The roundworm, segmented worm (earthworm), and grasshopper shown here are examples of organisms with increasingly complex digestive systems. They are complete and one-way, as there are two openings. Name some of the digestive organs used by these organisms, and what these organs do.

And Finally…the Human Digestive System

https://www.niddk.nih.gov/health-information/digestive-diseases/digestive-system-how-it-works

- Humans have a complex digestive system with specialized organs. The food passes directly through some of the organs, while others produce bile and enzymes crucial for digestion.

13. Put the following organs in order, showing the pathway of food through the digestive system:
stomach, mouth, small intestine, esophagus, large intestine

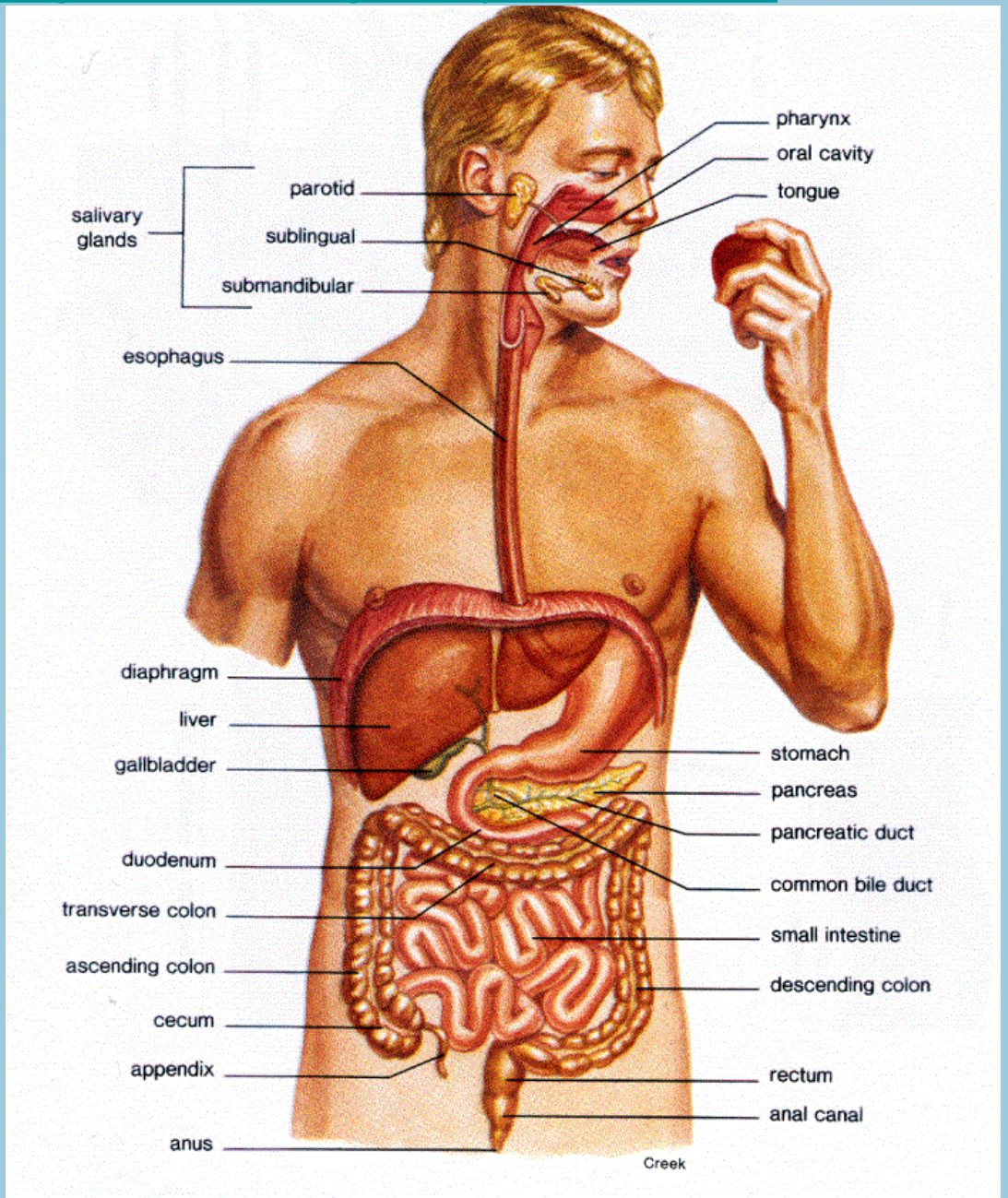
14. Use the site above. Where are the following macromolecules digested?

