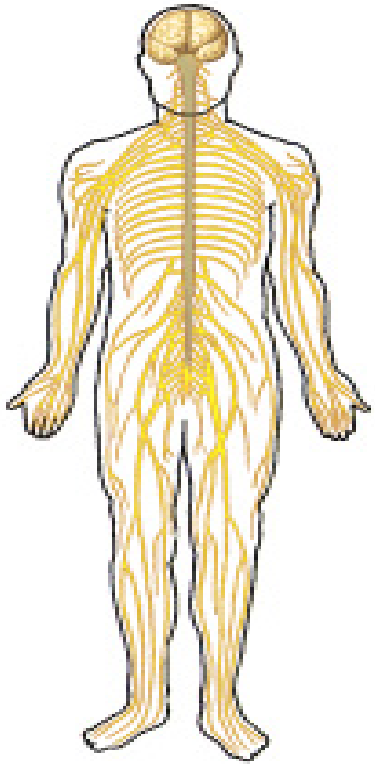
Biology 30 Diploma REVIEW

Are you ready to begin????

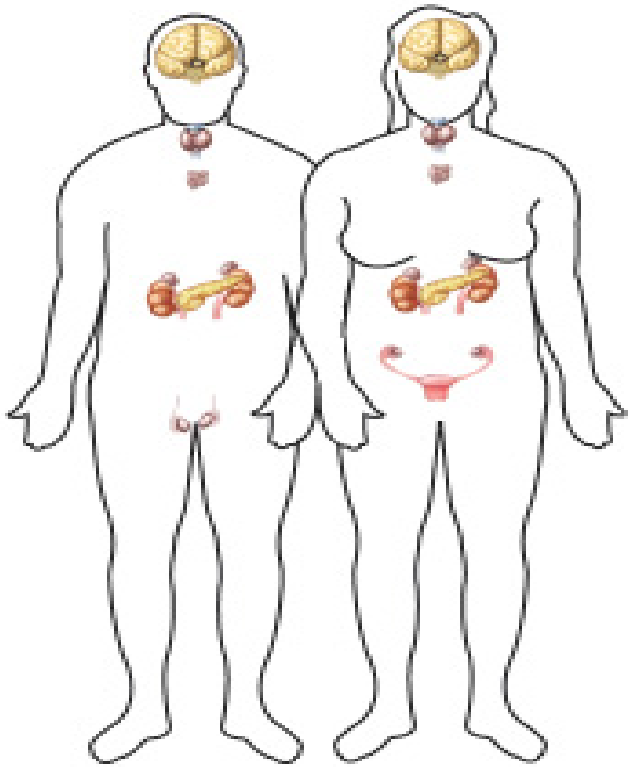
Be sure you ask any questions you may have…that is why we are here!!!

NERVOUS AND ENDOCRINE SYSTEMS

Control



Nervous system



Endocrine system

Endocrine System

Endocrine Glands

- **Ductless**
- Maintain control for a longer duration
- Examples include adrenal glands, pituitary gland, and thyroid gland

Exocrine Glands

- **Ducts**
- Examples include sweat and salivary glands
- What is an example of BOTH an exocrine and endocrine gland?

- What organ acts as both an endocrine and exocrine gland?

PANCREAS...why??

Produces and releases digestive enzymes and hormones

Types of Hormones

Steroid Hormones

- Made of cholesterol
- Fat soluble
- Attach to receptors in cytoplasm
- Examples include sex hormones and cortisol

Protein Hormones

- Made of amino acids
- Water soluble
- Attach to receptors on cell membrane
- Examples include insulin, hGH and thyroxine

Homeostasis – (+) & (-) feedback

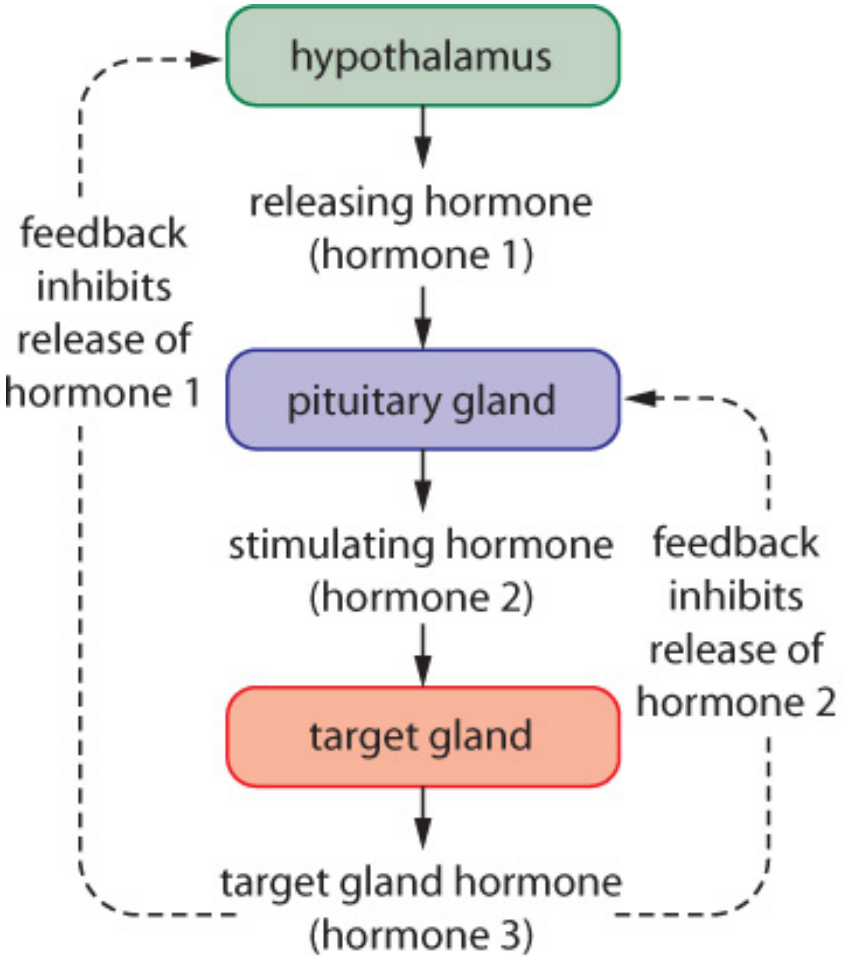


Figure 13.10 The generalized regulatory pathway of tropic hormones. The target gland hormone will affect other tissues in the body, such as the bones and muscles. How are tropic hormones regulated by negative feedback?

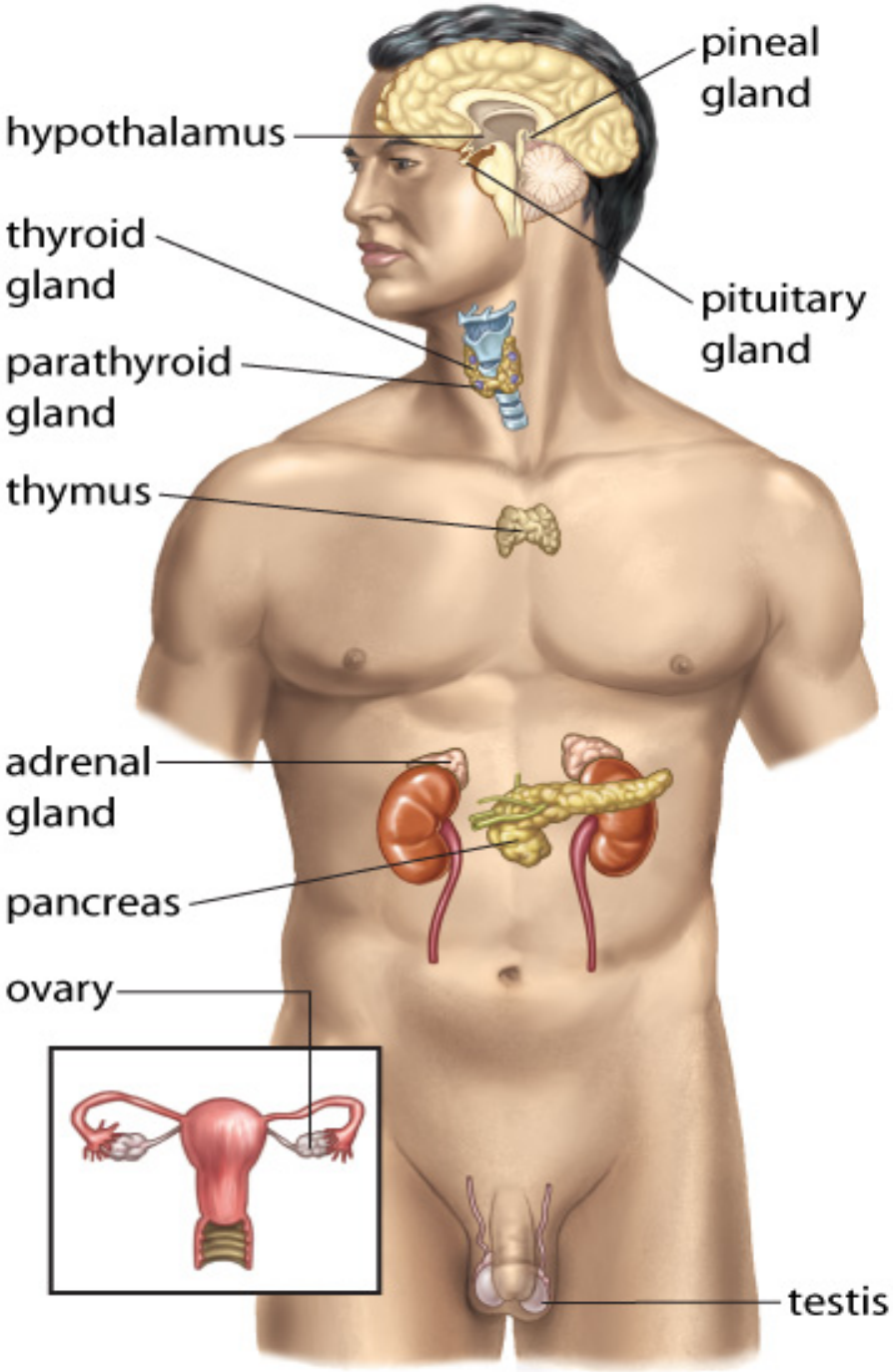


Figure 13.7 The anatomical location of the major endocrine glands of the body. The role of the thymus gland in the immune system is noted in Chapter 8.

Glands and Hormones

Pituitary (master gland)

- Made of 2 lobes:
  - Posterior Lobe – stores and releases hormones produced by the hypothalamus
    - Examples include ADH and oxytocin
  - Anterior Lobe – produces and releases its own hormones. Regulated by the hypothalamus
    - Examples include TSH, FSH, LH, hGH, ACTH and PRL

- NOTE - The diploma will <u>not</u> ask you to differentiate the hormones produced by the anterior and posterior lobe

Human Growth Hormone (hGH)

- Affects all cells, especially cartilage and bone cells
- At puberty:
  - A hypersecretion causes GIGANTISM
  - A hyposecretion causes DWARFISM

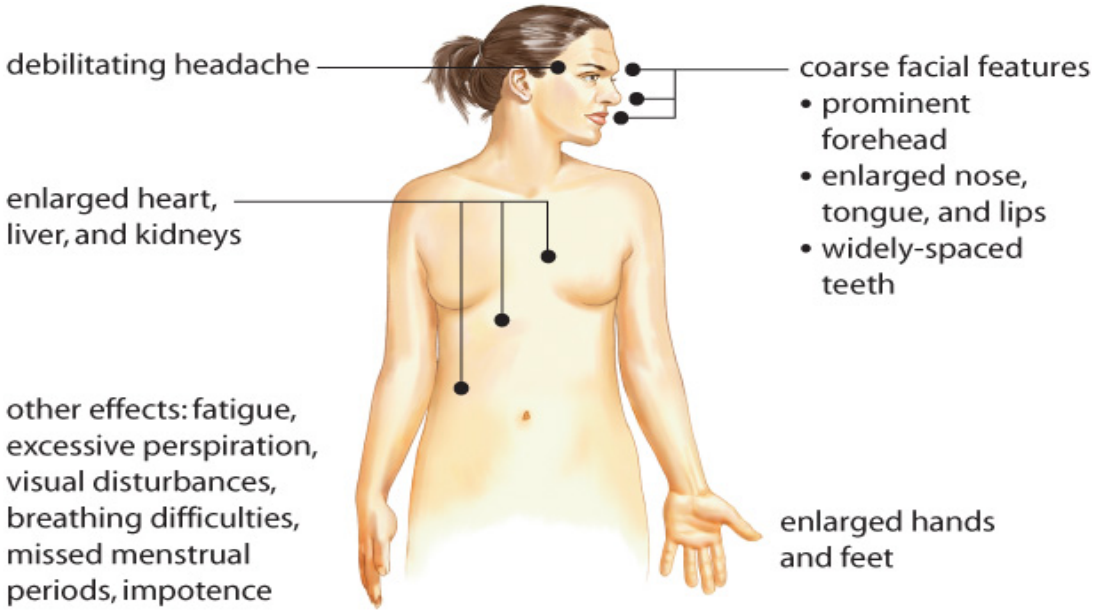


Figure 13.15 Acromegaly results from excessive production of hGH during adulthood. It may be difficult to diagnose the condition in the early stages before a person's appearance noticeably changes.

