Development of the nervous system

THINK ABOUT IT

– Imagine that you are at a favorite place. Now, think about the way you experience that place.

– You gather information about your surroundings through senses such as vision and hearing. Your nervous system collects that information. Your brain decides how to respond to it.

– The same is true for all animals—though the structures that perform these functions vary from phylum to phylum.

Purpose

- The purpose of the “nervous system” is to receive information from outside and inside the body and direct the response of the body based on that information.
- The Response may be regulated by electrical or chemical means

How quickly do you respond

- Working in pairs
- One person drops a ruler between the other's hands (say start when you drop)
- The second person catches the ruler between their hands
- Record the number (cm) on the ruler just above the clasped hands
- Repeat three times for each person
- Compare results

How Animals Respond

- How do animals respond to events around them?

- When an animal responds to a stimulus, body systems—including sensory neurons, the nervous system, and muscles—work together to generate a response.

How Animals Respond

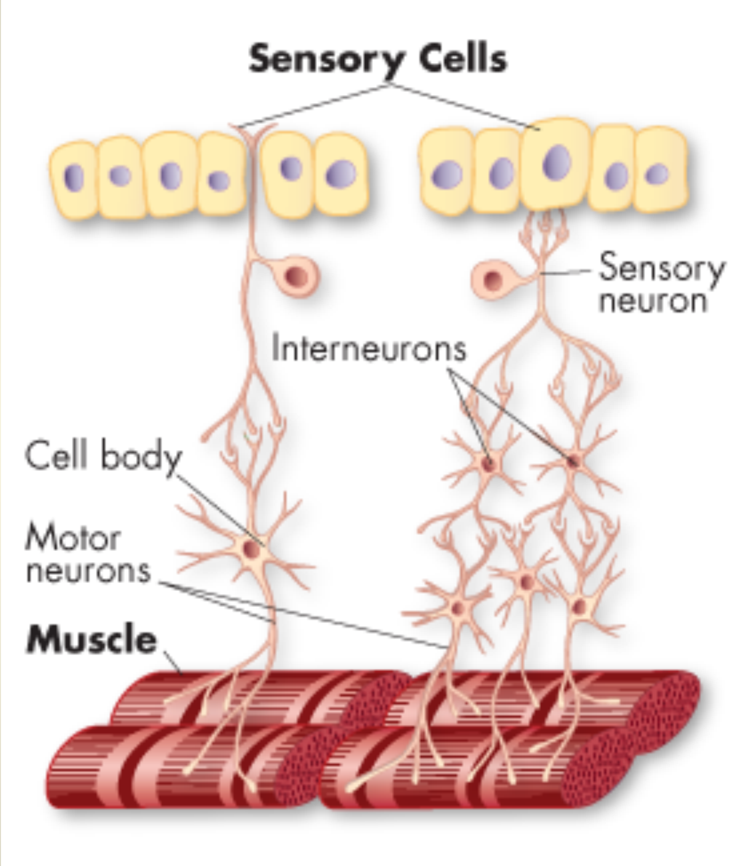
– Most animals have evolved specialized nervous systems that enable them to respond to events around them.

– Nervous systems are composed of specialized nerve cells, or **neurons.**

– Working together, neurons acquire information from their surroundings, interpret that information, and then “decide” what to do about it.

Detecting Stimuli

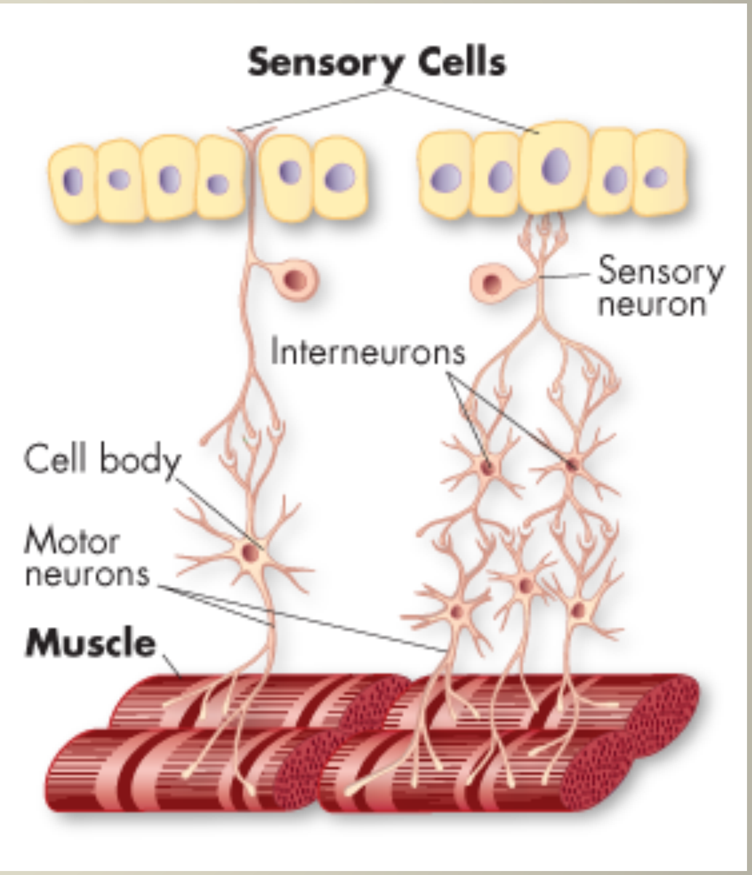
- Information in the environment that causes an organism to react is called a **stimulus.**
- Animals' ability to detect stimuli depends on specialized cells called **sensory neurons.**
- Each type of sensory neuron responds to a particular stimulus such as light, heat, or chemicals.