proteins

carbohydrates

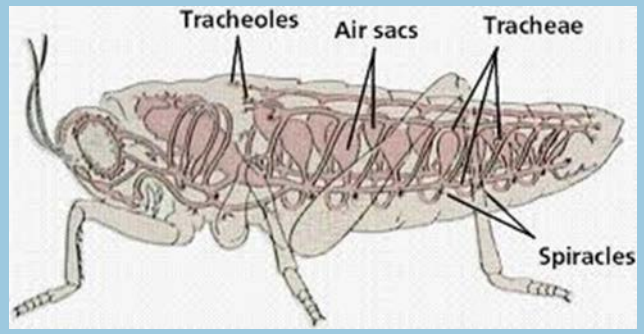
fats

nucleic acids



Respiratory Mechanisms

- Respiratory systems of aquatic and terrestrial animals are varied, but share some elements in common.
  - Their respiratory organs include <u>moist surfaces with a large surface area.</u>
  - The large surface area allows for a great deal of gas exchange with the environment. For example, humans use their lungs to breathe in oxygen and breathe out carbon dioxide. Fish pass water over their gills where oxygen from the water moves into their blood vessels. Insects have spiracles on their exoskeleton and air sacs throughout their body.



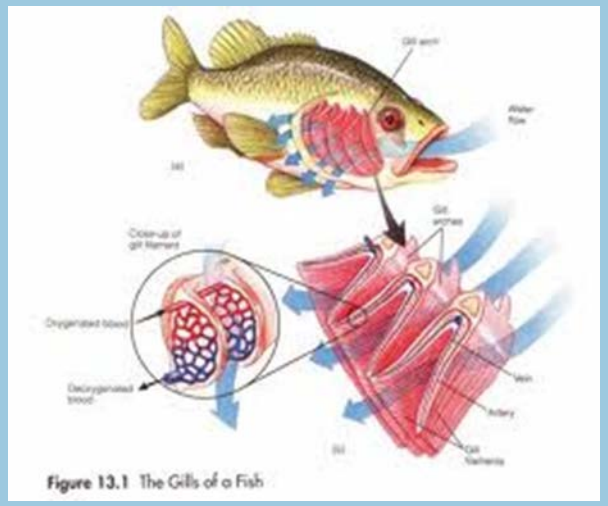
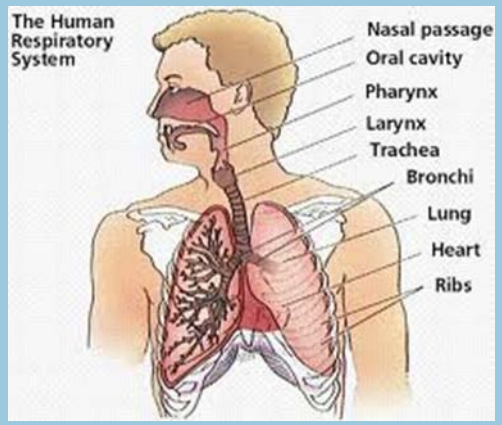