Adrenal Glands

a. Adrenal Medulla (inner gland)

- Regulated by nervous system
- Produces norepinephrine (sustain BP) and **epinephrine** during stress. Functions are:
  - Increased blood sugar
  - Increased heart rate
  - Increased breathing rate
  - Increased metabolism
  - Blood vessels dilate
  - Pupils dilate
  - Peristalsis stops

- **NOTE:** The Diploma will not ask you to differentiate between the hormones produced by the adrenal medulla and cortex

Adrenal Glands

b. Adrenal Cortex (outer gland)

- Small amounts of sex hormones
  - Testosterone in females and estrogen in males
- **Aldosterone**
  - Increase Na^+ reabsorption into blood. Released when blood volume and BP are low
- **Cortisol (LONG TERM stress)**
  - Amino acids/fats are converted into glucose

Antidiuretic Hormone (ADH)

- Makes nephron permeable to water so water can be reabsorbed back into the blood
- Released when the body is dehydrated and needs to conserve body water
- Produces a concentrated urine
- **Diabetes Insipidus** – body can't produce enough ADH

Negative Feedback Loop for Release of Cortisol

Stress signals to brain:

hypothalamus

↓ releasing hormone

pituitary gland

↓ **ACTH**

adrenal gland

↓ **cortisol**

target cells in liver and muscles

change amino acids/fats to glucose

"-" feedback

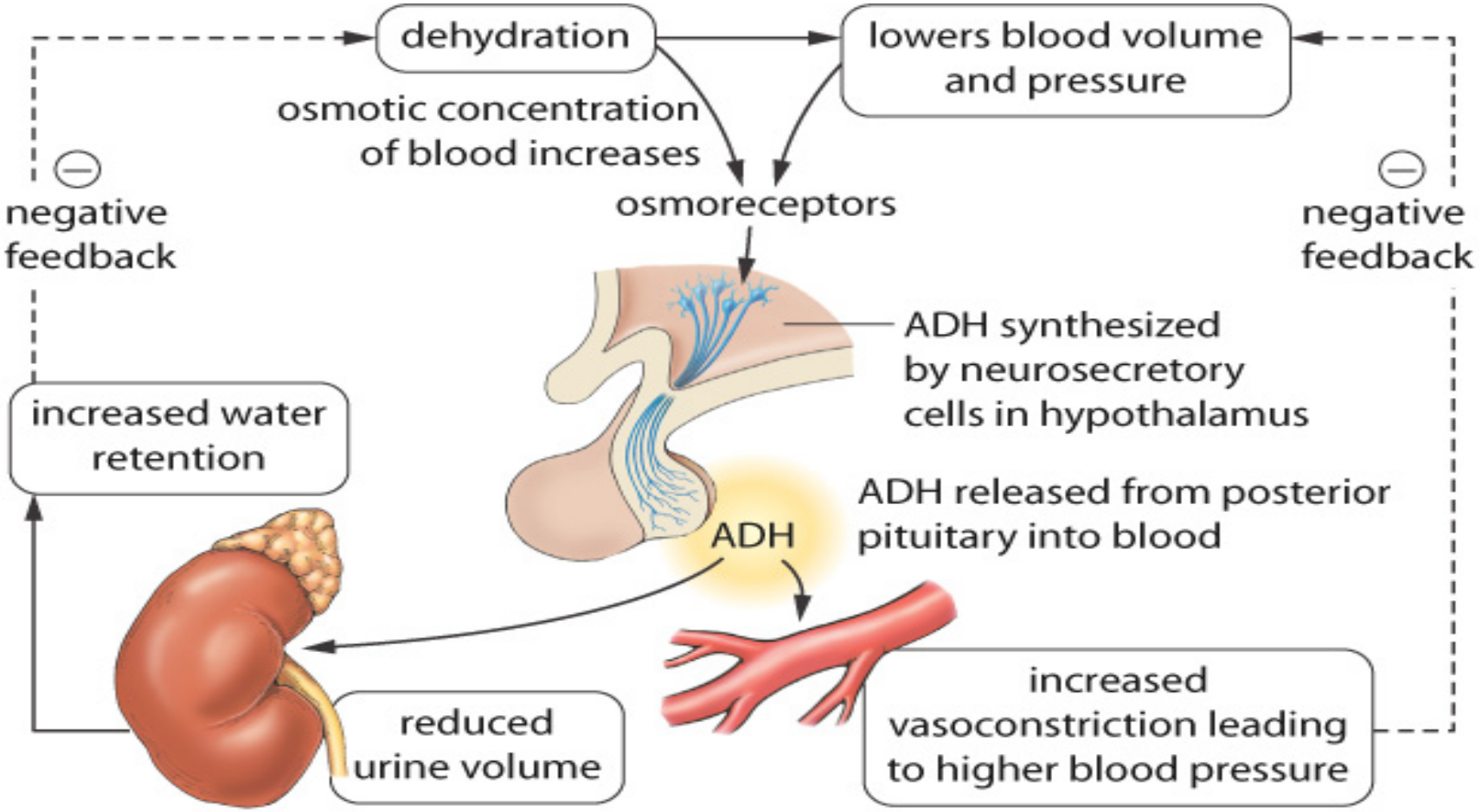


Figure 13.9 A negative feedback mechanism controls the secretion of ADH from the hypothalamus.

Multiple Choice #1

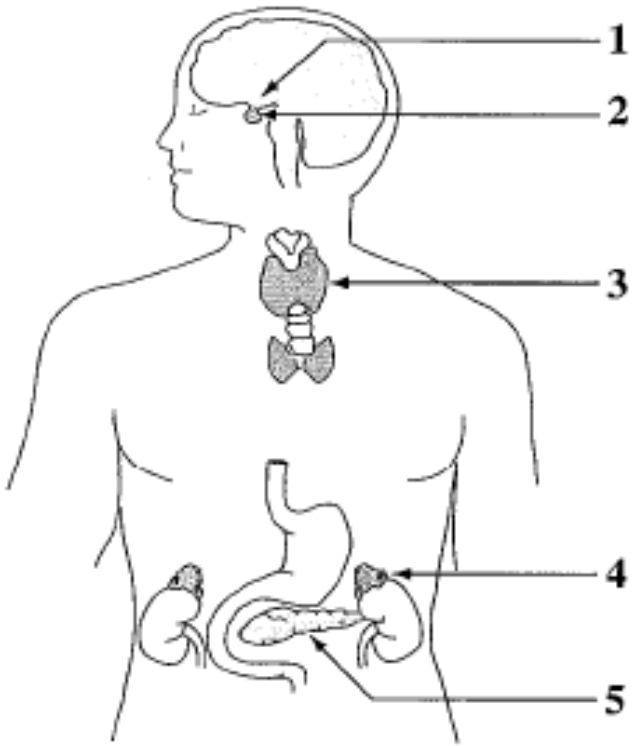
Which of the following rows identifies the source of cortisol, the hormone that stimulates the release of cortisol, and an effect of cortisol?

Row	Source	Hormone	Effect
A.	Adrenal gland	ACTH	Increased conversion of amino acids to glucose
B.	Pituitary gland	ACTH	Increased protein synthesis
C.	Adrenal gland	ADH	Increased conversion of glycogen to glucose
D.	Pituitary gland	ADH	Increased water reabsorption

Numerical Response #1

Use the following diagram to answer the next question.

Some Structures Involved in Endocrine Control

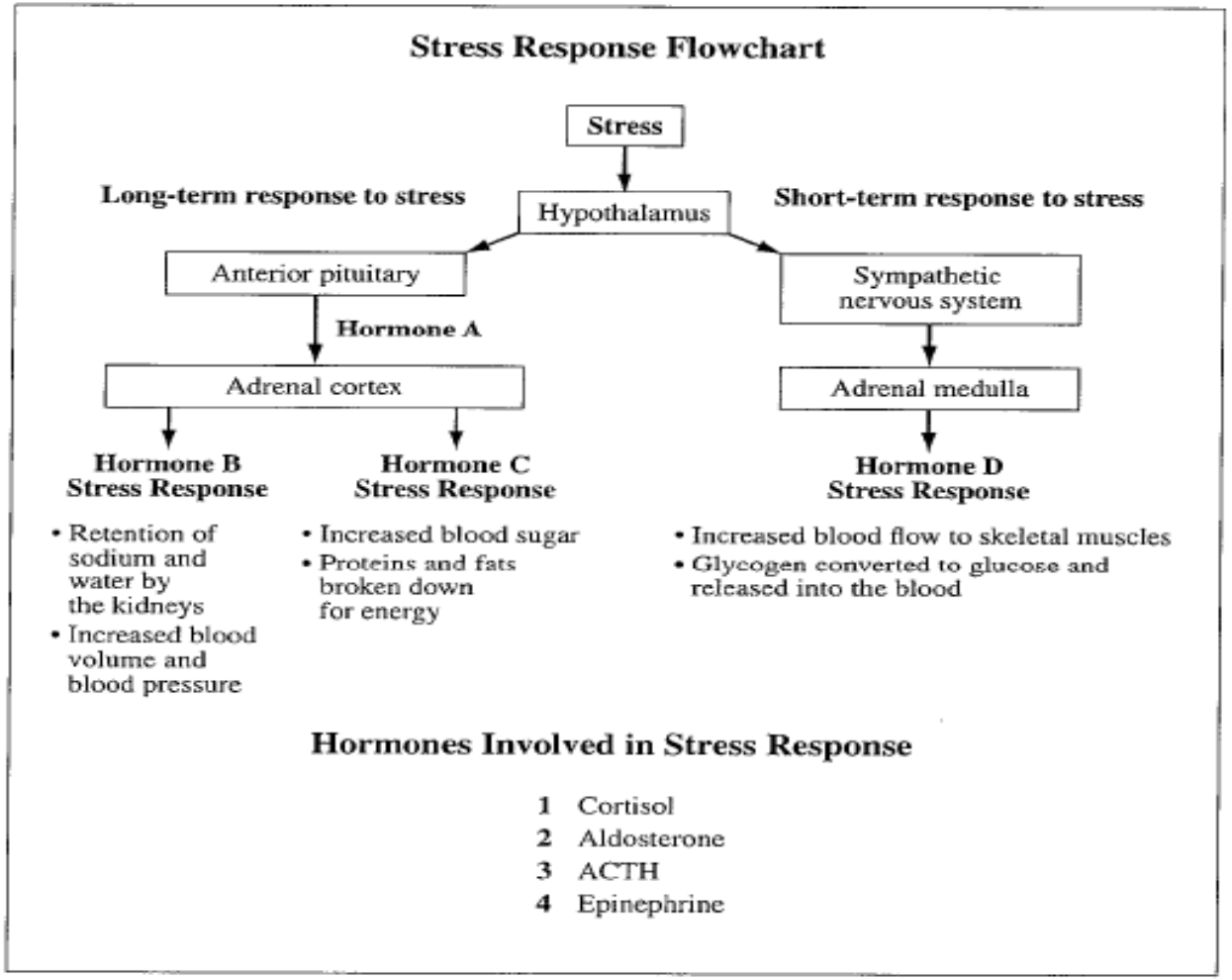


The three structures in the diagram above involved in the normal feedback control of cortisol secretion are numbered _____, _____, and _____.

(Record all **three digits** of your answer **in lowest-to-highest numerical order** in the numerical-response section on the answer sheet.)

Numerical Response #2

Use the following information to answer the next two questions.



Match each of the hormones involved in the stress response with the hormones represented in the flowchart above.

Hormone Number:	_____	_____	_____	_____
Flowchart Letter:	**Hormone A**	**Hormone B**	**Hormone C**	**Hormone D**

(Record your **four-digit answer** in the numerical-response section on the answer sheet.)

Multiple Choice #2

The short-term response to stress occurs faster than the long-term response to stress because the

A. blood from the adrenal medulla travels faster than does the blood from the adrenal cortex

B. adrenal medulla responds to nervous stimulation, which is faster than hormonal stimulation

C. adrenal medulla is controlled by the hypothalamus whereas the adrenal cortex is controlled by the pituitary

D. hormone from the adrenal medulla acts on cells more quickly than the hormones from the adrenal cortex

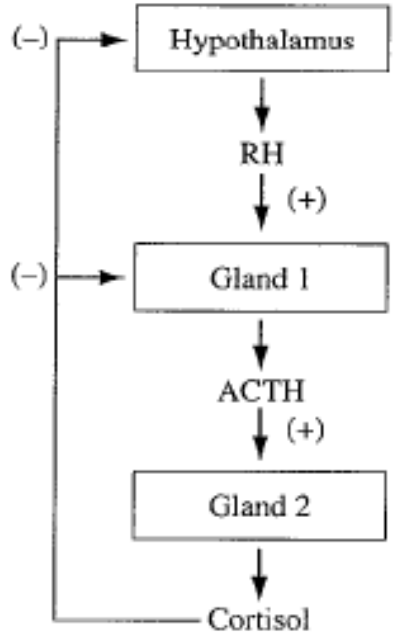
Multiple Choice #3

Use the following information to answer the next two questions.

Researchers suggest that the brain has a daily "internal clock" that is controlled by the endocrine and nervous systems. The hormone ACTH helps to regulate the nervous system and gives the body the ability to respond to changes in sleep patterns. The release of ACTH is suppressed during sleep but increases before a person awakes.

The feedback loop below illustrates part of the regulatory hormonal control of the internal clock.

Regulatory Hormone Feedback Loop



The secretion of ACTH is suppressed during sleep as a result of

A. increased activity of the pituitary gland
B. decreased secretion of RH by the hypothalamus
C. decreased secretion of cortisol by the adrenal cortex
D. increased nervous system input to the medulla oblongata

Multiple Choice #4

Use the following additional information to answer the next question.

In a study in which the brain's internal clock was investigated, two groups of volunteers were awakened at 6:00 A.M. One group had been told that they would be awakened at 6:00 A.M., and the other group had been told that they would be awakened at 9:00 A.M. The group expecting to be awakened at 6:00 A.M. had increased levels of ACTH at 5:00 A.M., but the level of ACTH remained low in the group expecting to sleep later.

—based on Born, Jan, Kirsten Hansen, Lisa Marshall, Matthias Mölle, and Horst L. Fehm. 1999. Timing the end of nocturnal sleep. *Nature* 397 (January): 29.

The results of this study indicate that the sleep-wake cycle is

A. variable, because the adrenal cortex responded to an anticipated event
B. variable, because the hypothalamus responded to an anticipated event
C. not variable, because the adrenal cortex cannot respond to an anticipated event
D. not variable, because the hypothalamus cannot respond to an anticipated event

Pancreas (Islets of Langerhans)

a. Insulin

- Released from beta cells when blood sugar levels are high
- Makes cells permeable to glucose and converts glucose into glycogen in the liver
- Effect on blood glucose levels???

b. Glucagon

- Released from alpha cells when blood sugar levels are low
- Converts glycogen into glucose
- Effect on blood glucose levels??

Negative Feedback Loops

High blood sugar

↓

Pancreas (beta cells)

↓ **insulin**

Liver changes glucose into glycogen

AND

Cells become permeable to glucose

Low blood sugar

↓

Pancreas (alpha cells)

↓ **glucagon**

Liver changes glycogen into glucose

Diabetes Mellitus

Early Onset/Juvenile or Type 1 Diabetes

- Early degeneration of the beta cells of the islets of langerhans and thus insulin production decreases significantly
- Treat with **insulin injections**

Adult Onset or Type 2 Diabetes

- Decreased production of insulin due to the ineffectiveness of the islets of langerhans
- Treat with sulfa drugs and modified diet

Symptoms of Diabetes Mellitus

- Glucose in urine (sweet urine)
- High urine output
- Low energy levels

Thyroid Gland

- Located in front of trachea
- Produces 3 hormones
  - **Thyroxine**
  - Triiodothryonine
  - **Calcitonin**
- **Thyroxine** and triiodthyronine regulate metabolism
- **Thyroxine** **decreases blood sugar levels** because it **increases metabolism**

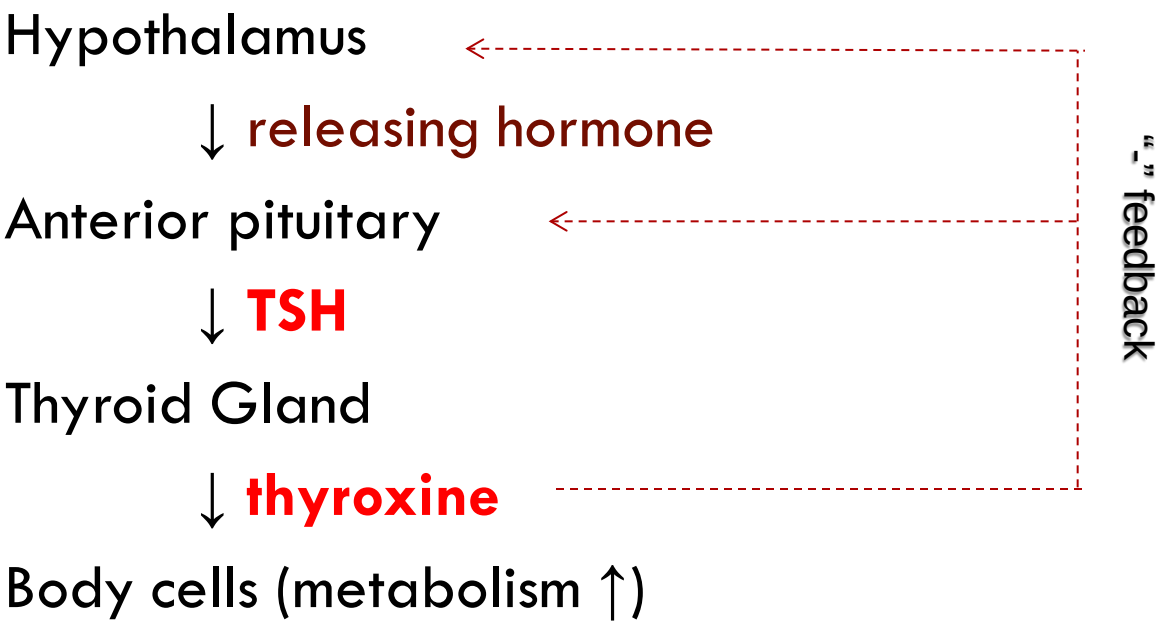
Hypothyroidism

- Release low amounts of thyroxine
- What happens to excess glucose that can't be broken down???
- Symptoms include:
  - Dry skin
  - Tired
  - Weight gain
  - Sensitive to cold
  - Constipation
- Treatment??