Processing Information

- When sensory neurons detect a stimulus, they pass information about it to other nerve cells called **interneurons.**

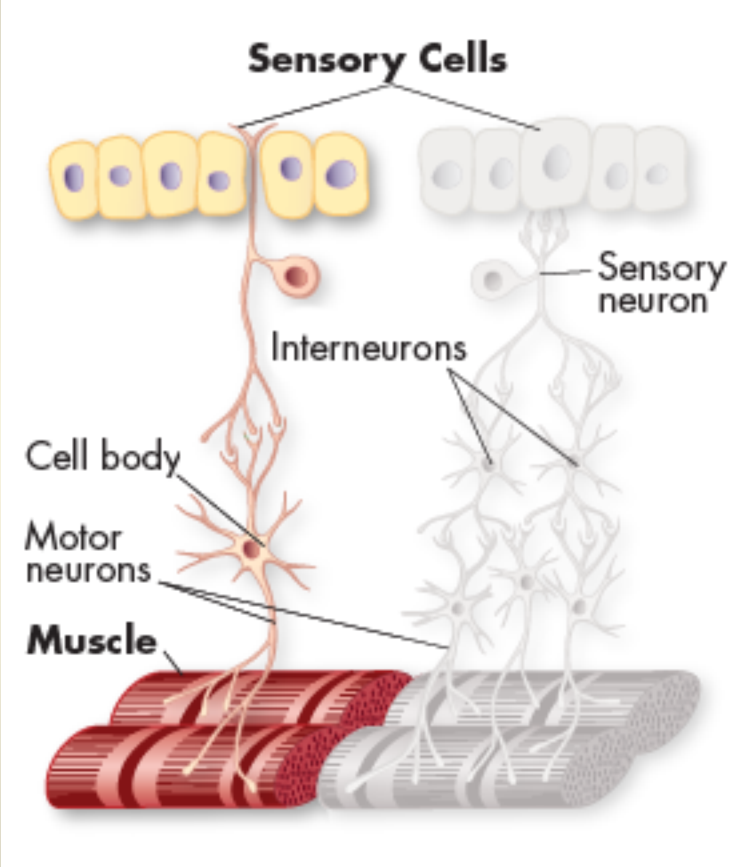
- Interneurons process information and determine how an animal responds to stimuli.



Processing Information

- The number of interneurons an animal has, and the ways those interneurons process information, determine how flexible and complex an animal's behavior can be.

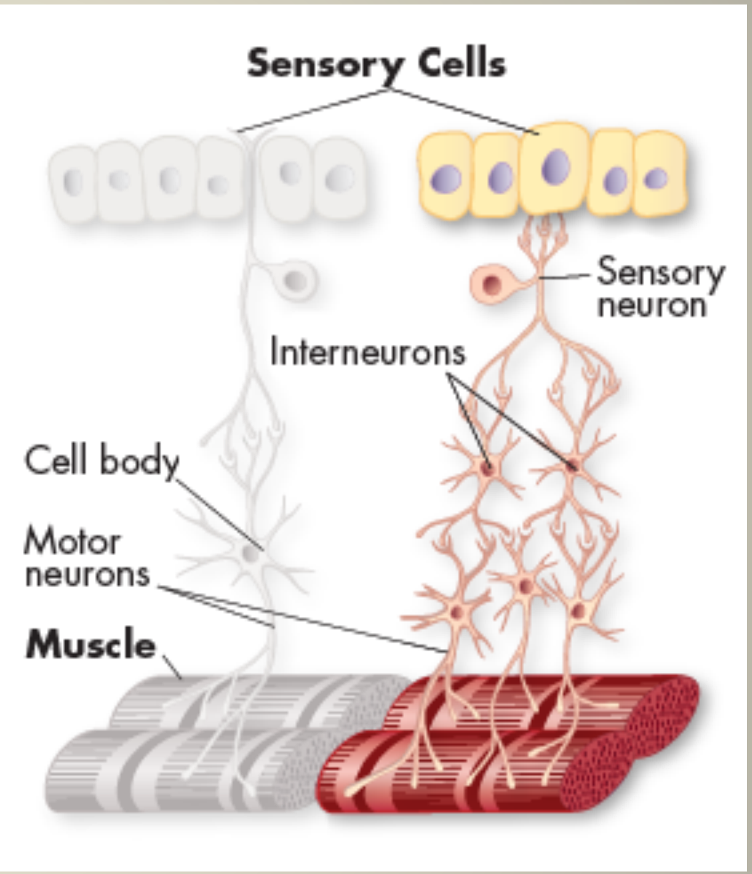
- Some invertebrates, such as cnidarians and worms, have very few interneurons and are capable of only simple responses to stimuli.



Processing Information

- Vertebrates have more highly developed nervous systems with large numbers of interneurons and are capable of more-complex behaviors than those of most invertebrates.

- The brain is formed by many of these interneurons.



Responding

- A specific reaction to a stimulus is called a **response.**

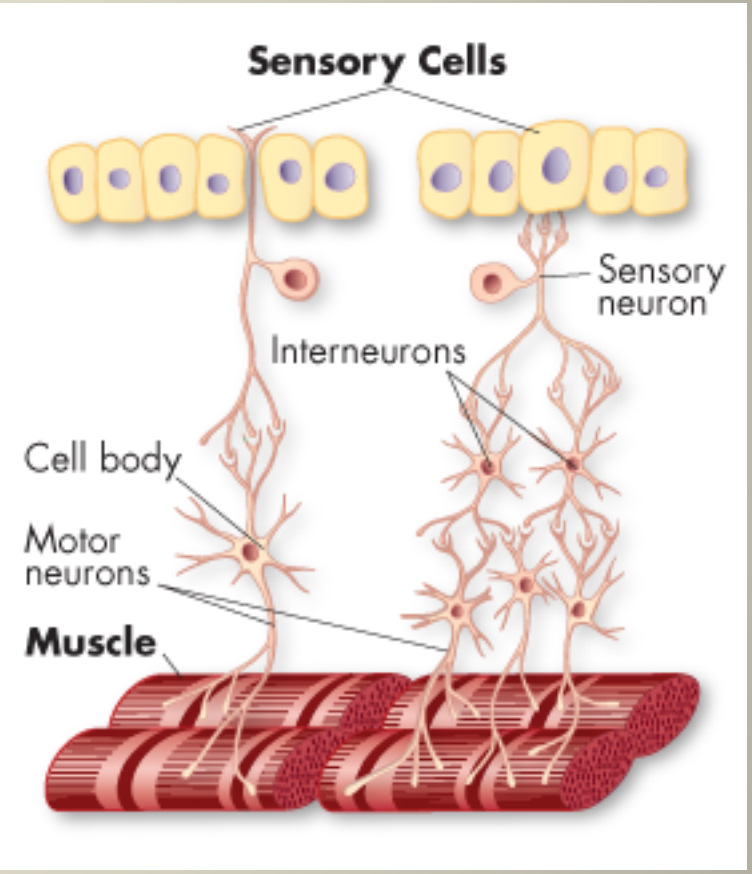
- Responses to many stimuli are directed by the nervous system. However, those responses are usually carried out by cells or tissues that are not nerve cells.