Figure 13.1 The Gills of a Fish

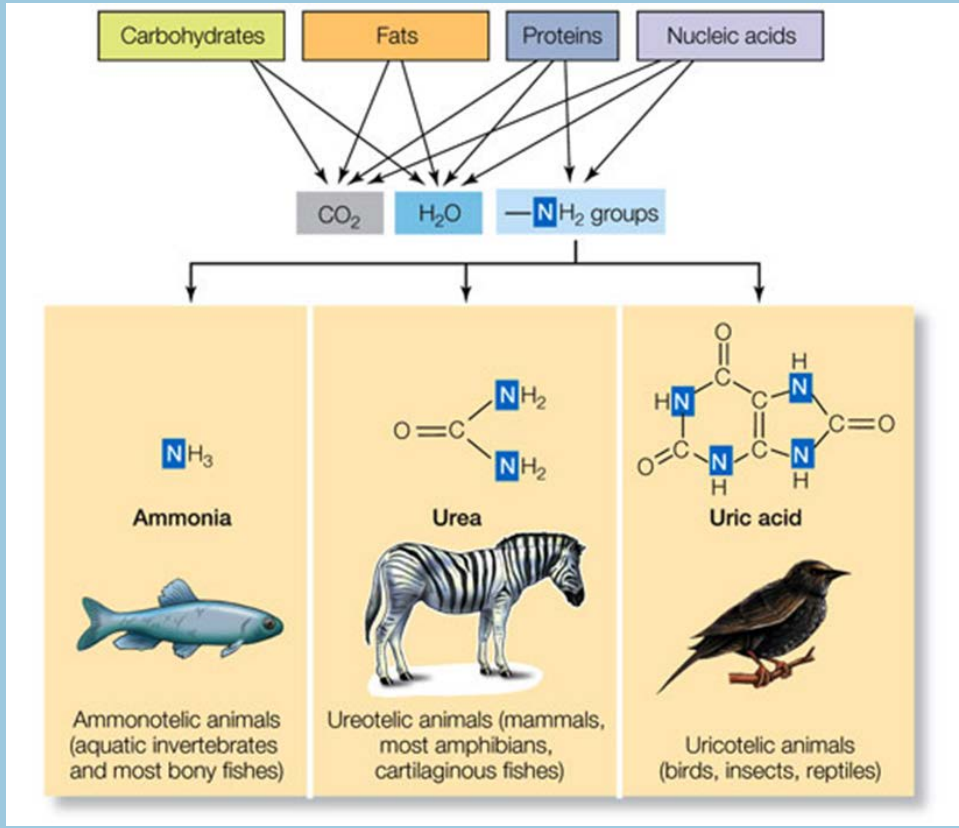


15. What do an insect's air sacs, fish gill filaments, and the alveoli of the human lungs have in common?

Excretory Systems (Nitrogenous Waste)

- Nitrogenous waste production and elimination are crucial processes in aquatic and terrestrial animals. Animals produce solid waste products as food passes through their digestive system. But they also need a special way to deal with nitrogen-containing waste products that are produced as macromolecules are broken down.

16. Which 2 macromolecules produce waste products containing nitrogen?



- Different animals process the nitrogen in different ways and produce a nitrogenous waste product that they will release.
- Fish produce ammonia, which is relatively toxic. But because they are in the water, it is quickly diluted and doesn't harm the fish.

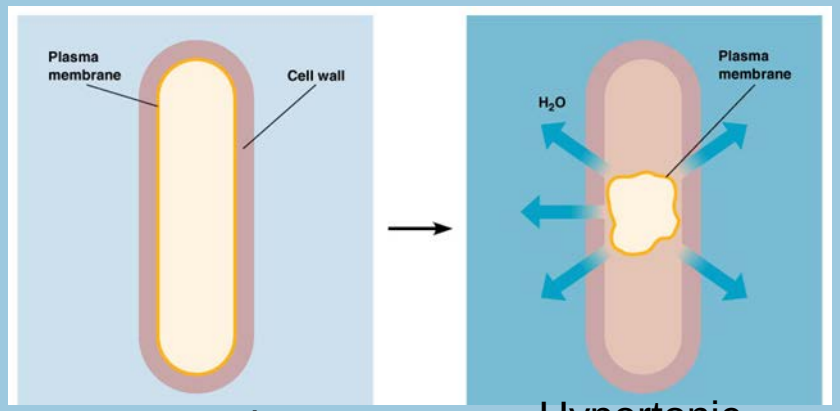
17. Humans produce _____ which is released in urine.
A snake produces _____, which is released as a solid, white substance.

Regulation is Found in Various Species & Kingdoms

- Homeostatic control systems in species of microbes, plants and animals support common ancestry.
- All of these organisms have ways to regulate their bodies or cells to maintain homeostasis.
- Examples of regulatory mechanisms include:
  - **Excretory systems** in flatworms, earthworms and vertebrates
  - **Osmoregulation** in bacteria, fish and protists
  - **Osmoregulation** in aquatic and terrestrial plants
  - **Circulatory systems** in fish, amphibians and mammals
  - **Thermoregulation** in aquatic and terrestrial animals (countercurrent exchange mechanisms)

- Osmoregulation: Organisms in aquatic and terrestrial environments must maintain the right concentration of solutes and the right amount of water in their body fluids.
- To do this, they must keep the amount of water in the body in balance. This is known as **osmoregulation**.
- See the pictures on the next 2 slides…