Goiter

- An enlarged thyroid gland due to a lack of iodine in diet (component of thyroxine). As a result, the production of thyroxine is diminished
- Thyroid increases in size due to a buildup of TSH in the thyroid gland
- What is the source of our dietary iodine??

Negative Feedback Loop for Normal Release of Thyroxine



Hyperthyroidism

- Release high amounts of thyroxine
- Symptoms include:
  - Anxiety
  - Sweating
  - Weight loss
  - Heat intolerant
  - Racing heart
  - Bulging eyes
  - Graves Disease (in children)
- Treatment??

Calcitonin

- Released when blood Ca^{2+} levels are:

high

- 3 functions:
  - Increases Ca^{2+} excretion from the kidneys
  - Decreases Ca^{2+} release from the bones
  - Decreases Ca^{2+} absorption from the small intestine

- Effect on Ca^{2+} levels???

Parathyroid Gland

- Located on top of the thyroid gland
- Releases **parathyroid hormone (PTH)** when blood Ca^{2+} levels are

LOW

- 3 functions:
  - Decreases Ca^{2+} excretion from the kidneys
  - Increases Ca^{2+} release from the bones
  - Increases Ca^{2+} absorption from the small intestines

- Effect on Ca^{2+} levels??

Prostaglandins

- Hormones that have an affect on a small localized area

Multiple Choice #5

Use the following information to answer the next two questions.

Thyroid cancer can develop slowly over many months or even years. Because the symptoms are frequently overlooked, diagnosis is often delayed. However, thyroid cancer is usually treated successfully with a combination of surgery, radioactive iodine, and thyroid medication.

Surgical removal of the thyroid gland results in

A. a decrease in thyroxine levels and TSH levels
B. an increase in thyroxine levels and TSH levels
C. an increase in thyroxine levels and a decrease in TSH levels
D. a decrease in thyroxine levels and an increase in TSH levels

Multiple Choice #6 and #7

Following the removal of the thyroid gland, thyroid medication is prescribed in order to

A. increase sodium reabsorption and water retention
B. decrease sodium reabsorption and water retention
C. increase the rate of metabolism and the rate of heat production
D. decrease the rate of metabolism and the rate of heat production

Use the following information to answer the next question.

Chemicals found in alcohol and tea have a diuretic effect. Diuretics cause the body to produce greater-than-normal volumes of urine.

Diuretic chemicals counteract the effect of the hormone

A. ADH
B. insulin
C. cortisol
D. prolactin

Multiple Choice #8 and #9

Which of the following hormones plays a role in returning the salt concentration in the blood to homeostatic levels following heavy exercise?

A. Cortisol
B. Thyroxine
C. Aldosterone
D. Epinephrine

Low levels of calcium ions in the blood cause

A. decreased secretion of PTH and increased deposition of calcium in the bones

B. decreased secretion of calcitonin and increased deposition of calcium in the bones

C. increased secretion of PTH and movement of calcium from the bones to the blood

D. increased secretion of calcitonin and movement of calcium from the bones to the blood

Multiple Choice #10

The release of thyroxine from the thyroid is directly regulated by

A. TSH
B. TRH
C. iodine
D. thyroxine

Multiple Choice #11, #12 and #13

A characteristic symptom of hyperthyroidism is

A. lethargy
B. weight loss
C. intolerance to cold
D. slowed mental processes

Parathormone and calitonin are hormones that work antagonistically. Two other hormones that work antagonistically are

A. TSH and thyroxine
B. insulin and glucagon
C. ADH and aldosterone
D. prolactin and oxytocin

Diabetes insipidus is a disorder in which the body fails to produce sufficient ADH. One symptom of this disorder that is directly related to ADH secretion is

A. the production of large amounts of dilute urine
B. a decrease in the glucose concentration in the blood
C. an increase in the glucose concentration in the urine
D. the production of small amounts of concentrated urine

Multiple Choice #14 and #15

Use the following information to answer the next two questions.

Drinking coffee may protect a person against Parkinson disease, a neurological disorder resulting from reduced production of the neurotransmitter dopamine by affected cells in the brain. In an experiment, mice were given caffeine in an amount equivalent to approximately one cup of coffee for a human. The mice were then given MPTP, a chemical that destroys dopamine-producing neurons, thus causing symptoms similar to those of Parkinson disease. These mice showed a much smaller reduction in dopamine levels than mice that were not given caffeine before being given MPTP.

The manipulated variable in the experiment described above was the

A. ingestion of MPTP
B. ingestion of caffeine
C. secretion of dopamine
D. destruction of dopamine-producing neurons

In a well-designed experiment, variables that would be kept the same in both the experimental and control groups of mice are the

A. diet and health of the mice
B. amounts of caffeine and MPTP ingested
C. age of the mice and amount of caffeine ingested
D. size of the mice and amount of dopamine produced

NERVOUS SYSTEM

- works with endocrine system to maintain homeostasis

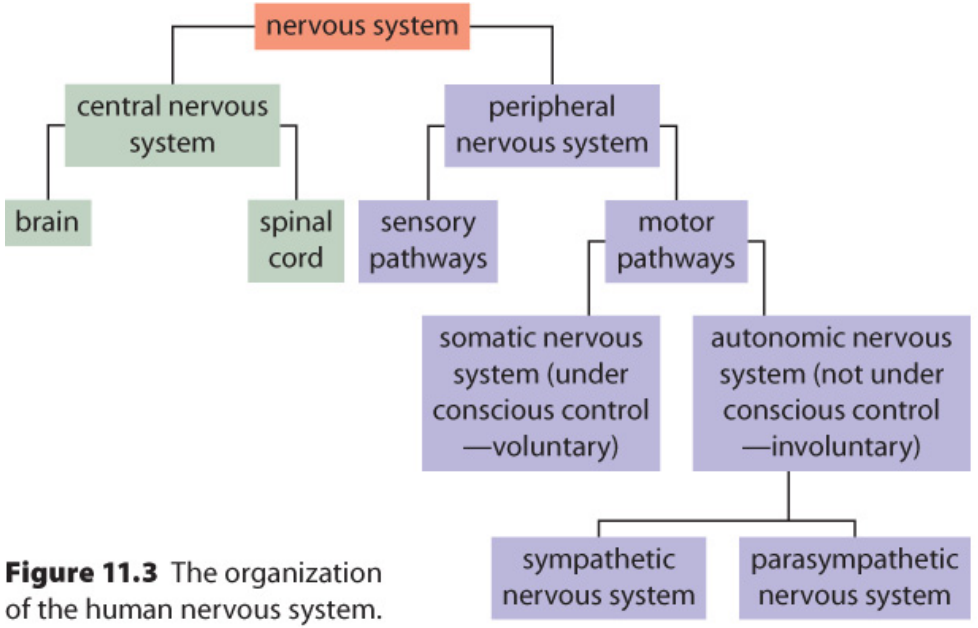
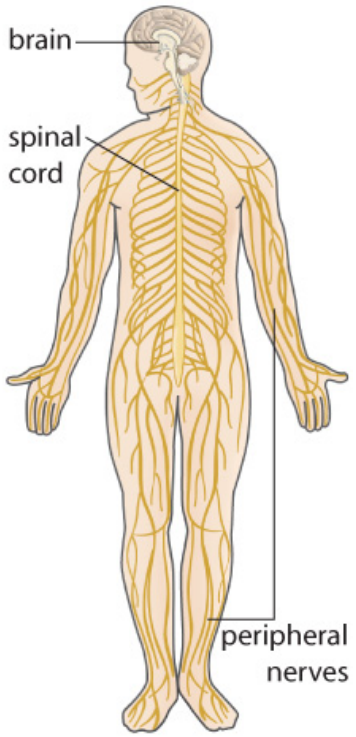
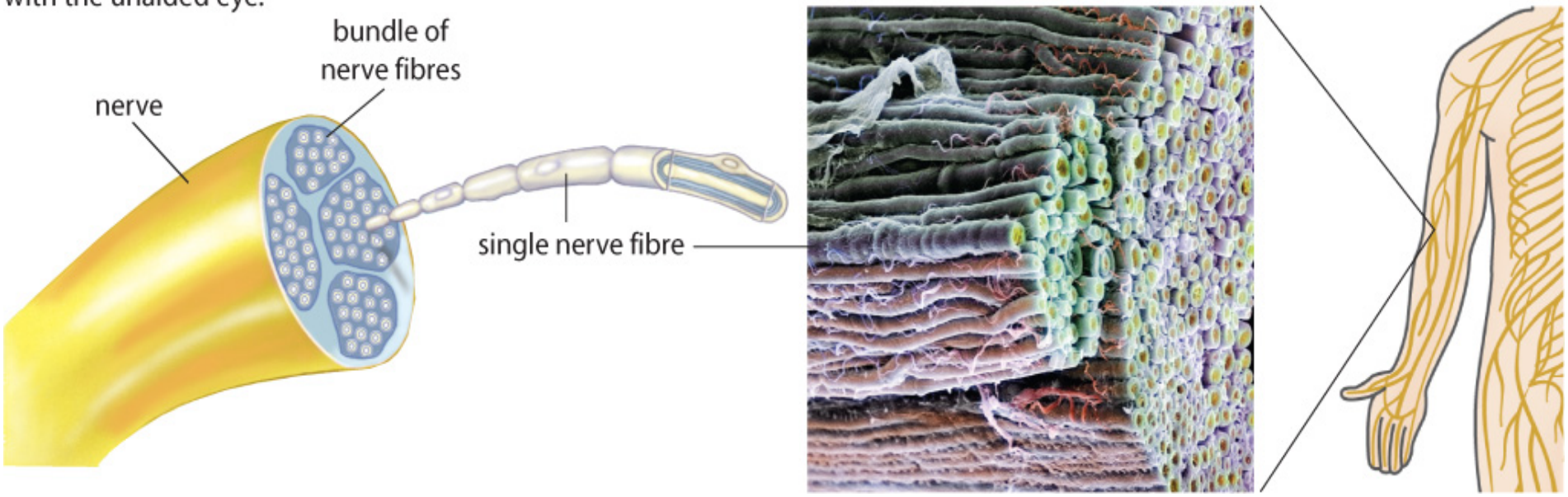


Figure 11.3 The organization of the human nervous system.



Nerves vs. Neurons

Figure 11.5 Neurons are bundled together into nerves in the peripheral nervous system and into tracts in the central nervous system. Nerves are macroscopic structures. Neurons, however, are microscopic structures. Even a neuron that is over 1 m long cannot be seen with the unaided eye.



Three Types of Neurons

1. **Sensory** – carries information from the Sensory environment to the CNS. Located in the PNS
2. **Motor** – carries information from the CNS to the effectors (muscles/glands). Located in the PNS
3. **Interneurons** – link the sensory and motor neurons. Located in the CNS

****Glial Cells** – nourish the neurons, remove their wastes, and defend against infection. Outnumber neurons 10 to 1

Structure of Neuron

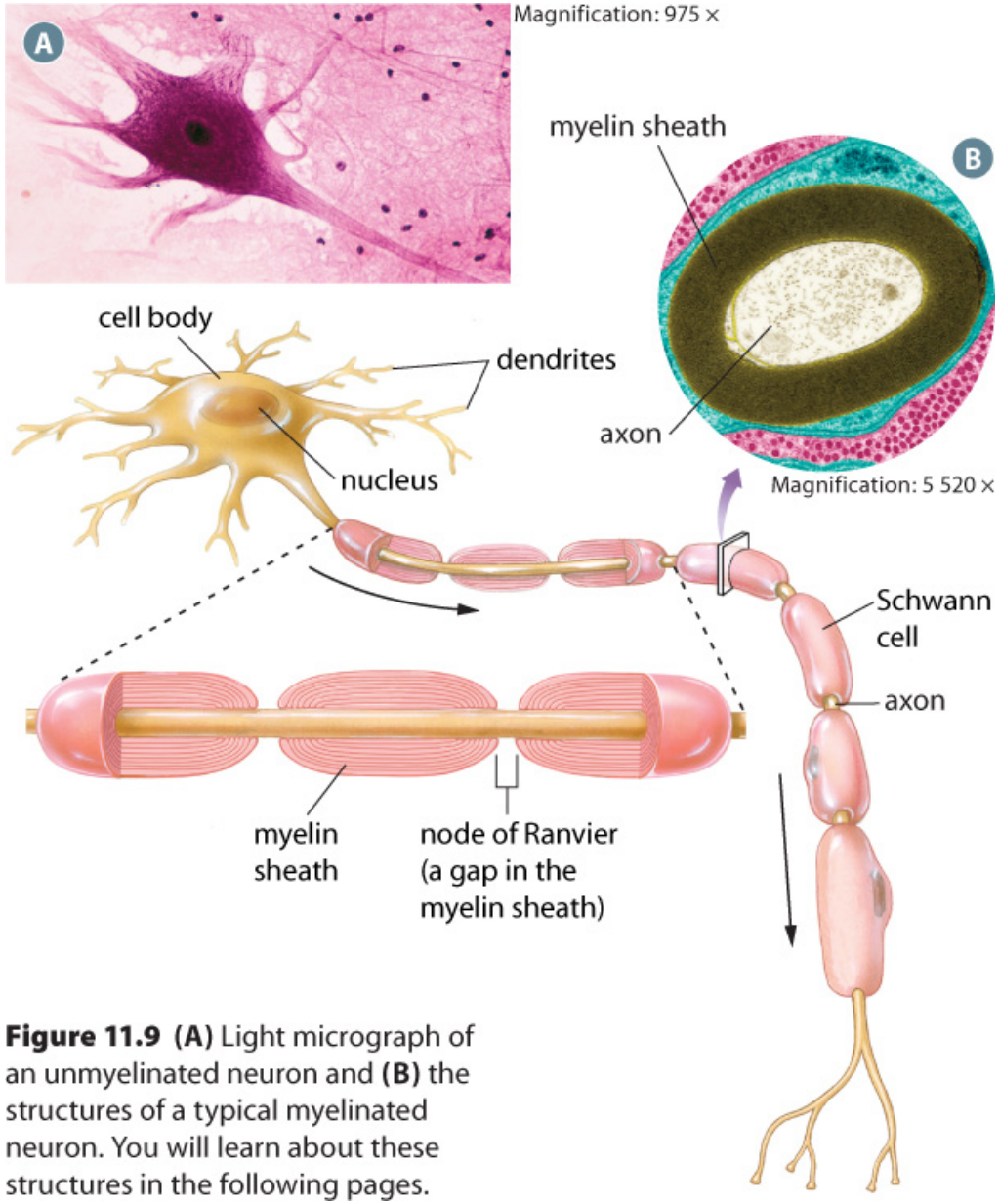


Figure 11.9 **(A)** Light micrograph of an unmyelinated neuron and **(B)** the structures of a typical myelinated neuron. You will learn about these structures in the following pages.