- For example, a lion’s decision to lunge at prey is carried out by muscle cells.

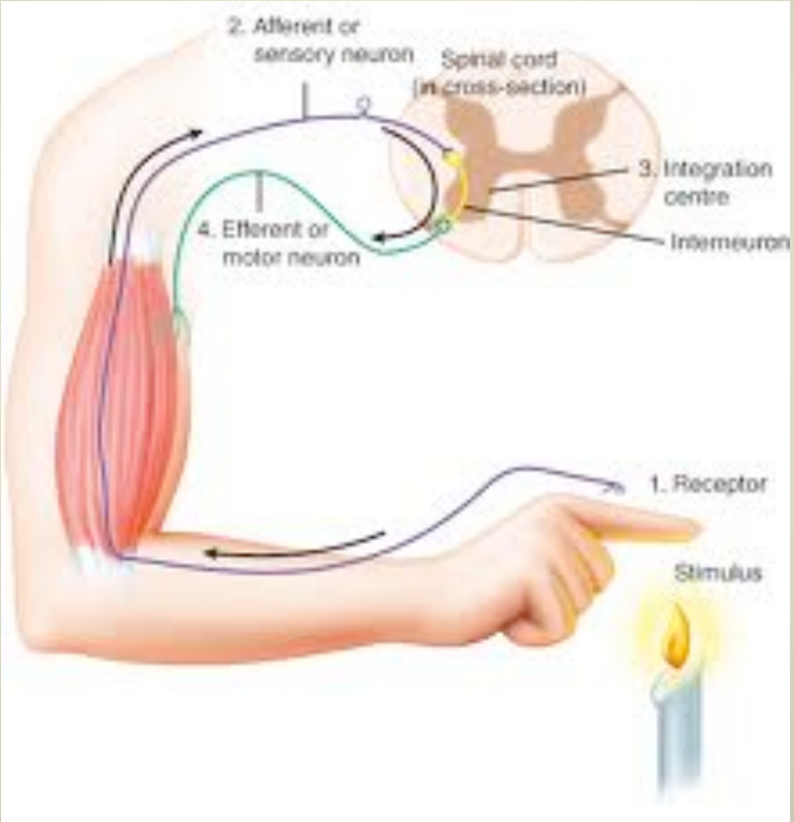
Responding

- Nerve cells called **motor neurons** carry “directions” from interneurons to muscles.

- Other responses to environmental conditions may be carried out by other body systems, such as respiratory or circulatory systems.



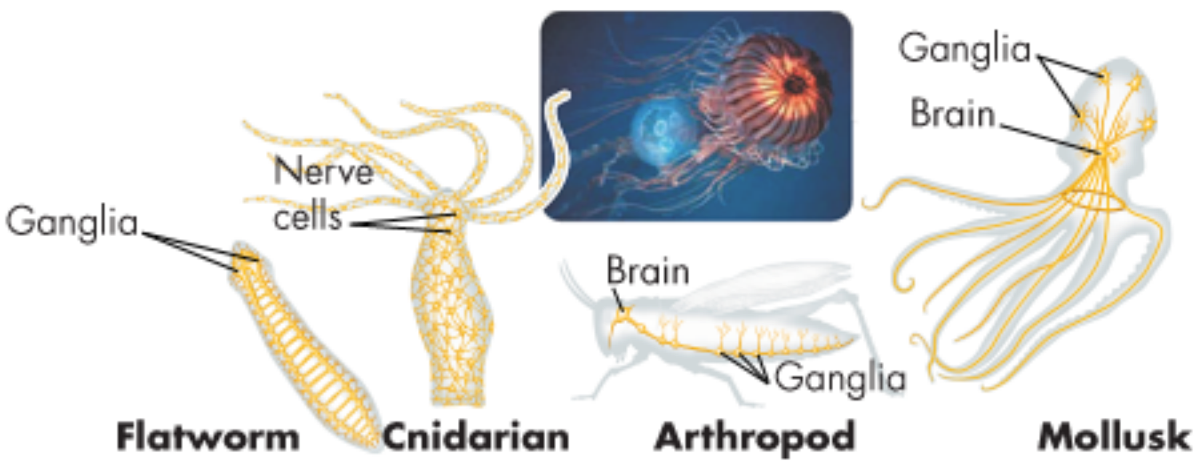
Reflex Arc



2. Afferent or sensory neuron
Spinal cord (in cross-section)
3. Integration centre
Interneuron
4. Efferent or motor neuron
1. Receptor
Stimulus