Osmoregulation in Bacteria and Protists

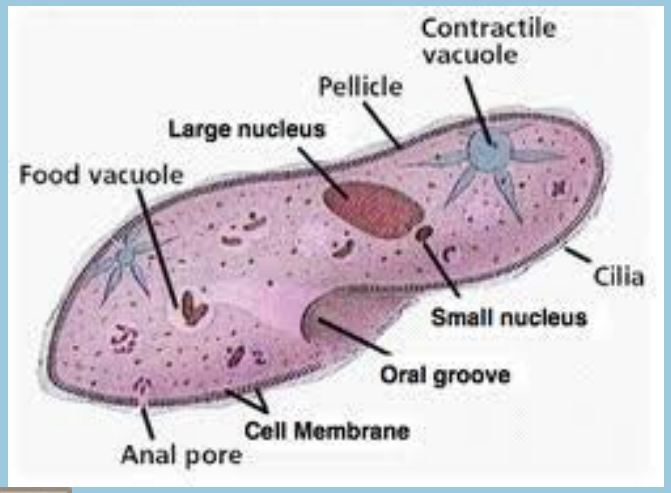


Isotonic environment

Hypertonic environment

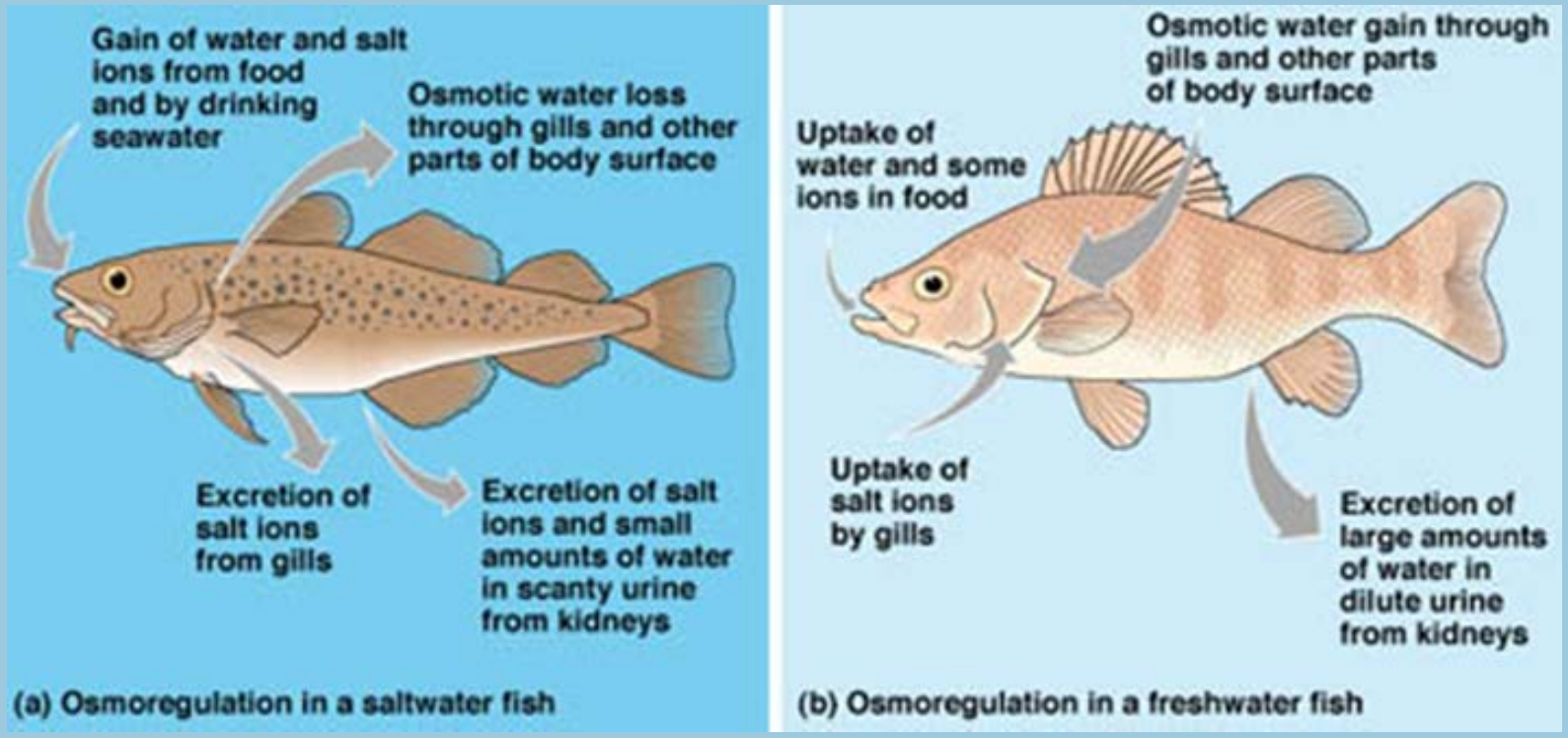
- The top picture shows what happens when a bacterium is placed in an isotonic solution vs. a hypertonic solution (higher salt concentration than inside the cell).