Structures of Neuron

- **Dendrites**
  - Pick up impulses from the previous neuron and carry to the cell body
- **Cell Body**
  - Produces many chemicals needed by the neuron
  - Performs metabolism
- **Axon**
  - Carries the impulses from the cell body to the synapse
  - Function is to insulate the axon and thus increase the speed of impulse transmission (about 50X)
  - The larger the diameter of the axon, the faster the impulses will travel

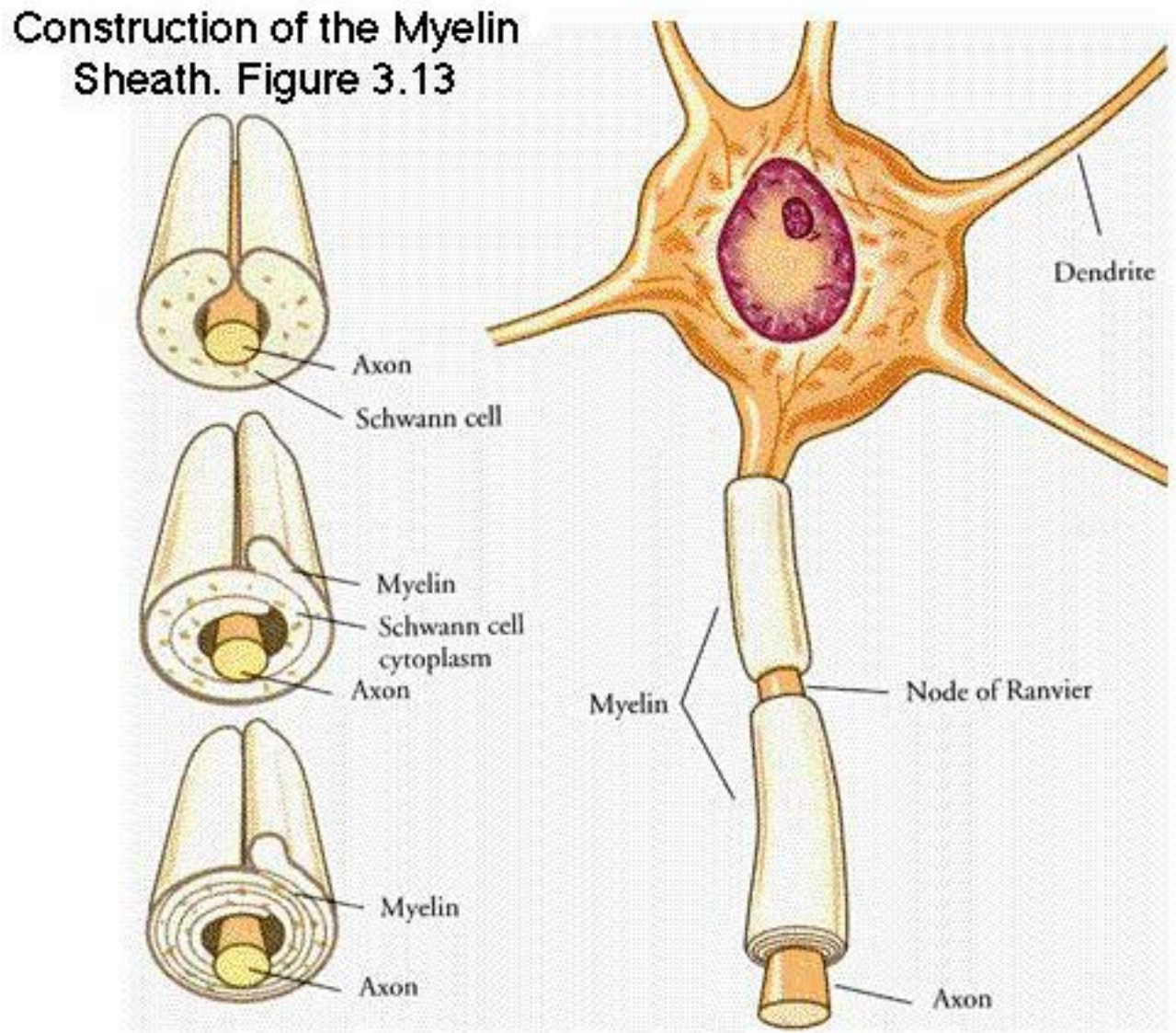
Axon

- In the CNS, **oligodendrocytes** form the fatty white myelin sheath around the axon

- In the PNS, **Schwann Cells** form the fatty white myelin sheath by wrapping around the axon. As each Schwann Cell wraps around the nerve fiber, its nucleus and cytoplasm are squeezed to the perimeter to form the **neurilemma**

- The function of **neurilemma** in the regeneration of neurons

Myelin Sheath Formation

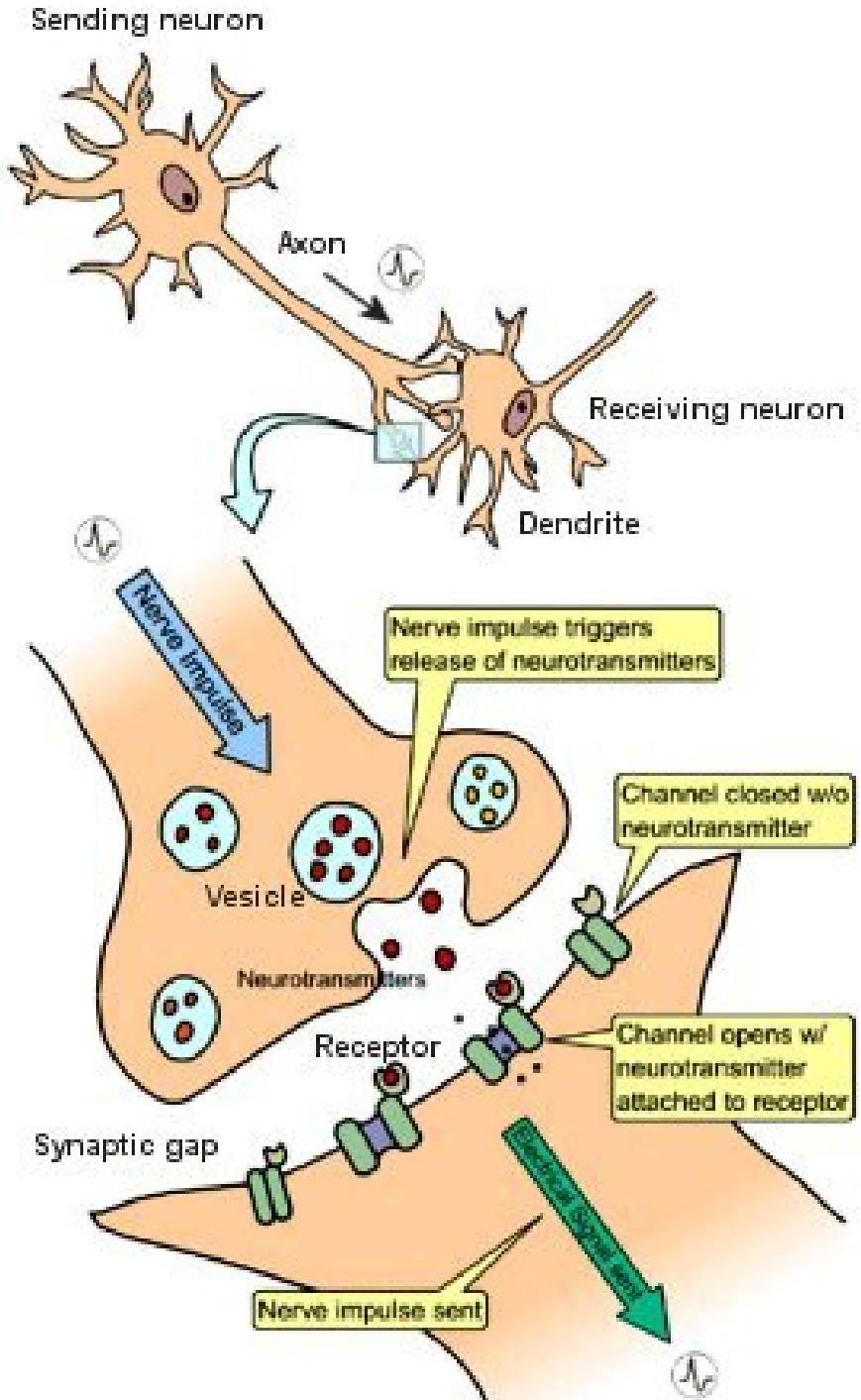


Structures of Neuron

- **Nodes of Ranvier**
  - Gaps between the myelin sheath
  - Impulses jump from one node to the next node during **saltatory conduction**

- Synapse
  - Junction between the pre-synaptic neuron and post-synaptic neuron
  - Synaptic knobs contain
    - Vesicles that release the neurotransmitter **acetylcholine**
    - Mitochondria to produce ATP for neurotransmitter synthesis

Synapse


Sending neuron
Axon
Receiving neuron
Dendrite
Nerve impulse
Nerve impulse triggers release of neurotransmitters
Channel closed w/o neurotransmitter
Vesicle
Neurotransmitters
Receptor
Channel opens w/ neurotransmitter attached to receptor
Synaptic gap
Nerve impulse sent

Reflex Arc

- Occurs without any brain involvement or conscious thought
- Involves the spinal cord ONLY and thus the response is quick and involuntary
- Example: touching a flame
- Reflex Arc Pathway:

Sensory receptor → Sensory neuron → Interneuron → Motor neuron → Effector

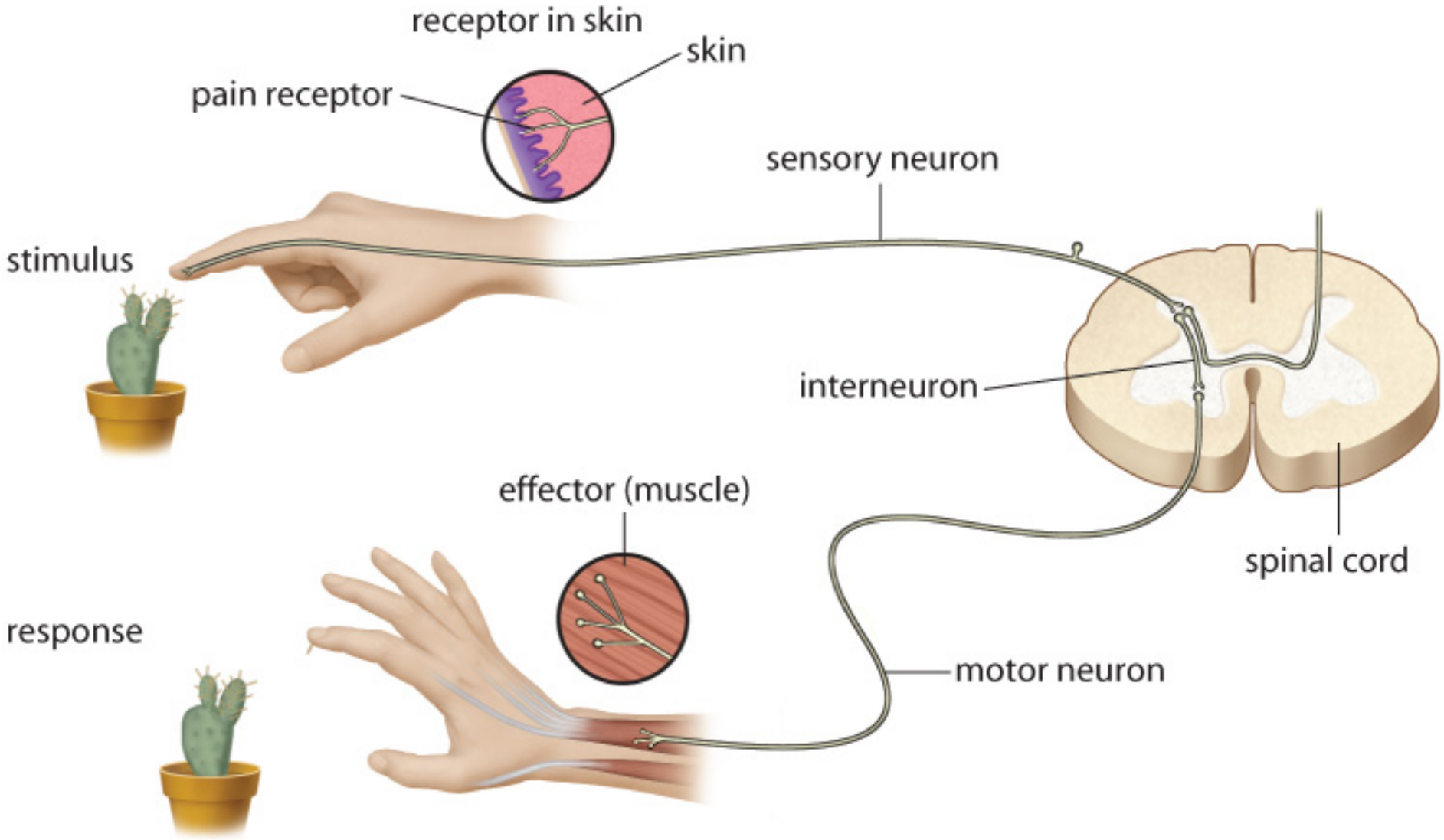


Figure 11.8 A withdrawal reflex. Receptors in the skin perceive the stimulus. Sensory information is conducted from the senses into the spinal cord. Motor information is then conducted away from the spinal cord to the muscles and glands.