Invertebrates

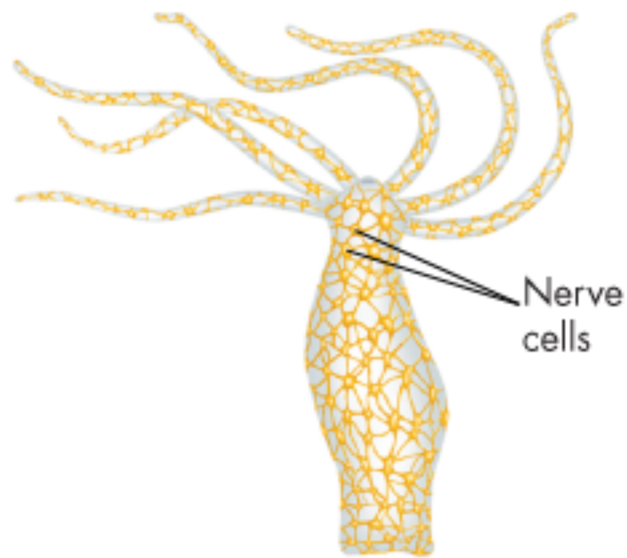
– Invertebrate nervous systems range from simple collections of nerve cells to complex organizations that include many interneurons.



Nerve Nets, Nerve Cords, and Ganglia

- Cnidarians, such as jellyfishes, have simple nervous systems called nerve nets.

- Nerve nets consist of neurons connected into a netlike arrangement with few specializations.

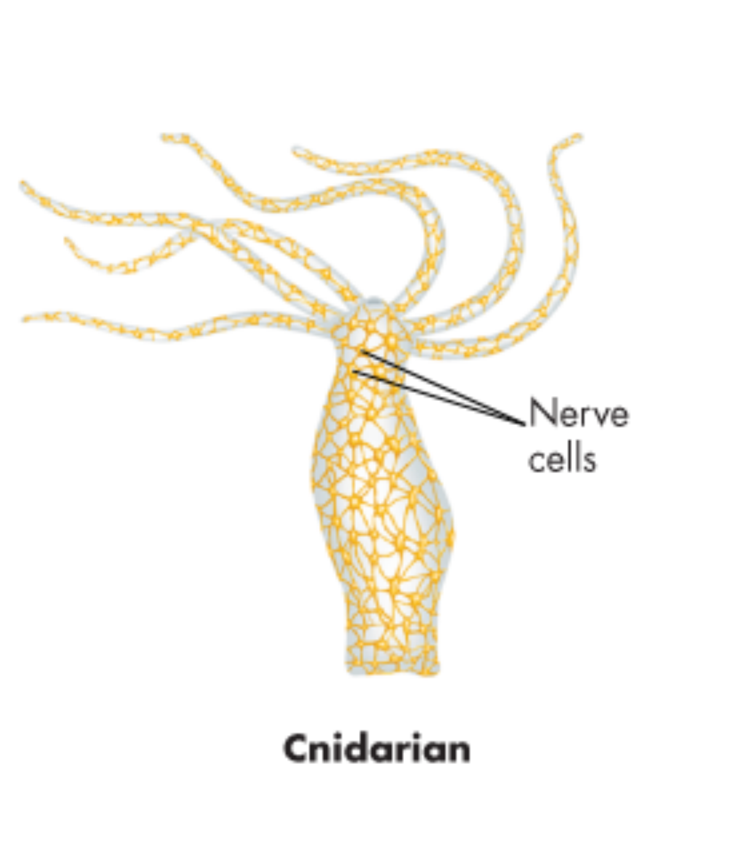


Cnidarian

Nerve Nets, Nerve Cords, and Ganglia

- In other radially symmetric invertebrates, such as sea stars, some interneurons are grouped together into nerves, or nerve cords, that form a ring around the animals' mouths and stretch out along their arms.

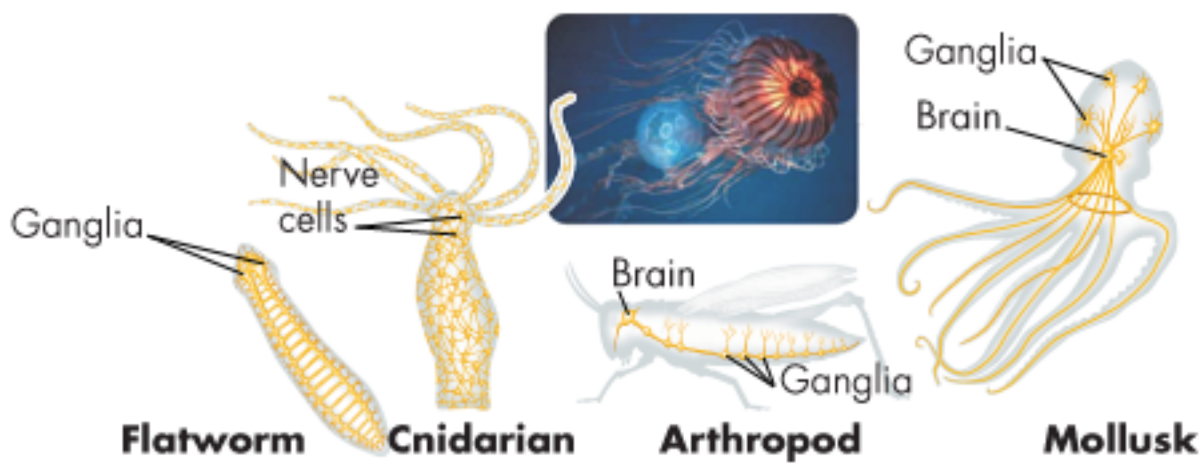
- In still other invertebrates, a number of interneurons are grouped together into small structures called **ganglia,** in which interneurons connect with one another.



“Heads”

- Bilaterally symmetric animals often exhibit cephalization, the concentration of sensory neurons and interneurons in a “head.”