18. This is similar to what happens in plants. Like a plant cell, a bacterium has a plasma membrane and a cell wall. When placed in a hypertonic solution the membrane pulls or shrinks away from the cell wall. This is called plasmolysis. Why does this occur?



19. Protists, such as this paramecium, are freshwater-dwellers and face an influx of water into their cells on a daily basis. Luckily, they have a _____ _____, an organelle that pumps water out. (Which organelle in the diagram probably acts as a pump?)

Osmoregulation in Fish (Freshwater vs. Saltwater)

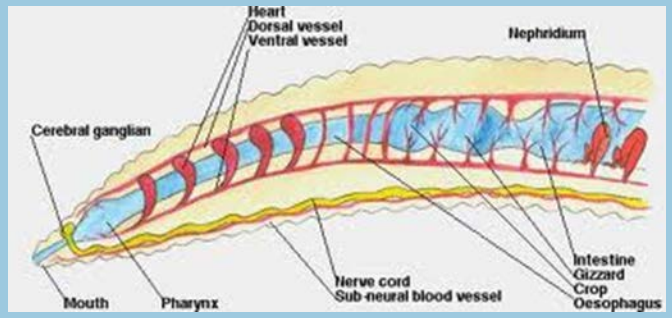


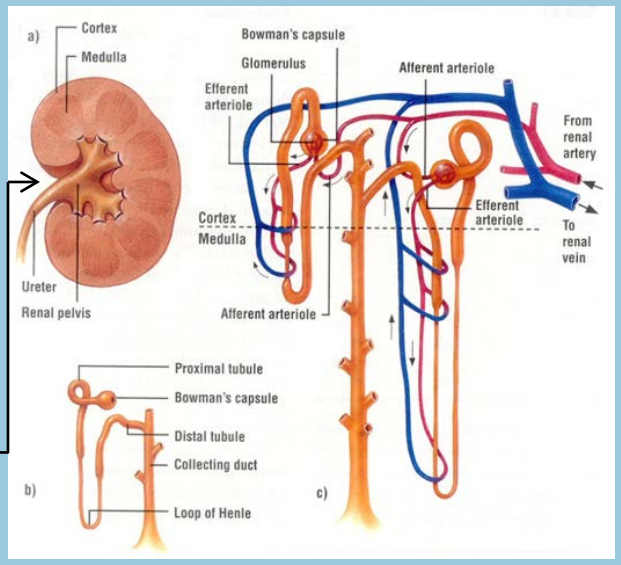
- Fish that live in **freshwater are in a hypotonic environment** and the tendency would be for them to take in excess amounts of water and to lose valuable salts. To avoid this, they drink very little water, have the ability to reabsorb salts, and produce large amounts of watery urine.

20. Fish that live in marine saltwater environments have the opposite problem. What is their problem and what strategies do you suppose they use to maintain homeostasis?

Excretory Systems

- These diagrams show the organs used by flatworms, earthworms, and humans as part of their excretory systems. You can see that they increase in complexity as you move from the simple flatworm to the more complex mammalian excretory system. But all 3 systems provide a way for the organisms to retain what is needed by the body and excrete what is not needed as waste.