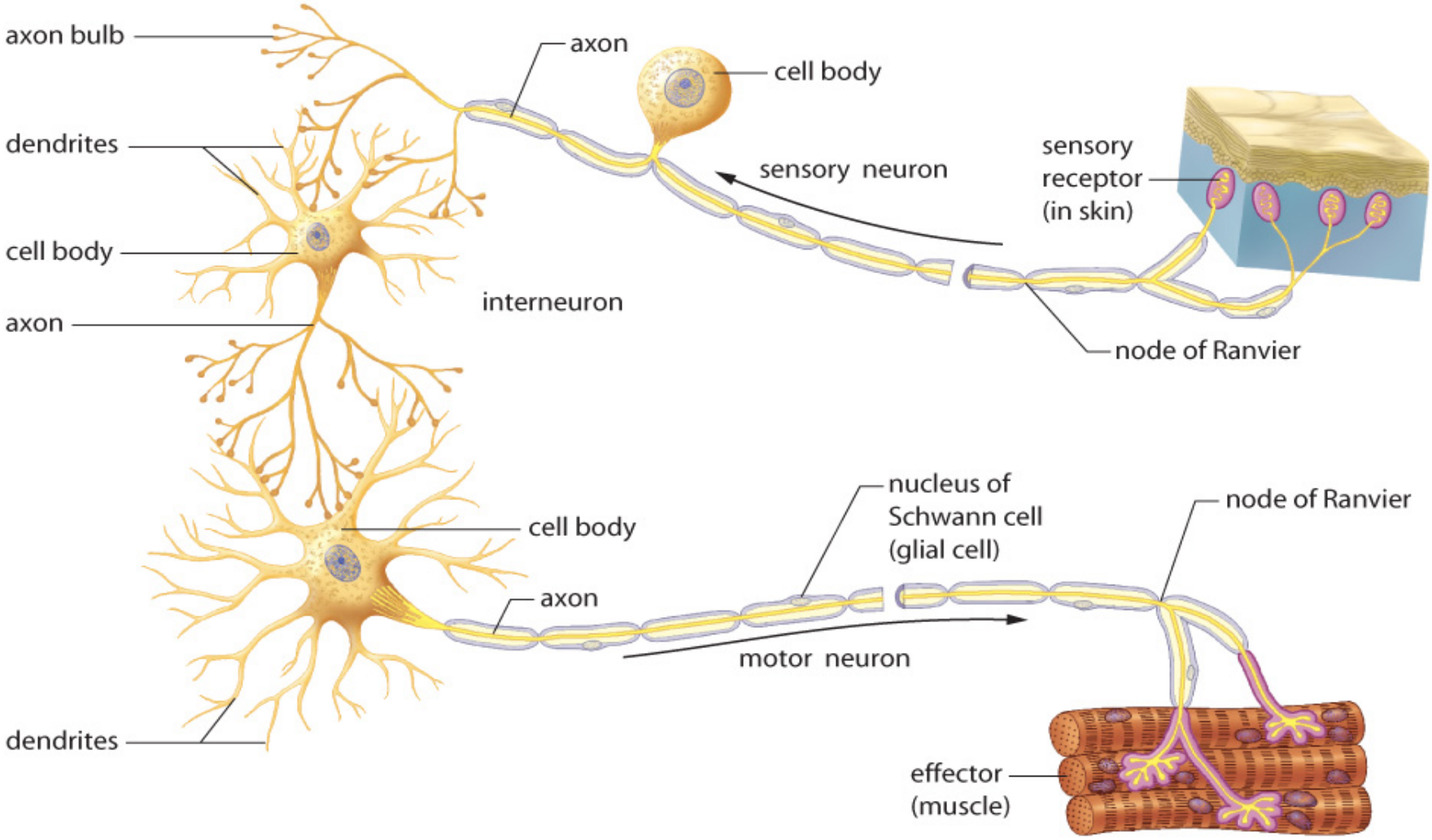


Figure 11.6 This diagram shows how a sensory neuron, an interneuron, and a motor neuron are arranged in the nervous system. (The breaks indicate that the axons are longer than shown).

Impulse Transmission (Excitatory)

1. Resting Potential

- A positive outside and negative inside **MUST** be created across the axon's membrane **BEFORE** it can transmit an impulse!
- Created by the sodium-potassium pump that pumps 3 Na^+ out for every 2 K^+ in (requires ATP)
- This difference in charge creates a voltage of -70 mV when measured with a voltmeter
- The axon membrane is also described as **polarized**. The axon membrane is impermeable to Na^+ but K^+ can leak out. The negative inside is due to the presence of negatively charged proteins and fewer K^+ than Na^+

Impulse Transmission (Excitatory)

2. Action Potential

- As the impulse starts moving down the axon, the axon's permeability changes in that Na^+ starts moving into the axon to create an axon membrane with a positive inside and a negative outside
- Called a **wave of depolarization or depolarized membrane. This occurs ONLY at the nodes of Ranvier as the myelin sheath insulates the axon that it encircles**

Impulse Transmission (Excitatory)

3. Repolarization

- **Na gates close, K gates open**
- K ions diffuse out of axon making inside more negative, outside more positive
- After the impulse passes through the axon, the Na^+ and K^+ are on opposite sides of the axon. Thus, the sodium-potassium pump restores the resting membrane potential by pumping 3 Na^+ out for every 2 K^+ in
- **Every axon membrane must repolarize BEFORE it can transmit a second impulse**!

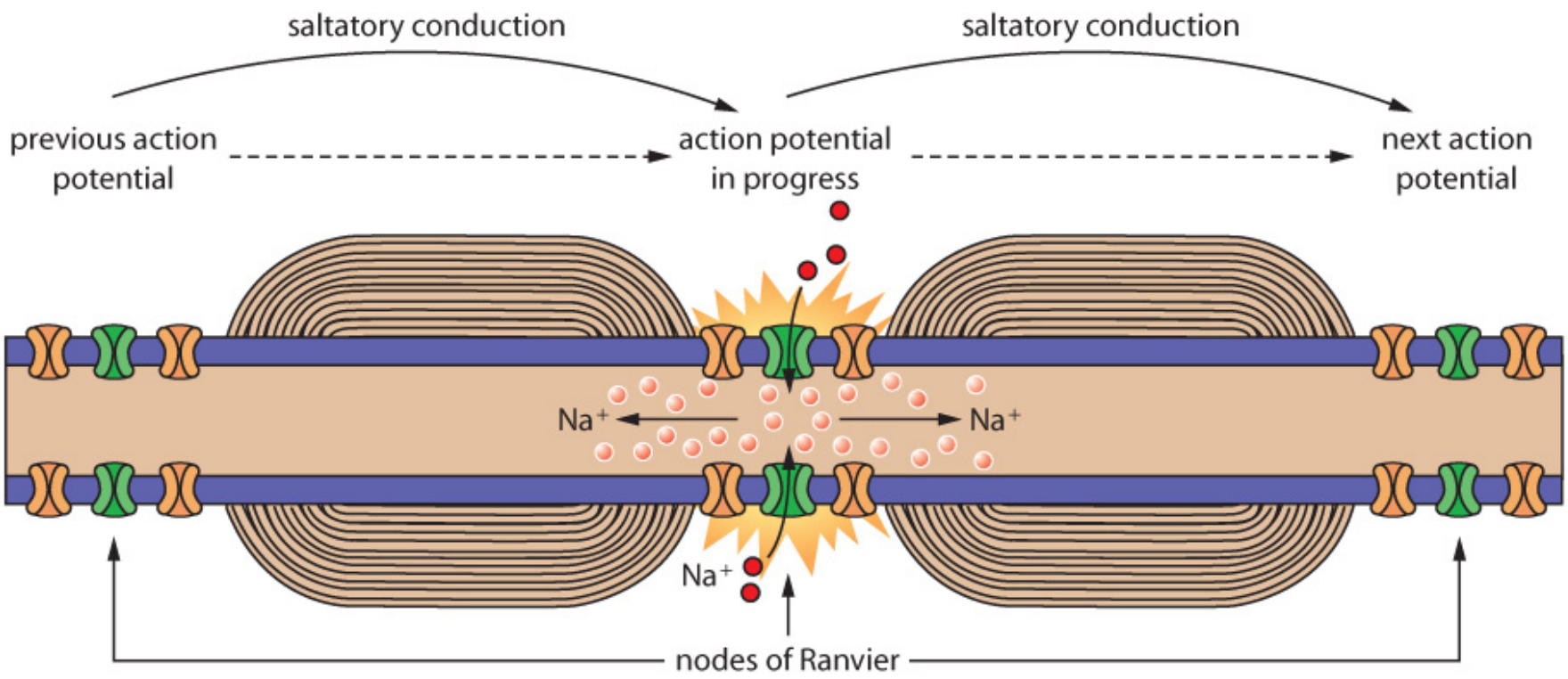
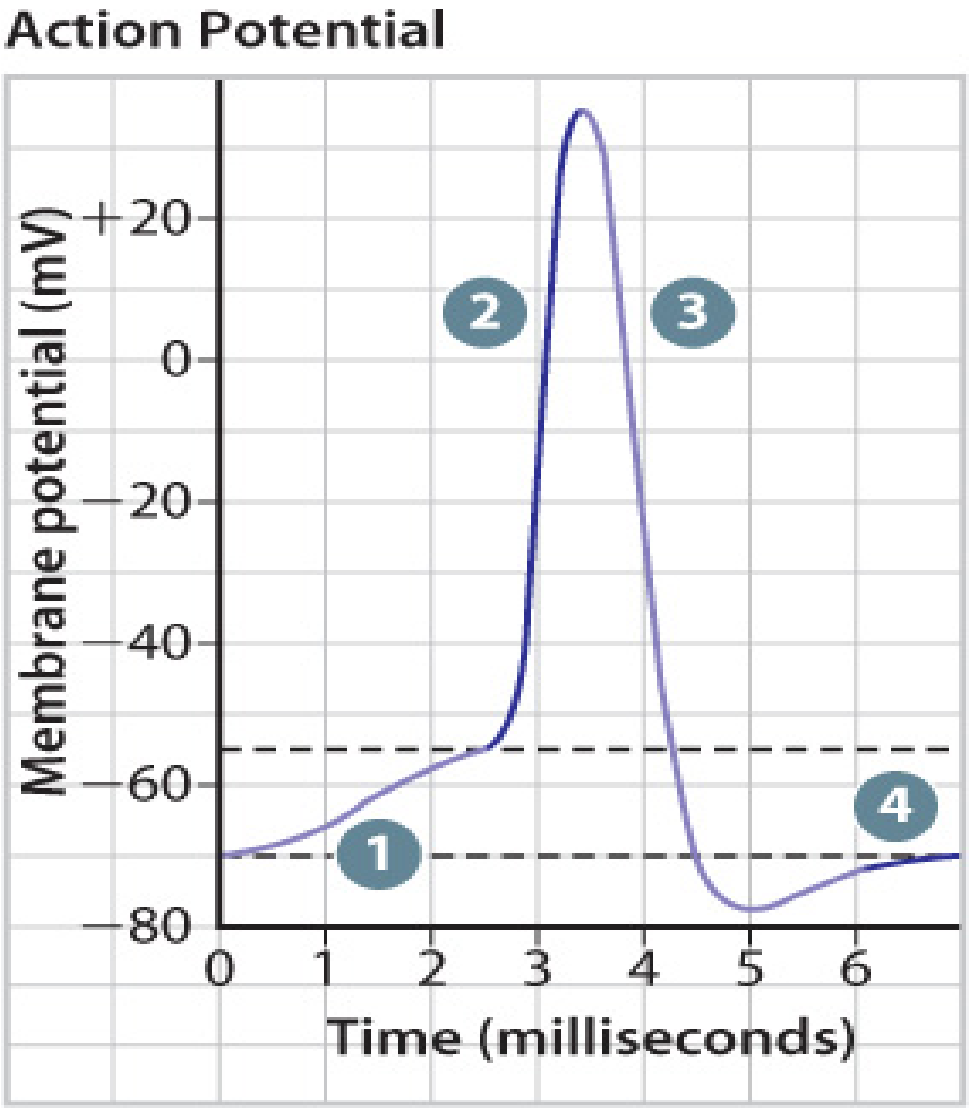


Figure 11.16 Sodium ions that accumulate inside an axon during an action potential diffuse in both directions along the inside of the axon.

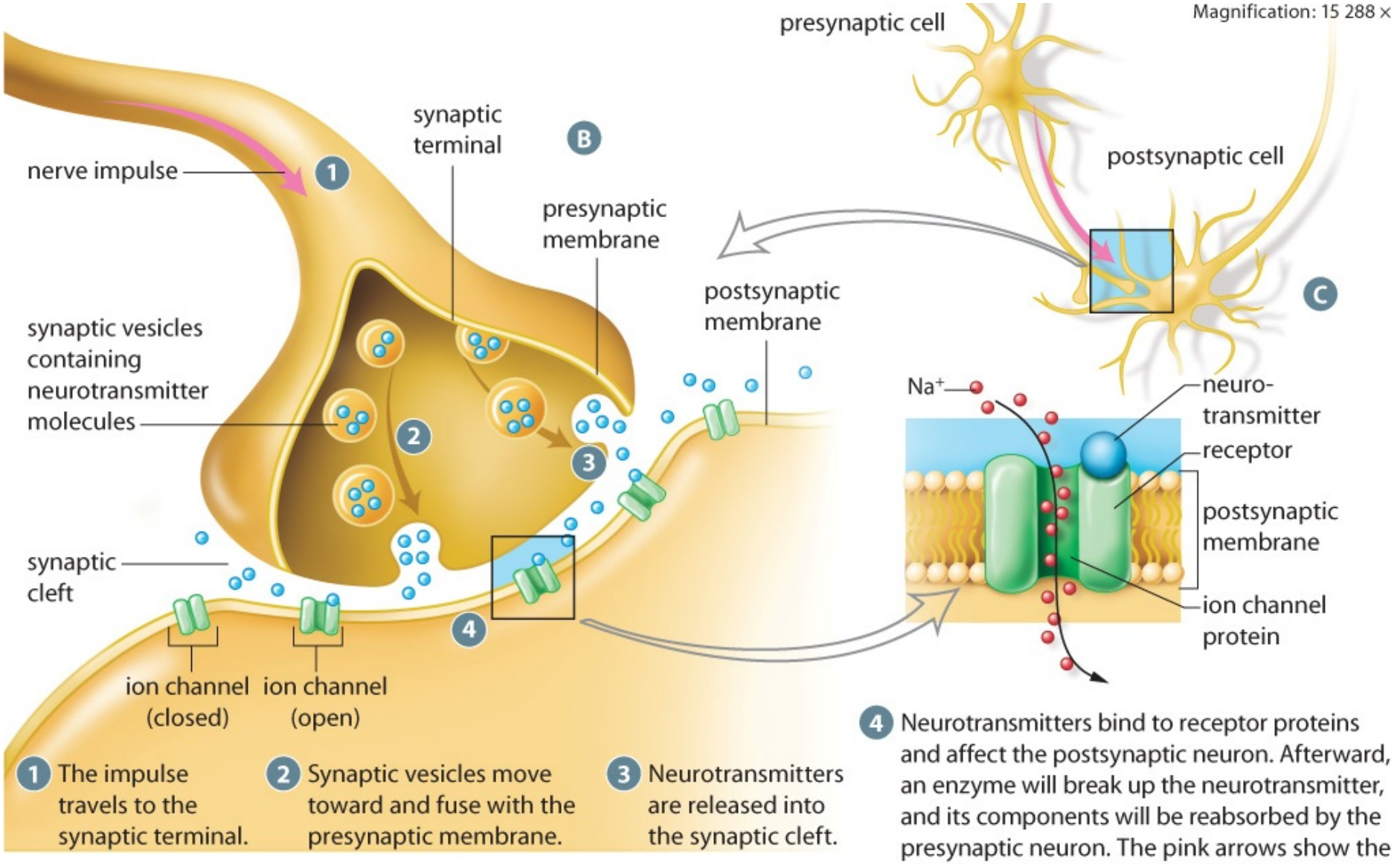
Threshold Level

- The minimum amount of impulse needed to get an action potential (response)
- Each neuron has a different threshold level
- If the impulse exceeds the threshold, the response is the SAME…called the **ALL or NONE RESPONSE**



Synapse

- Once impulse reaches the synapse, the synaptic knobs release **acetylcholine**
- Attaches to receptors on the dendrites of the post-synaptic neuron
- Causes depolarization of post-synaptic neuron so impulse continues
- Acetylcholine is then broken down by **cholinesterase** (released by dendrites of post-synaptic neuron)
- Repolarization is allowed to occur


Magnification: 15 288 ×
presynaptic cell
postsynaptic cell
synaptic terminal
B
nerve impulse
1
presynaptic membrane
postsynaptic membrane
C
synaptic vesicles containing neurotransmitter molecules
2
3
Na+
neuro-transmitter
receptor
postsynaptic membrane
synaptic cleft
4
ion channel protein
ion channel (closed)
ion channel (open)
1 The impulse travels to the synaptic terminal.
2 Synaptic vesicles move toward and fuse with the presynaptic membrane.
3 Neurotransmitters are released into the synaptic cleft.
4 Neurotransmitters bind to receptor proteins and affect the postsynaptic neuron. Afterward, an enzyme will break up the neurotransmitter, and its components will be reabsorbed by the presynaptic neuron. The pink arrows show the direction of nerve impulse transmission.