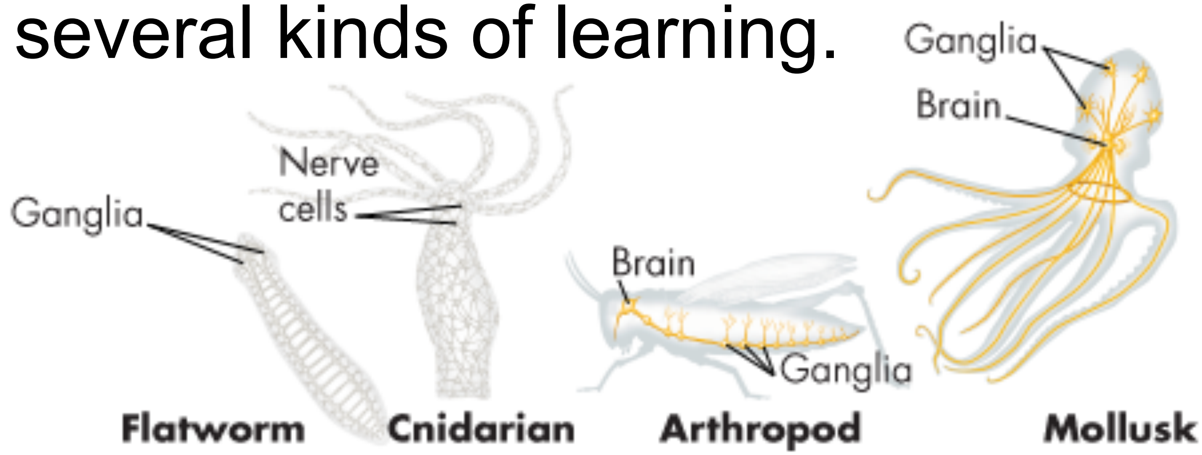
- Interneurons form ganglia in several places,



Brains

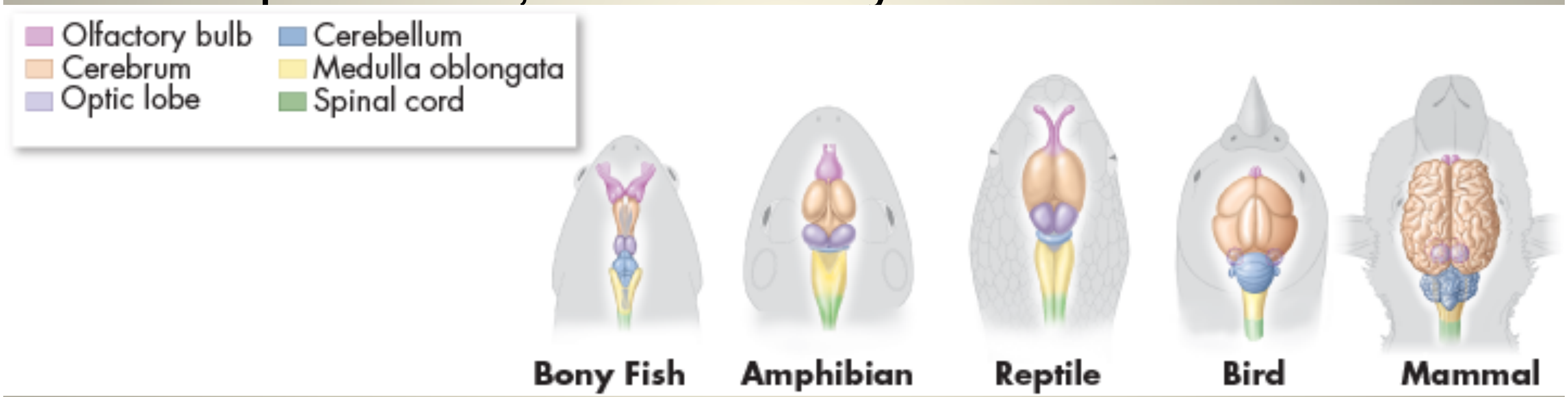
– In some species, cerebral ganglia are further organized into a structure called a brain.

– The brains of some cephalopods, such as octopi, enable complex behavior, including several kinds of learning.



Parts of the Vertebrate Brain

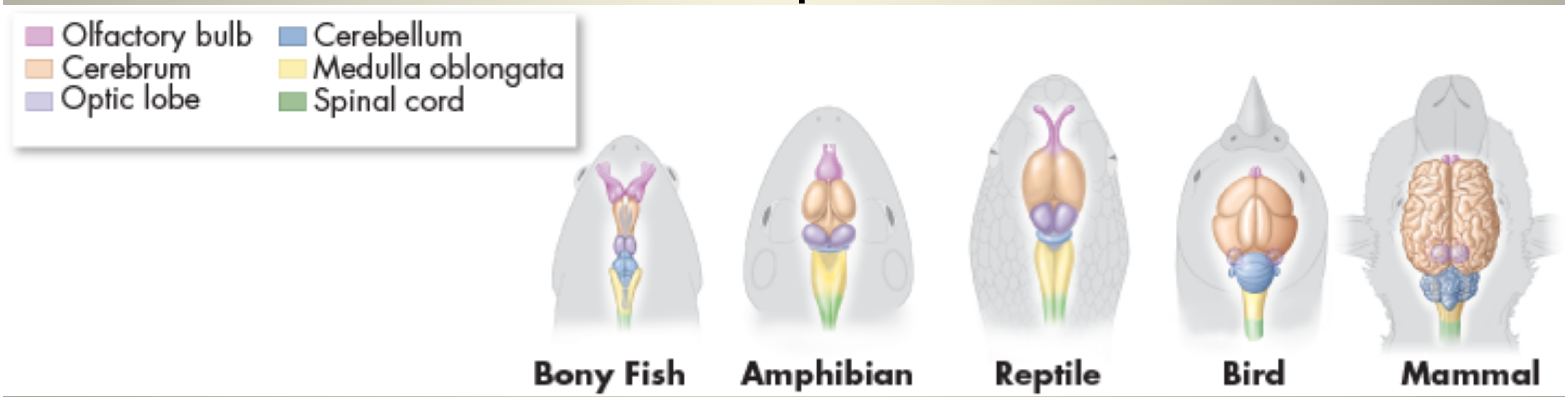
– Regions of the vertebrate brain include the cerebrum, cerebellum, medulla oblongata, optic lobes, and olfactory bulbs.