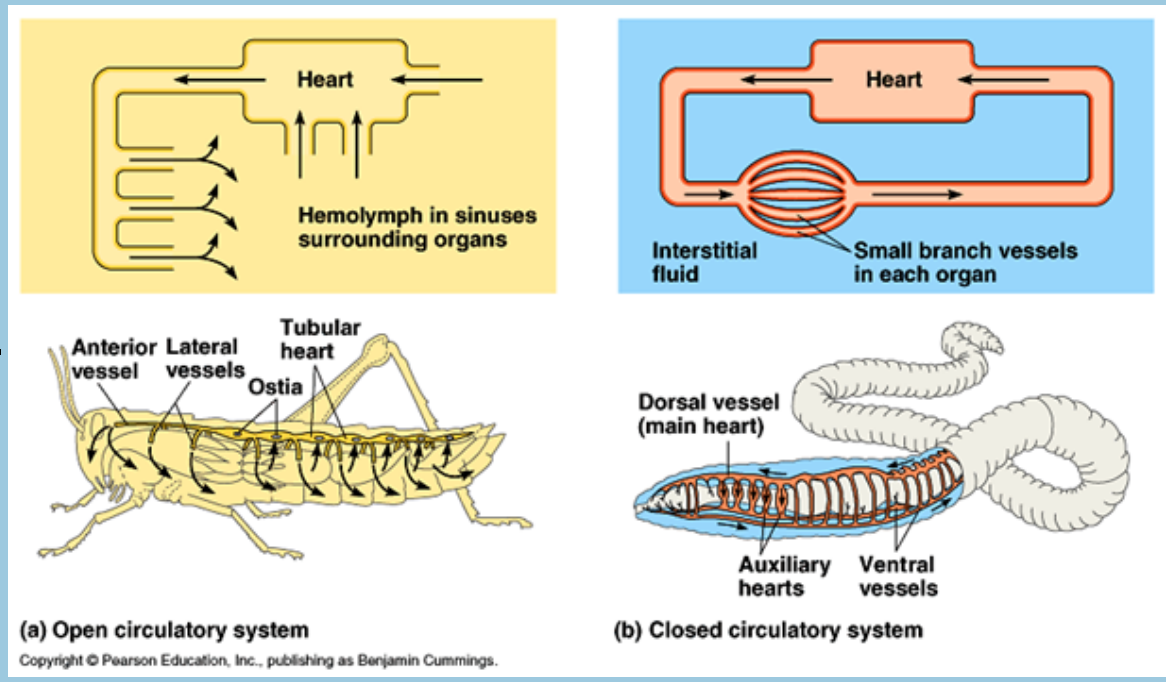




21. In humans and other mammals, it is the job of the _____ to filter the blood. Functional units, called nephrons, accomplish this filtration process by returning needed materials to the body and removing toxins, urea, and excess water from the body in the form of _____, a liquid waste product stored in the urinary bladder before exiting the body through the urethra. (see https://www.niddk.nih.gov/health-information/kidney-disease/kidneys-how-they-work for more detail).