Random Bits of Information…

- **Stimuli Intensity** is detected 2 ways:
  - The more intense the stimulus, the higher the frequency of impulses
  - Each neuron has its own threshold level. The more impulses reaching the brain, the stronger the response

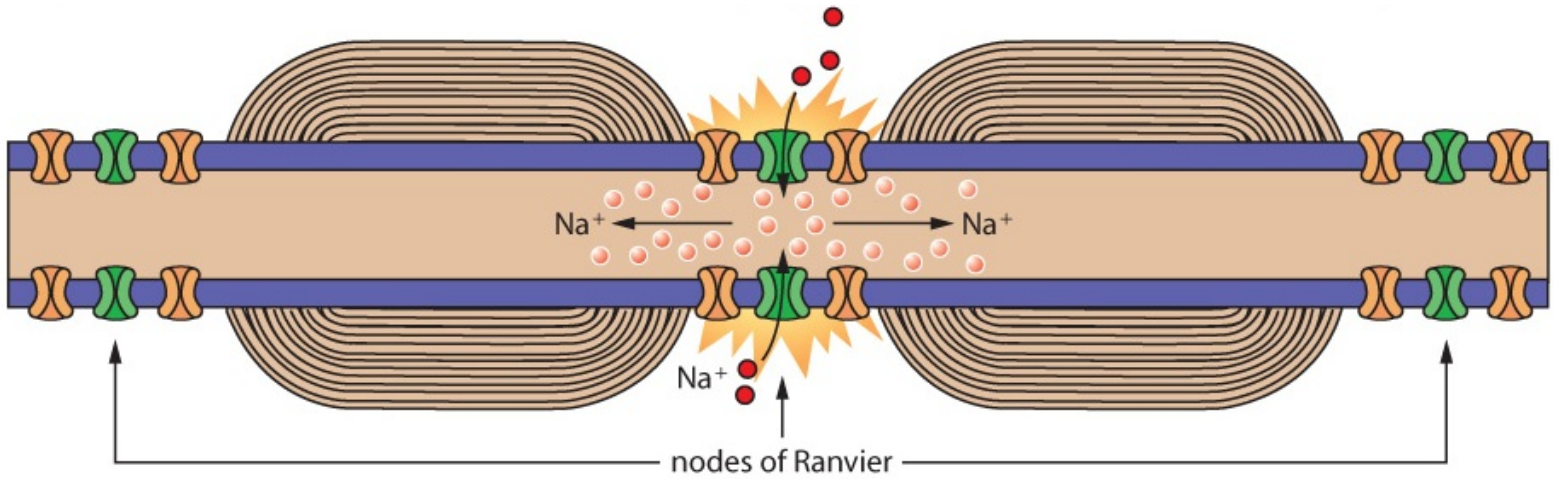


Figure 11.16 Sodium ions that accumulate inside an axon during an action potential diffuse in both directions along the inside of the axon.

Random Bits of Information…

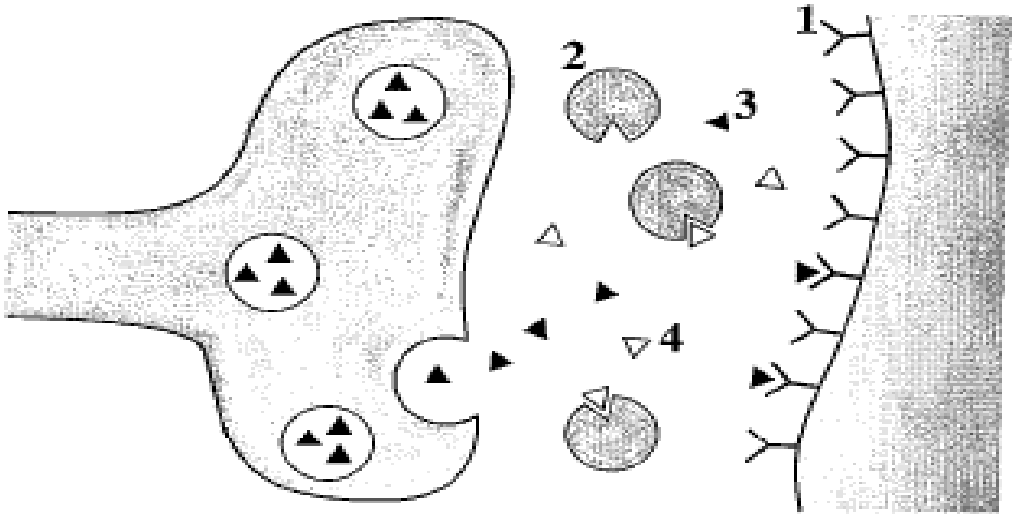
- A **neuromuscular junction** is a synapse between a motor neuron and a muscle cell
- **Tetanization** occurs when cholinesterase is blocked/destroyed so action potentials are continuous
- The refractory period is the time it takes a neuron to repolarize
- **Summation** occurs when acetylcholine is needed from 2 or more neurons to cause depolarization of post-synaptic neurons
- **Hyperpolarization** of an axon inhibits impulses from being transmitted when the outside of an axon becomes even more positive than normal due to an accumulation of K^+ leaking outside the axon. As a result, getting enough Na^+ inside the axon for depolarization to occur is almost impossible

Multiple Choice #16

Use the following information to answer the next two questions.

Alzheimer disease is caused by a decrease in the production of the neurotransmitter acetylcholine in the brain. Cholinesterase inhibitors, such as the drug donepezil, can slow the development of symptoms in the early-to-middle stages of Alzheimer disease, but they cannot stop the progression of the disease. The donepezil molecule has a shape that allows it to attach to the active site on cholinesterase, thereby preventing the cholinesterase from binding to acetylcholine.

A Synapse



In the diagram above, acetylcholine and donepezil are numbered

A. 1 and 2 respectively
B. 2 and 1 respectively
C. 3 and 4 respectively
D. 4 and 3 respectively

Multiple Choice #17 and Numerical Response #3

How does donepezil affect synaptic transmission?

A. Donepezil breaks down acetylcholine so that less acetylcholine is available in the synapse.

B. Donepezil replaces cholinesterase so that more acetylcholine is available in the synapse.

C. Donepezil blocks the release of acetylcholine so that less acetylcholine is available in the synapse.

D. Donepezil prevents the breakdown of acetylcholine so that more acetylcholine is available in the synapse.

Another symptom of MS is an exaggerated pupillary light reflex. Some of the events that occur during this reflex are listed below.

1 Motor neuron depolarizes
2 Sensory neuron depolarizes
3 Interneuron depolarizes
4 Light receptors stimulated

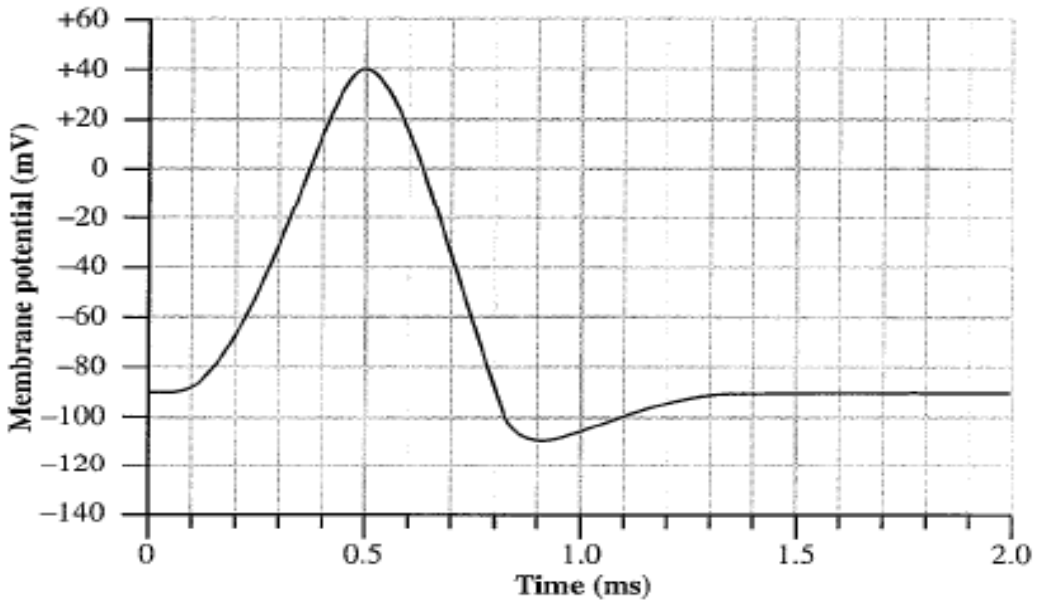
The order in which the events listed above occur during a pupillary light reflex is _____, _____, _____, and _____.

(Record all **four digits** of your answer in the numerical-response section on the answer sheet.)

Numerical Response #4

Use the following additional information to answer the next three questions.

Stimulation of a sensory neuron produces an action potential. An abnormal pattern in this action potential can be used to detect MS in its early stages. The graph below illustrates the membrane potential of a normal neuron after stimulation.



What is the resting membrane potential for this neuron, expressed to two digits, **and** what is the maximum membrane potential during depolarization, expressed to two digits? (Record your answers as absolute values.)

Answers: _____ _____ , _____ _____

Membrane Potential: **Resting** **Maximum During Depolarization**

(Record all **four digits** of your answer in the numerical-response section on the answer sheet.)

Multiple Choice #18 and #19

Which of the following types of ion movement across an axon membrane would cause the action potential to change during the interval from 0.2 ms to 0.4 ms?

A. Sodium ions moving into the axon
B. Sodium ions moving out of the axon
C. Potassium ions moving into the axon
D. Potassium ions moving out of the axon

On the graph, the period from 0.5 ms to 1.0 ms represents the neuron's

A. refractory period, which is when repolarization occurs
B. refractory period, which is when minimum depolarization occurs
C. threshold period, which is when repolarization occurs
D. threshold period, which is when minimum depolarization occurs

Multiple Choice #20 and #21

Use the following information to answer the next question.

> After accidentally hitting your thumb with a hammer, you immediately withdraw your hand. You do not feel pain for a short period of time.

This sequence of events may be explained by the fact that the

A. threshold of the receptor has been so greatly exceeded that the neuron does not pass the message to the brain

B. neural impulse is so large that the brain is unable to interpret the signal because it is beyond the range of tolerance

C. neural processing occurred in the spinal cord first, which caused you to quickly remove your thumb from further damage

D. sensory receptors in the thumb were damaged by the blow and are unable to initiate a stimulus to the sensory nerve

Use the following information to answer the next question.

> Individuals know that touching a hot stove can be painful. When an individual accidentally touches a hot stove, a reflex arc is initiated, which causes the person to withdraw his or her hand before he or she senses the pain.

Which of the following lists identifies the neural pathway in a reflex arc?

A. Receptor, sensory neuron, effector, motor neuron
B. Motor neuron, interneuron, sensory neuron, effector
C. Sensory neuron, receptor, interneuron, motor neuron
D. Receptor, sensory neuron, interneuron, motor neuron

Autonomic Nervous System (ANS) - involuntary

Sympathetic

- Prepares body for stress
- Nerves originate from ribs and lower back of the spinal cord
- Effects include:
  - Increased heart rate
  - Increased release of epinephrine
  - Increased breathing rate
  - Increased metabolism
  - Increased blood flow (vessels dilate)
  - Pupils dilate
  - Decreased peristalsis
  - Increased conversion of glycogen to glucose
  - Bladder sphincter relaxes

Parasympathetic

- Returns body to normal
- Nerves originate from the brain, neck and tail bone of the spinal cord
- Effects include:
  - Decreased heart rate
  - Release of epinephrine stops
  - Decreased breathing rate
  - Decreased metabolism
  - Decreased blood flow (vessels constrict)
  - Pupils constrict
  - Increased peristalsis
  - Stores glucose in liver and muscles
  - Bladder sphincter contracts

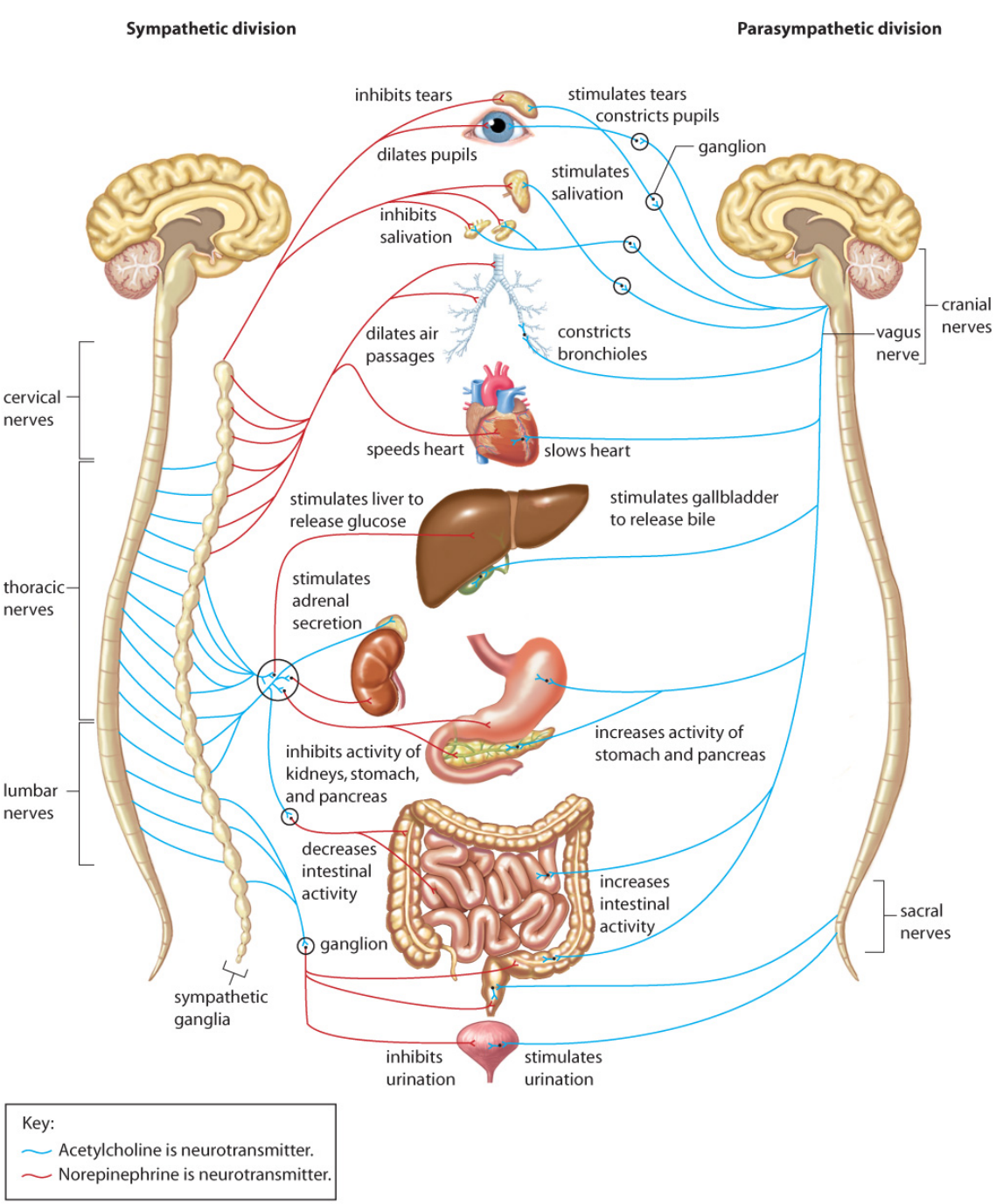


Figure 11.36 The structure and function of the autonomic system: Both the sympathetic and parasympathetic nervous systems regulate the same organs, but with opposing effects.