Parts of the Vertebrate Brain

– The **cerebrum** is the “thinking” region of the brain.

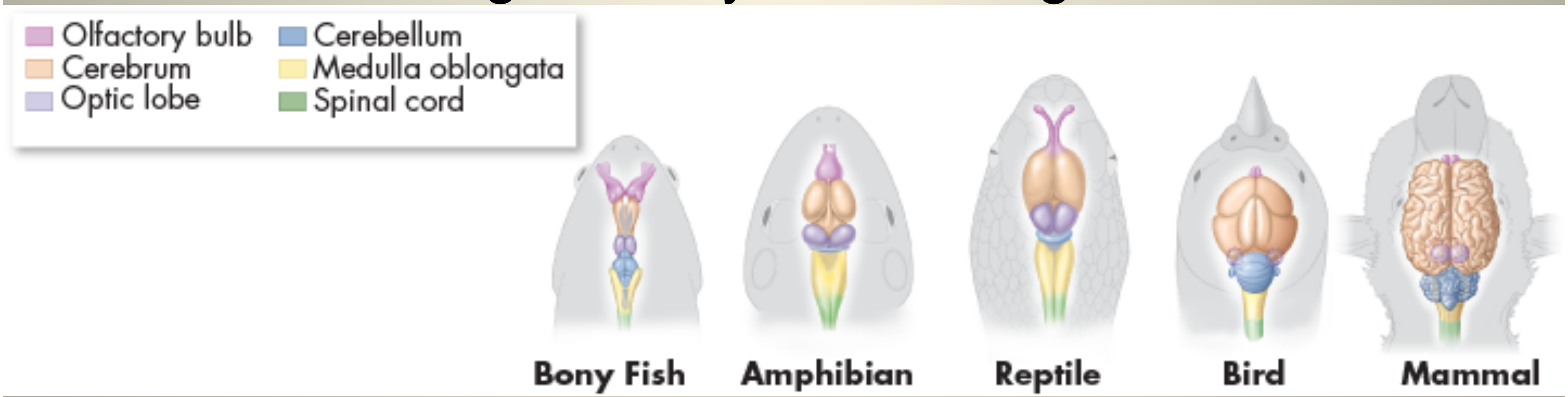
– It receives and interprets sensory information and determines a response.



Parts of the Vertebrate Brain

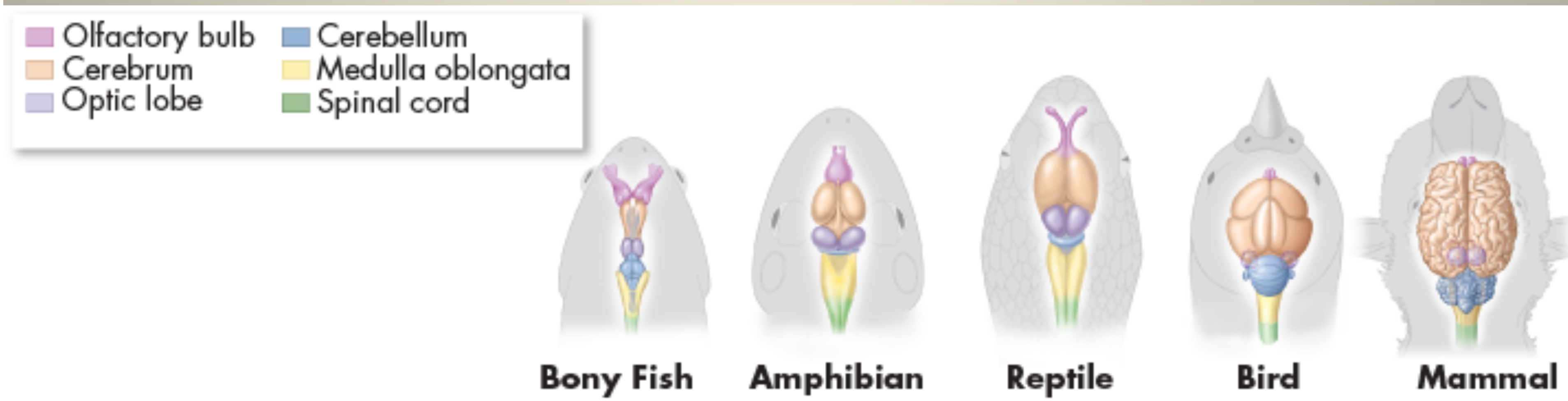
- The **cerebellum** coordinates movement and controls balance.

- The medulla oblongata controls the functioning of many internal organs.