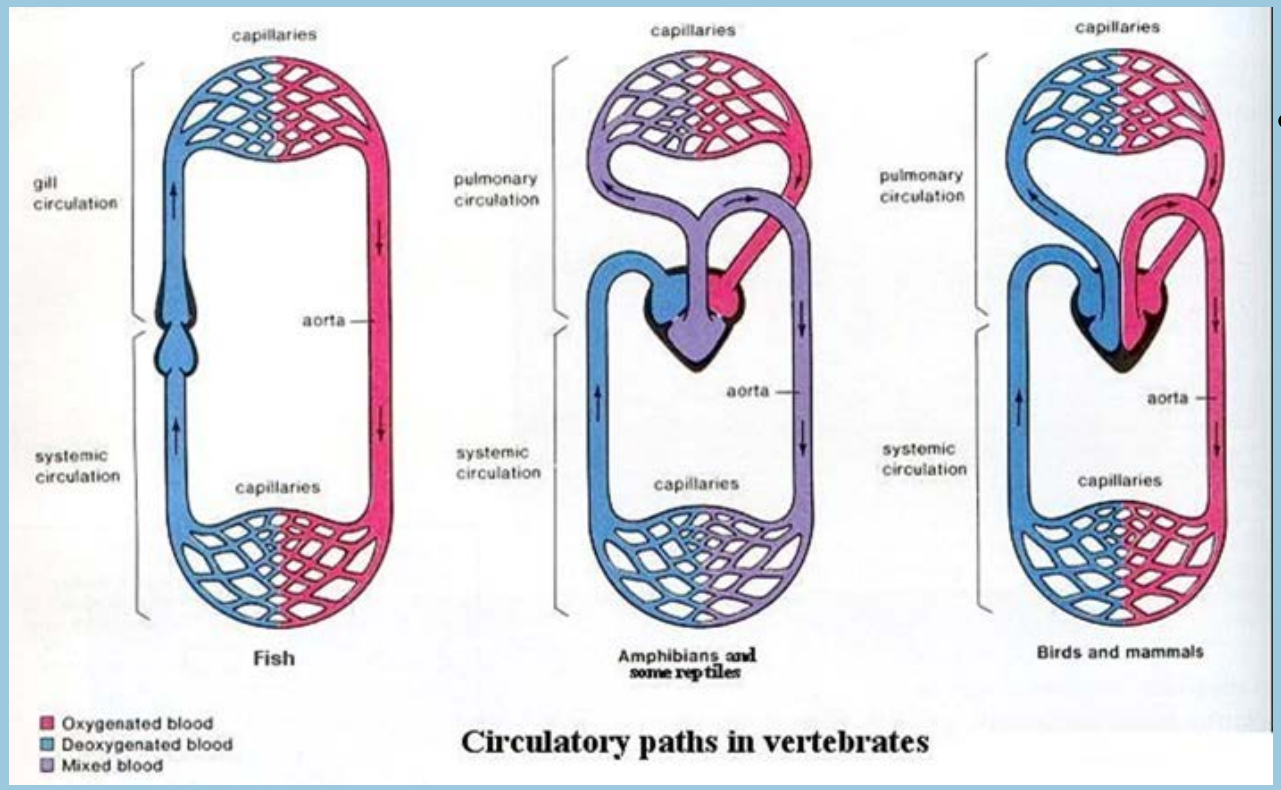
Open and Closed Circulatory Systems

- In an open circulatory system, the fluids are not contained within blood vessels. There is a simpler, more direct exchange of materials with body tissues. An open system doesn't require the organism to be active, though some are (insects) and there is less control over which tissues come in contact with the body fluids.



- In a closed circulatory system, the blood is contained within a completely closed system of vessels and there is usually some sort of pumping organ like a heart or contractile vessels. There is more control over the distribution of blood to different body regions. Muscular walls of vessels can constrict and dilate to vary the amount of flow through specific vessels. Blood pressures are fairly high and the circulation can be vigorous.

Circulatory Systems in Vertebrates



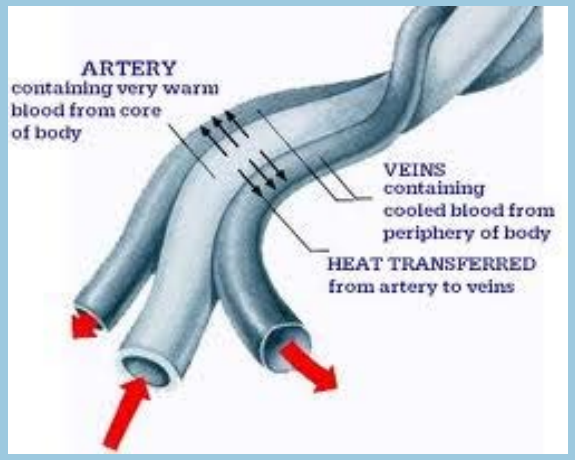
- Amphibians, reptiles, birds, and mammals all have double circulation, in which the blood is pumped to 2 different circuits. Blood is taken to and from the organs and tissues of the body systems in the **systemic circuit.**

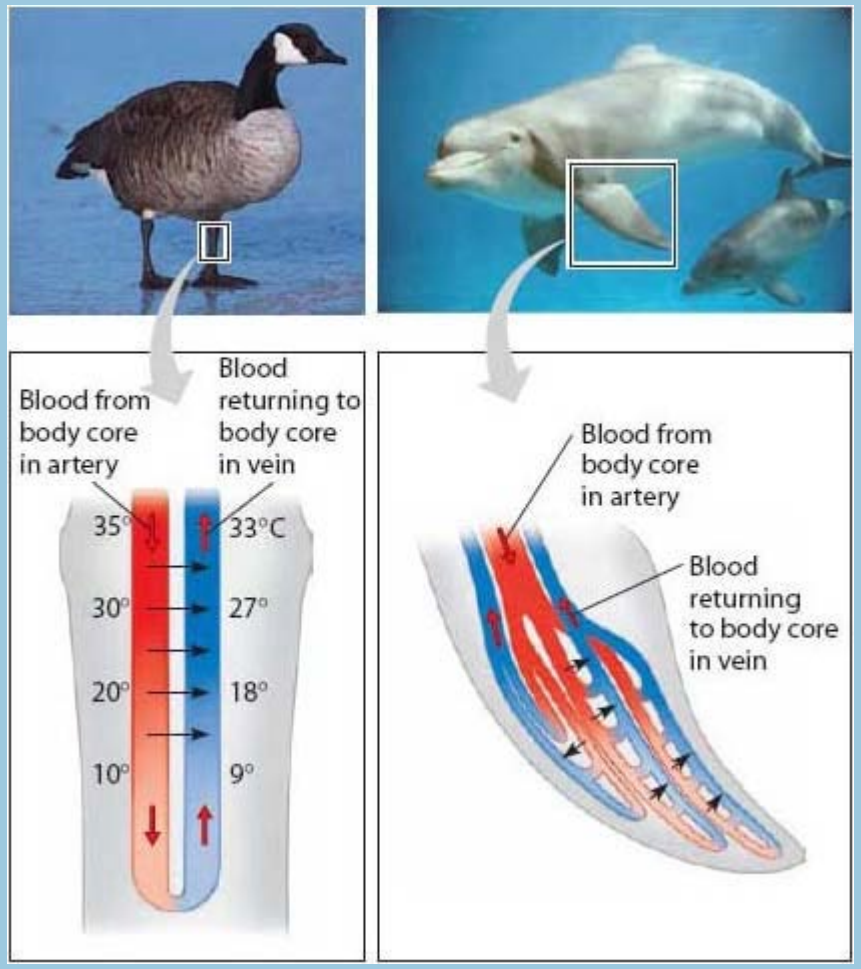
- Birds and mammals pump blood to and from the lungs in the pulmonary circuit. In amphibians, the **pulmonary circuit** allows for gas exchange at the lungs and also through their thin, moist skin.