Central Nervous System (CNS)

- Brain is protected by skull and 3 protective membranes called **meninges**
- Meninges prevent the direct circulation of blood through the cells of the brain and spinal cord
- This separation of blood and CNS is called the **blood-brain barrier**
- **Cerebrospinal fluid (CSF)** circulates between the meninges and the central canal of the spinal cord
- Function of the CSF is a shock absorber and transport of nutrients and wastes
- Level of brain development makes humans unique
- **Endorphins** (natural painkillers) prevent the production of pain transmitters

Spinal Cord

- Connects the sensory and motor nerves to the brain
- Contains white matter (myelinated from oligodendrocytes) and grey matter (unmyelinated)…will these nerves regenerate?? Why or why not??

Brain – Forebrain

- Contains the following:
  - Paired olfactory lobes
  - **Cerebrum** (2 hemispheres) – largest and most highly developed part of brain. Controls speech, reasoning, memory, personality, stores sensory information and initiates motor activities. Made of 4 lobes:
    - **Frontal** – front of head. Responsible for personality
    - **Parietal** – top of head. Responsible for touch, taste and pressure
    - **Occipital** – back of head. Responsible for vision
    - **Temporal** – near temple. Responsible for hearing and smell

Forebrain

- Contains the following (cont'd):
  - **Cerebral Cortex** – covers the cerebrum. Made of grey matter and has fissures to increase the surface area
  - **Corpus Callosum** – allows the 2 hemispheres to communicate
  - Thalamus – below the cerebrum. Coordinates/interprets sensory information
  - **Hypothalamus** – below the thalamus
  - **Pituitary Gland** – connected to the hypothalamus (links nervous and endocrine system)

Midbrain and Hindbrain

- Midbrain – less developed
- Hindbrain – joins with the spinal cord. Contains the following:
  - **Cerebellum** – coordinates muscle movement. Beneath the cerebrum
  - **Medulla Oblongata** – joins the spinal cord to the cerebellum. Controls all vital functions (ANS)
  - **Pons** – relay between the medulla and cerebellum
- Right side of brain controls left side of body and vice versa
- Right side: spatial skills
- Left side: math/verbal skills

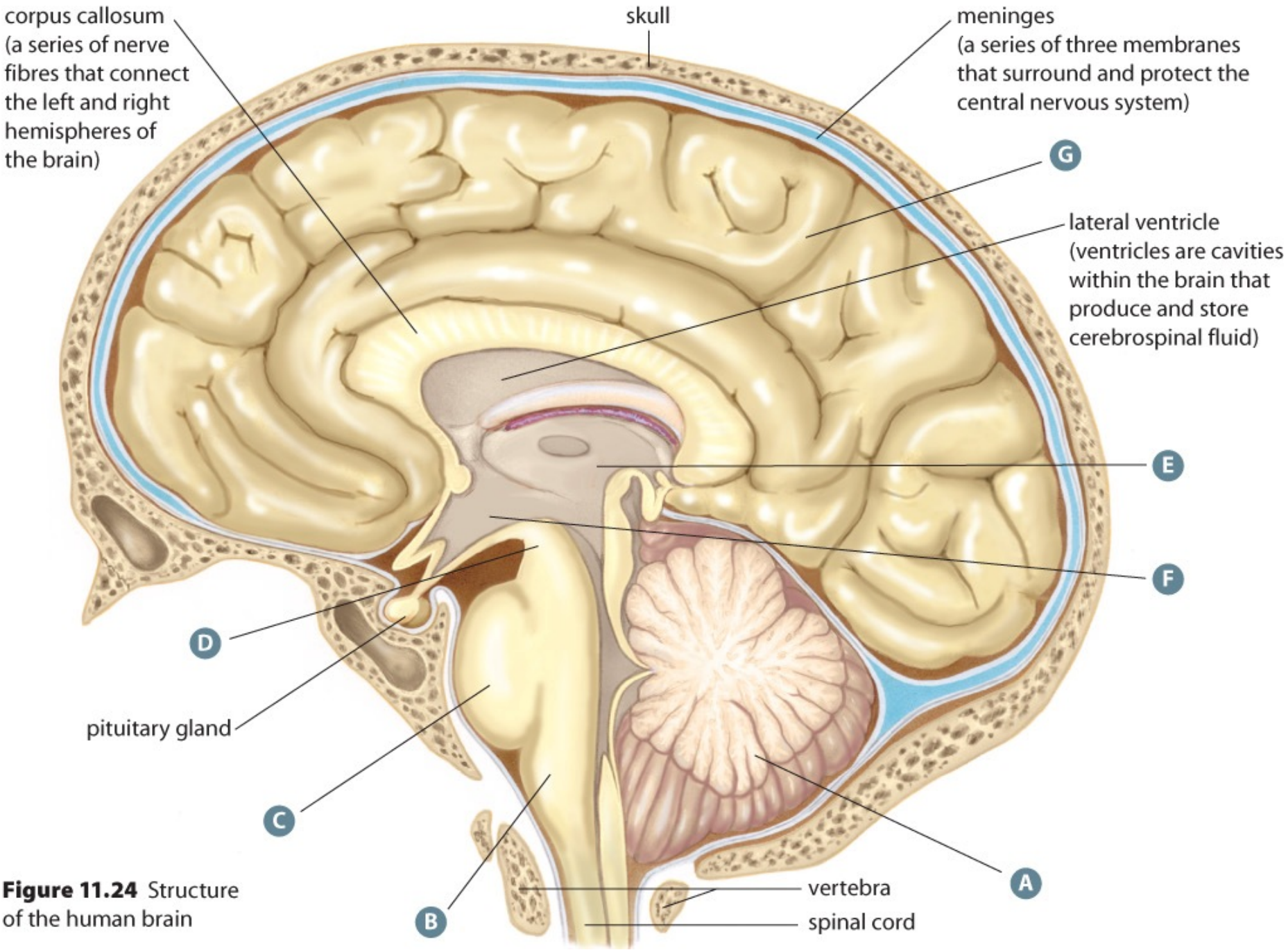


Figure 11.24 Structure of the human brain

Multiple Choice #22

Use the following information to answer the next five questions.

Multiple sclerosis (MS), a disease of the nervous system, typically has symptoms of uncontrolled muscle responses, weakness, paralysis, and vision difficulties. Researchers believe that MS occurs as a result of the body's immune system destroying the myelin sheath that surrounds the axon of a nerve cell. The result is a scarring of brain tissue or of spinal cord tissue.

Damage to the myelin sheath of an optic neuron affects the speed of neural transmission to the visual centre, which is found in which lobe of the cerebrum?

A. Frontal lobe
B. Parietal lobe
C. Occipital lobe
D. Temporal lobe

Multiple Choice #23

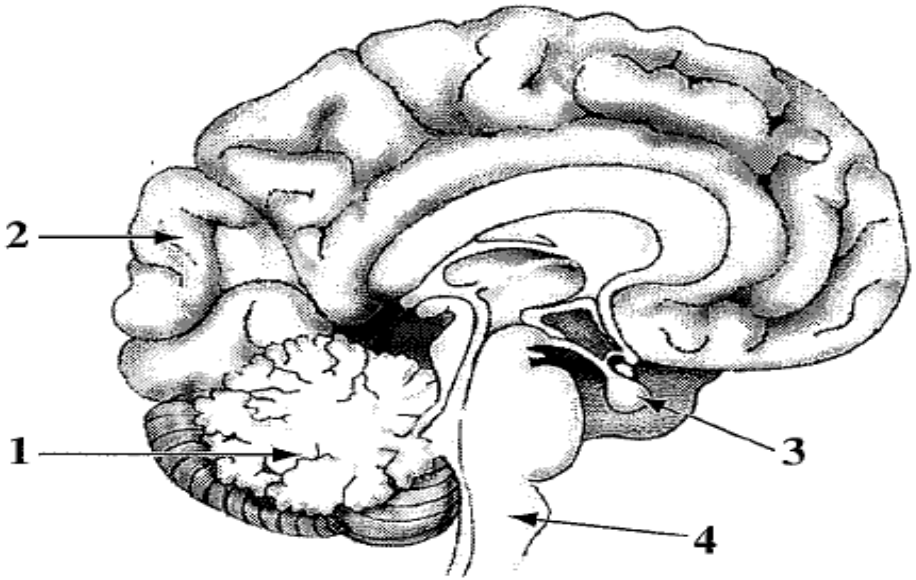
Which of the following rows indicates events that would result from stimulation of sympathetic motor neurons in the heart, skin, and liver?

Row	Heart	Skin	Liver
A.	Increased heart rate	Decreased blood flow	Conversion of glycogen to glucose
B.	Increased heart rate	Increased blood flow	Conversion of glucose to glycogen
C.	Decreased heart rate	Decreased blood flow	Conversion of glycogen to glucose
D.	Decreased heart rate	Increased blood flow	Conversion of glucose to glycogen

Multiple Choice #24

Use the following information to answer the next question.

The Human Brain



The area of the brain that controls the sympathetic and parasympathetic nervous systems is labelled

A. 1
B. 2
C. 3
D. 4

Multiple Choice #25 and #26

Use the following information to answer the next two questions.

> Between seven and 12 months of age, infants begin to display a marked fear of strangers. Infants also begin to socially reference their responses during the same period. Some research indicates that extremely fearful children often have very anxious parents.

The division of the nervous system that is directly responsible for physiological responses to fear is the

A. sensory nervous system
B. somatic nervous system
C. sympathetic nervous system
D. parasympathetic nervous system

Use the following additional information to answer the next question.

> Biofeedback consists of conscious efforts to control body responses that are normally involuntary. This technique can be used to control abnormal fear.

Conscious efforts to control body responses through biofeedback originate in the

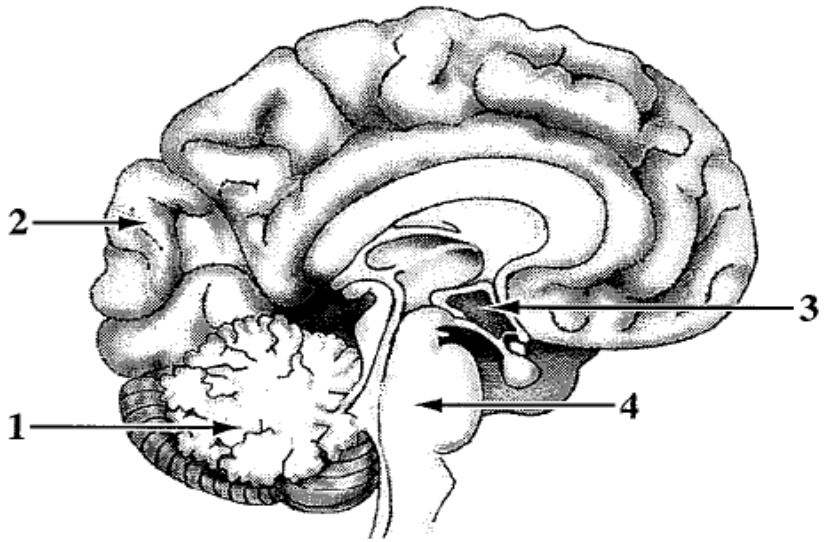
A. medulla
B. cerebrum
C. cerebellum
D. hypothalamus

Multiple Choice #27

Use the following information to answer the next two questions.

Individuals with Refsum disease cannot metabolize phytanic acid, which results in a buildup of phytanic acid in body tissues and impairs the development of the myelin sheath on neurons. Symptoms of Refsum disease include hearing and vision loss, decreased muscle coordination, and a reduced sense of smell.

Human Brain



In the diagram above, two areas of the brain whose function can be affected in a person with Refsum disease are numbered

A. 1 and 2
B. 1 and 4
C. 2 and 3
D. 3 and 4

Senses

- **Sensory receptors** pick up information from our environment and send this information to our brain along the sensory nerves
- **Sensation** occurs when the neural impulses arrive at the cerebrum
- Each person's unique **perception** results from how the cerebrum interprets the meaning of the sensory information
- **Sensory adaptation** occurs when the receptors have adjusted to changes in the environmental stimuli

Table 1 The Body's Sensory Receptors

Receptor Type	Stimulus	Information provided
taste	chemical	presence of specific chemicals (identified by taste buds)
smell	chemical	presence of chemicals (detected by olfactory cells)
pressure	mechanical	movement of the skin or changes in the body surface
proprioceptor	mechanical	movement of the limbs
balance	mechanical	body movement
audio	sound	sound waves
visual	light	changes in light intensity, movement, and colour
thermoreceptor	temperature changes	flow of heat

Taste and Smell

- Work together (eg. a cold)
- Taste sensory receptors are located on the tongue as taste buds
- 4 types: sweet, sour, salty and bitter

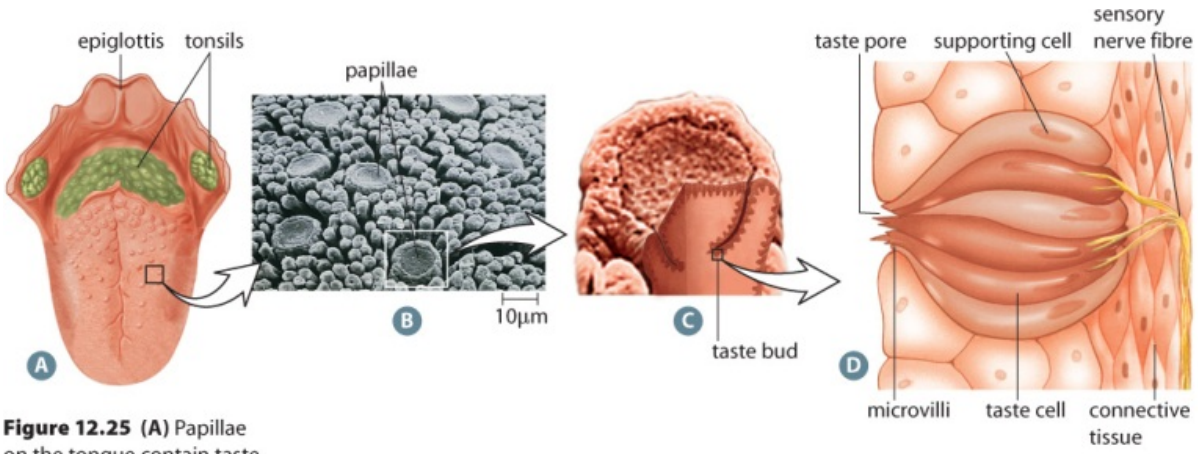


Figure 12.25 **(A)** Papillae on the tongue contain taste buds that are sensitive to salty, sweet, sour, and bitter molecules. **(B)** Electron micrograph of many papillae. **(C)** Electron micrograph of one papilla. **(D)** Taste cells within the taste buds. The taste buds depolarize in response to particular tastes and generate an action potential that sends a neural impulse to the brain.