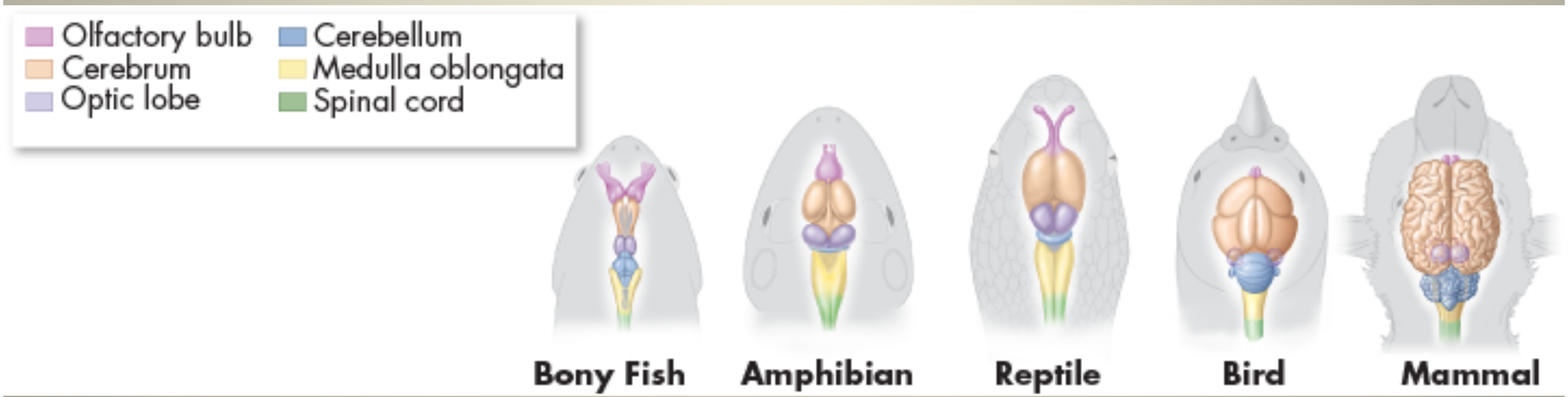
Parts of the Vertebrate Brain

– Vertebrate brains are connected to the rest of the body by a thick collection of nerves called a spinal cord, which runs through a tube in the vertebral column.



Vertebrate Brain Evolution

– Brain evolution in vertebrates follows a general trend of increasing size and complexity from fishes, through amphibians and reptiles, to birds and mammals.



Vertebrate Brain Evolution

– In fishes, amphibians, and reptiles, the cerebrum, or “thinking” region, is relatively small.

– In birds and mammals, and especially in primates, the cerebrum is much larger and may contain folds that increase its surface area.

– The cerebellum is also most highly developed in birds and mammals.

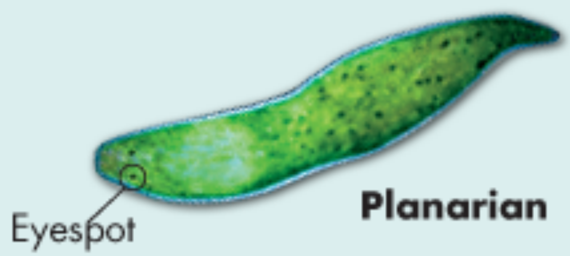
Invertebrate Sense Organs

– Many invertebrates have sense organs that detect light, sound, vibrations, movement, body orientation, and chemicals in air or water.

– Invertebrate sense organs vary widely in complexity.

Invertebrate Sense Organs

– Flatworms, for example, have simple eyespots that detect only the presence and direction of light.



Invertebrate Sense Organs

- More-cephalized invertebrates have specialized sensory tissues and well-developed sense organs.

- Some cephalopods, like the octopus have complex eyes that detect motion and color and form images. The compound eyes of mosquitoes detect minute changes in movement and color but produce less-detailed images.

Chordate Sense Organs

– Most vertebrates have highly evolved sense organs.

– Many vertebrates have very sensitive organs of taste, smell, and hearing.

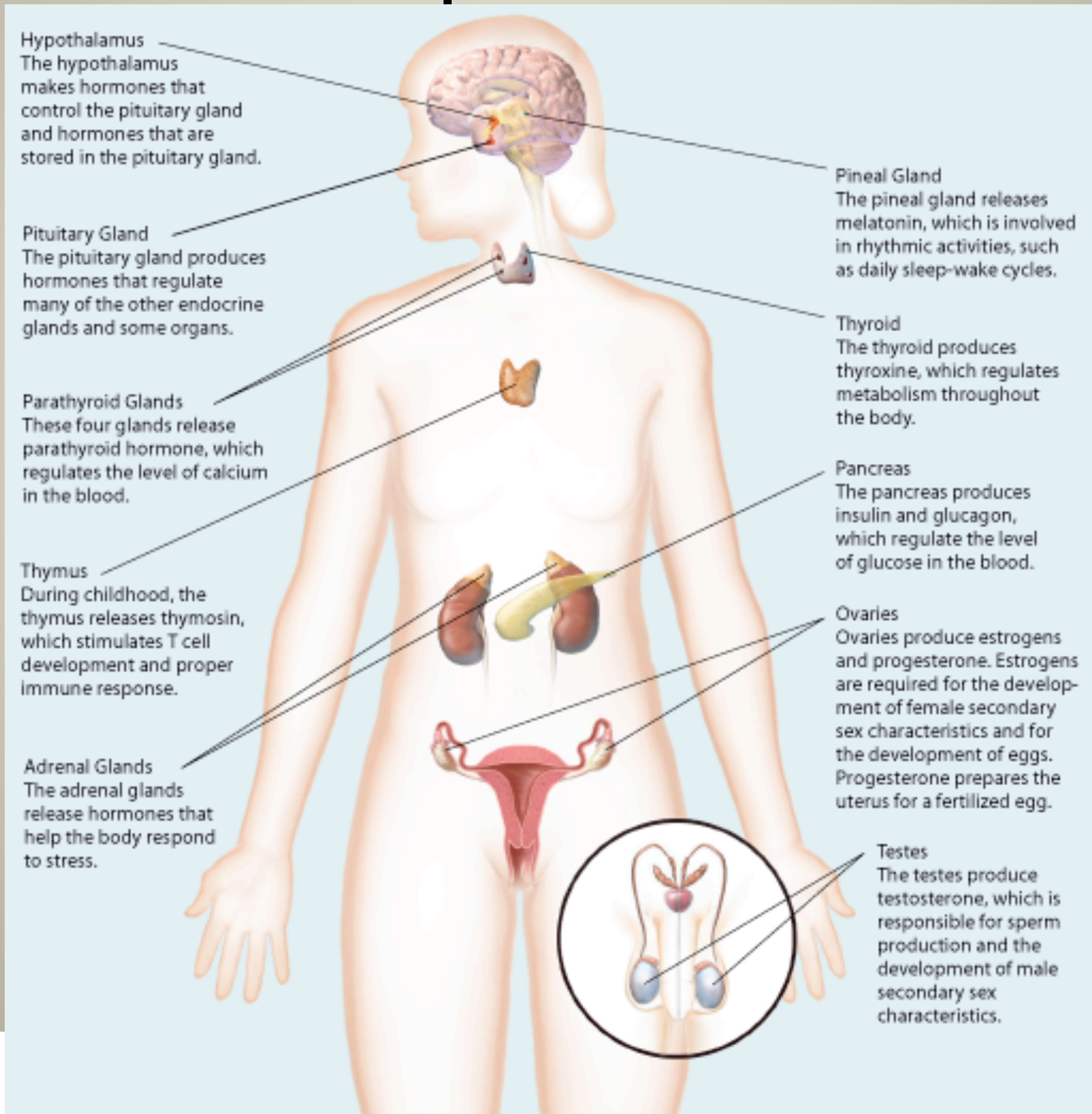
– Many species of fishes, amphibians, reptiles, birds, and mammals have color vision that is as good as, or better than, that of humans.