22. Which type of circulatory system do vertebrates have – open or closed?

23. Name one difference between the circulatory systems shown above.

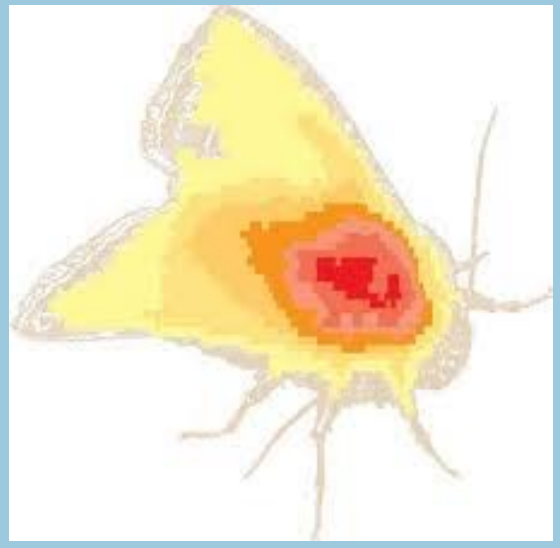
Thermoregulation in Aquatic and Terrestrial Animals

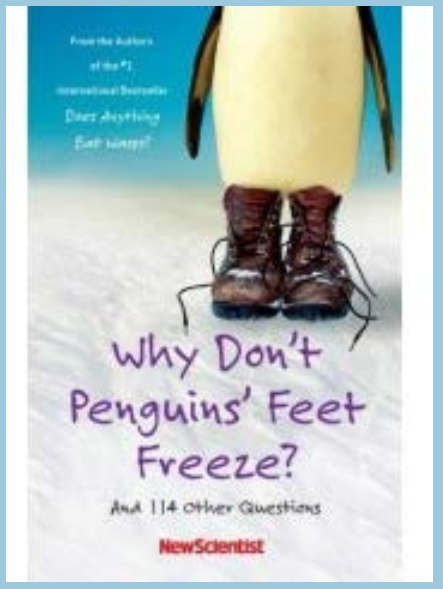




- The diagram illustrates a circulatory adaptation found in many birds and mammals. In **countercurrent heat exchange**, warm and cold blood flow in opposite (countercurrent) directions in two adjacent blood vessels. Warm blood (red) from the body core cools as it flows down the goose's leg or the dolphin's flipper. But the arteries carrying the warm blood are in close contact with veins (blue) carrying cool blood back toward the body core. Heat passes from the warmer blood to the cooler blood along the whole length of these side-by-side vessels. By the time returning blood leaves the leg or the flipper, it is almost as warm as the body core. Thus, heat loss is minimal, even when the animal is standing on ice or swimming in frigid water.

Countercurrent Heat Exchange





24. What does the picture of the moth illustrate about thermoregulation?

25. Based on what you know about circulatory adaptations, describe at least one reason why penguins' feet don't freeze after spending so much time on the snow and ice. (There is actually a book with that title – see above – that talks about this and many other quirky questions.)

The End…of Part 1 ☺