Chordate Sense Organs

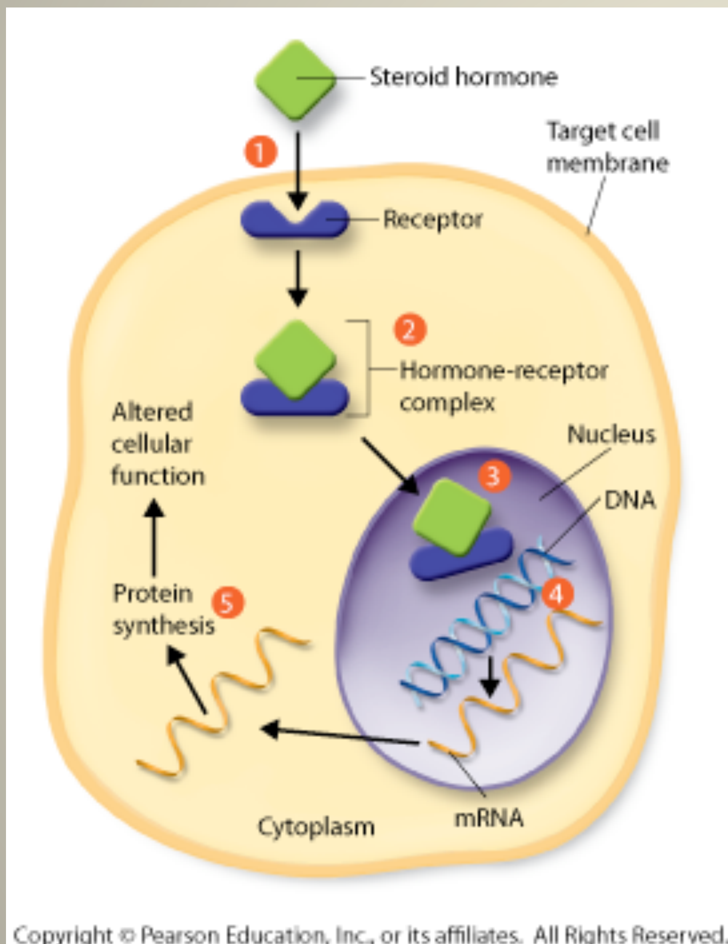
– Some species, including certain fishes and the duckbill platypus, can detect weak electric currents in water.

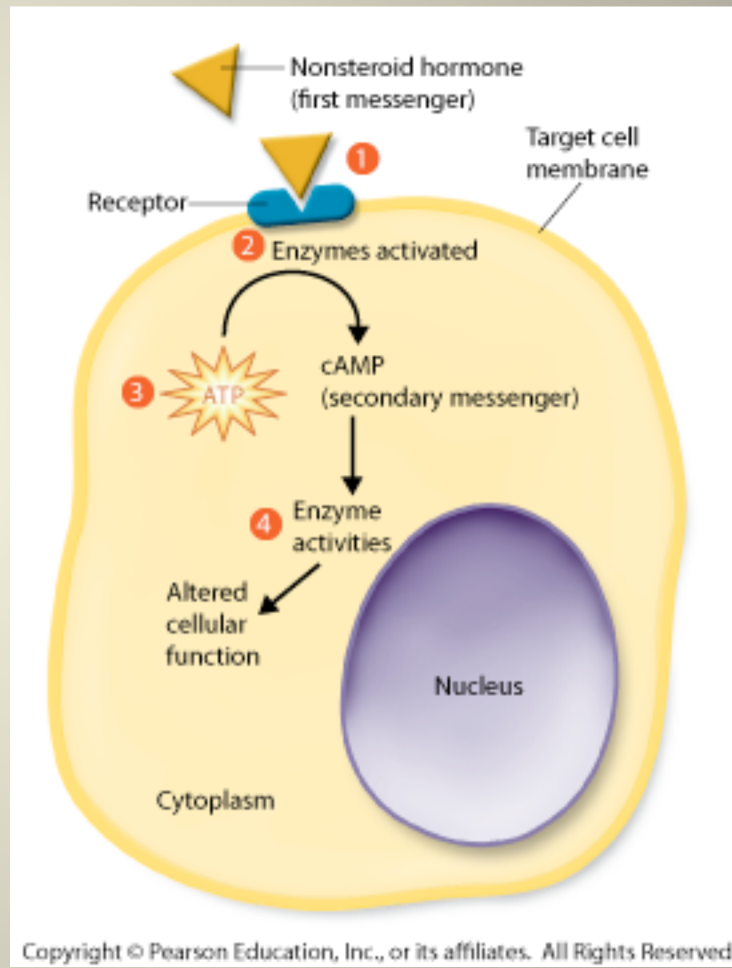
– Some animals, such as sharks, use this “electric sense” to navigate by detecting electric currents in seawater that are caused by Earth’s magnetic field.

Chemical response: Hormones



Hormones signal the cell





Hormone response Regulation