Smell and Touch

- Smell – sensory receptors are olfactory cells in the nose. Airborne particles cause depolarization of olfactory cells. They exhibit sensory adaptation
- Touch – sensory receptors located all over the body. Many are concentrated in the genitals, fingers, tongue and lips. Sensitive to touch, pressure, pain, and high/low temperatures

Vision

Structure – 3 layers

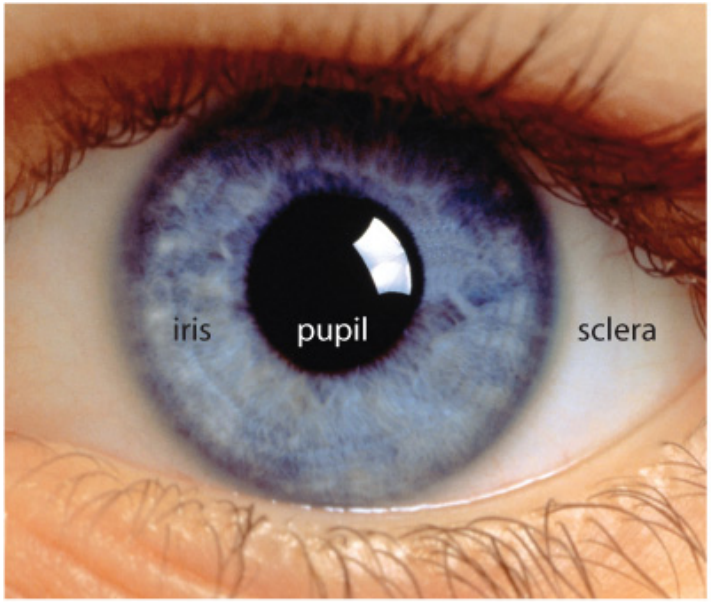
1. **Sclera** – outer layer that supports/protects the inner layers
   - **Cornea** – transparent and bends light towards the pupil. Receives oxygen from the gases dissolved in the tears (no blood vessels because they would distort vision).
   - **Aqueous Humor** – transparent fluid behind the cornea that supplies nutrients to the cornea

2. Choroid – middle layer

- **Iris** – controls the size of the pupil and thus the amount of light entering the eye
- **Lens** – behind the iris. Focuses the image on the retina. Ciliary muscles change the shape of the lens
- **Vitreous Humor** – jelly like fluid-filled chamber behind the lens. Maintains the shape of the eye

3. **Retina** – inner layer. Contains 2 sensory photoreceptors:
   - **Rods** – used when viewing in dim light. (ie. bats…why?)
   - **Cones** – used for color vision and vision in bright light
     - **Fovea Centralis** – center of retina and most sensitive. Contains cones **ONLY** and rods surround on the periphery
     - **Blind Spot** – where the optic nerve attaches to the retina. Contains **NO** rods/cones

Eye Structure



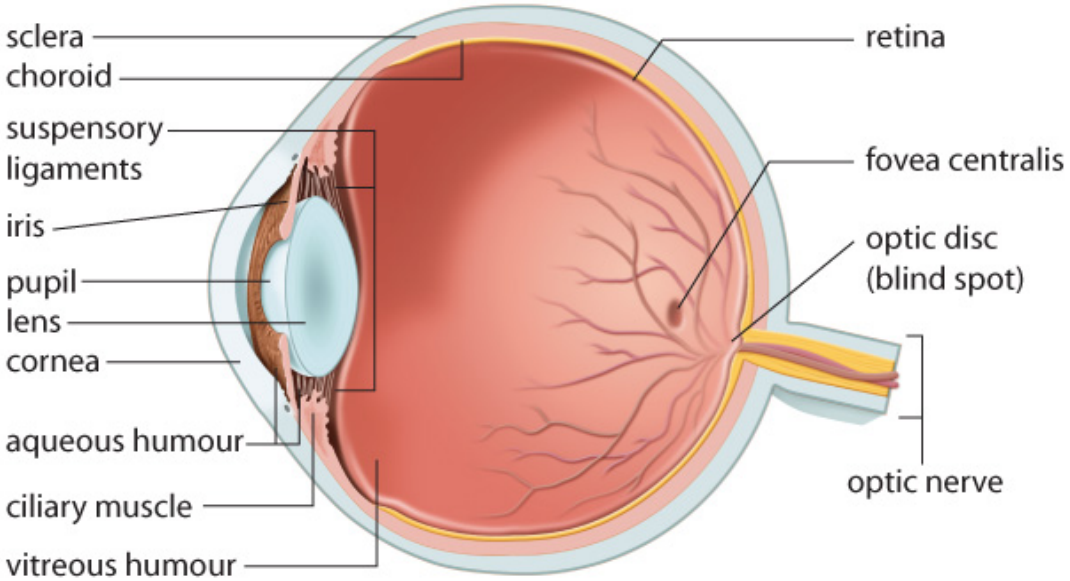


Figure 12.7 The anatomy of the human eye

Focusing An Image

- Light enters the eye through the pupil whose size is controlled by the iris
- Light is bent by the cornea towards the pupil/lens.
- Lens changes its shape as it bends the light onto the retina (inverted image)
- The lens' ability to change its shape when viewing near/far objects is called the **accommodation reflex**
  - Close Objects – ciliary muscles contract and thus the lens thickens. The pupil constricts to focus the image on the retina
  - Far Objects – ciliary muscles relax and the lens thins. Pupil dilates to increase the amount of light entering the eye. As we age, protein builds up on the lens and thus the lens is less flexible to accommodate when viewing close objects

Accommodation Reflex

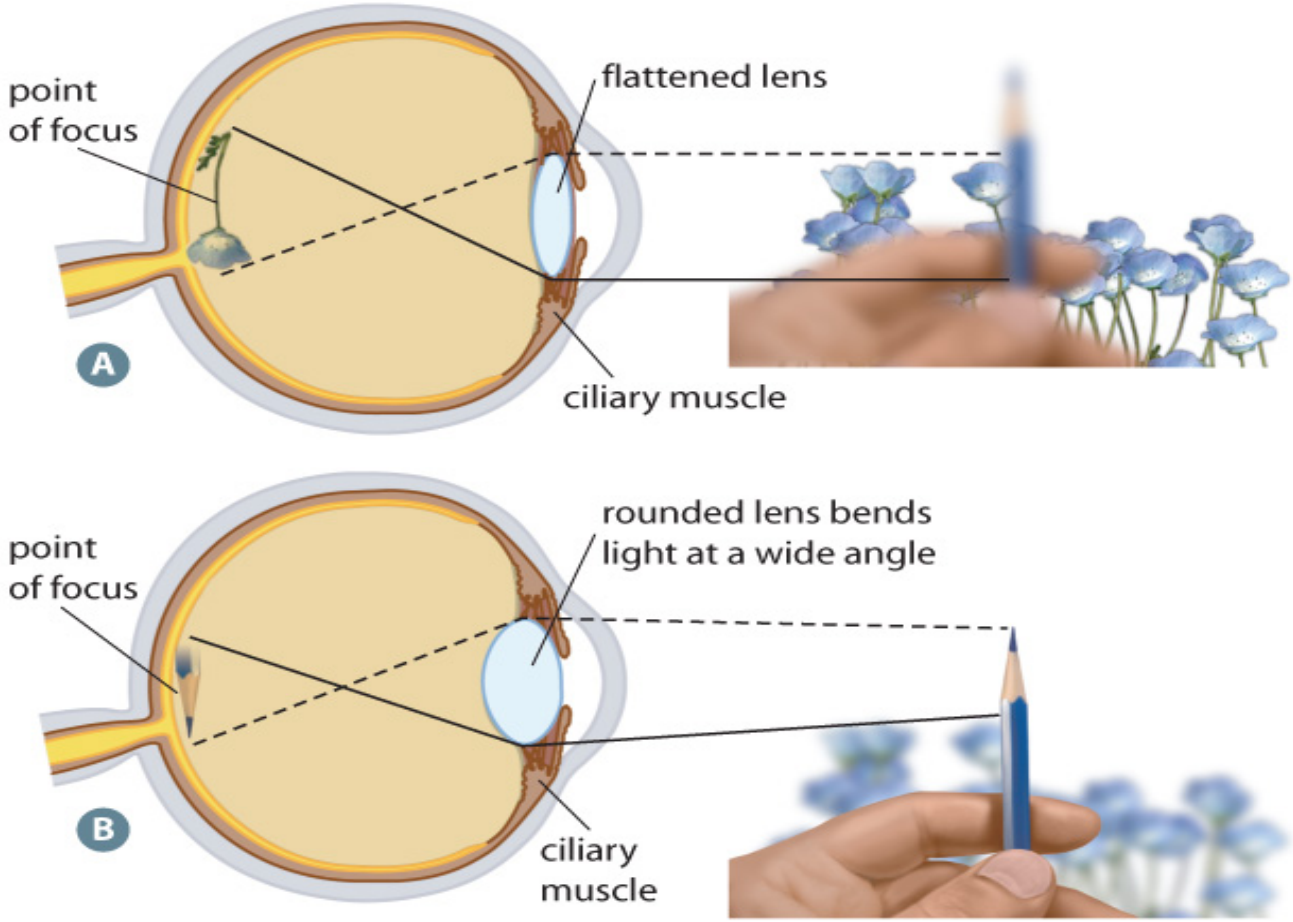


Figure 12.10 Accommodation. **(A)** What happens to the shape of the lens when the eye is focussed on a distant object? **(B)** What happens when the eye is focussed on a nearby object? Note that the ability of the lens to bend light is exaggerated in this diagram. In reality, the cornea also bends light.

Chemistry of Vision

- Rods surround the cones in the fovea centralis. The rods contain a light sensitive pigment, **rhodopsin** that requires vitamin A. A lack of vitamin causes night blindness

- The cones contain pigments sensitive to three light wavelengths: blue, red and green. When one or more types of pigments are defective, it causes **colorblindness**. The most common type is **red-green colorblindness** and is most common in males as the gene is carried on the X chromosome

Vision Defects = STS

- Glaucoma – a buildup of aqueous humor and thus the fluid pressure causes the blood vessels to collapse. Thus, oxygen and nutrients decrease. The result is neuron death and blindness
- Cataracts – the lens/cornea is cloudy and thus light can't pass through. The lens can be replaced
- Astigmatism – abnormal curvature of the lens/cornea
- Myopia/Nearsightedness – the eyeball is too long and thus the image is focused in front of the retina. Corrected with a concave lens
- Hyperopia/Farsightedness – the eyeball is too short and thus the image is focused behind the retina. Corrected with a convex lens

Optic Chiasma

- Where the optic nerve crosses on the underside of the brain to their respective occipital lobes

- Pathway of nerve impulses???

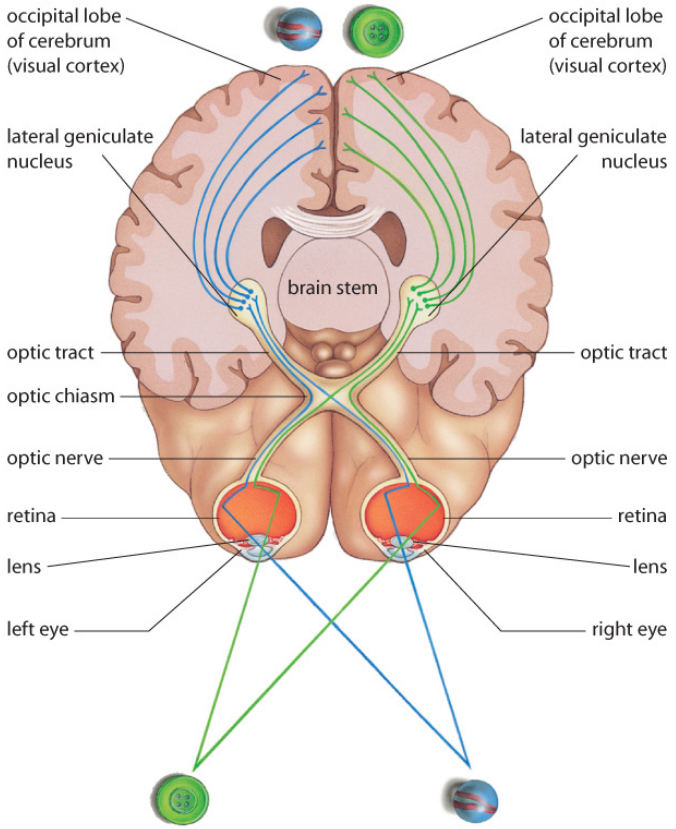


Figure 12.18 The neural pathway of the optic nerve from the retina to the occipital lobe. Data from the right half of each retina go to the right side of the occipital lobe, and data from the left half of each retina go to the left side of the occipital lobe. Integration of the image occurs in the brain.

Hearing

The ear has two functions – hearing and balance

Structure:

1. Outer Ear – air filled
   - **Pinna** – funnels sound vibrations into the auditory canal
   - **Auditory Canal** – carries sound waves to the eardrum. Contains wax to trap foreign particles

2. Middle Ear – Air filled

- **Tympanic Membrane/Eardrum** – vibrates and passes sound waves to the ossicles
- **Ossicles** – 3 tiny bones that amplify sound waves. These amplified sound waves are then passed onto the oval window membrane and then onto the round window membrane
  - Malleus/Hammer
  - Incus/Anvil
  - Stapes/Stirrup
- **Eustachian Tube** – equalizes air pressure between the internal and external ear. Has no function in hearing!!

3. Inner Ear – contains fluid filled structures

- Vestibule – connected to the oval window at the base of the semicircular canals. Function is balance and head position (static equilibrium)
- **Semicircular Canals** – attached to the vestibule. Function is balance and body position (dynamic equilibrium)
- **Cochlea** – contains specialized hair cells that convert amplified sound wave vibrations into electrochemical nerve impulses

Cochlea

- Contains the **Organ of Corti** (actual hearing apparatus) that is composed of hair cells attached to a basilar membrane. When fluid moves due to amplified sound vibrations, hair cells bend due to the movement of the basilar membrane
- Cochlea is protected by loud noises in 2 ways:
  - Muscles connected to the malleus contract and thus restricts its movement as it passes vibrations on
  - Muscles of the ossicles contract so the stapes is pulled away from the oval window

Cochlea Cont'd

- Cochlea detects different pitches when different parts of the cochlea are stimulated
- STS - Two types of hearing loss:
  - Nerve Deafness – damage to hair cells
  - Conduction Deafness – damage to the sound conduction system of the outer/middle ear
- Cochlea → Auditory Nerve → Temporal Lobe

Ear Structure

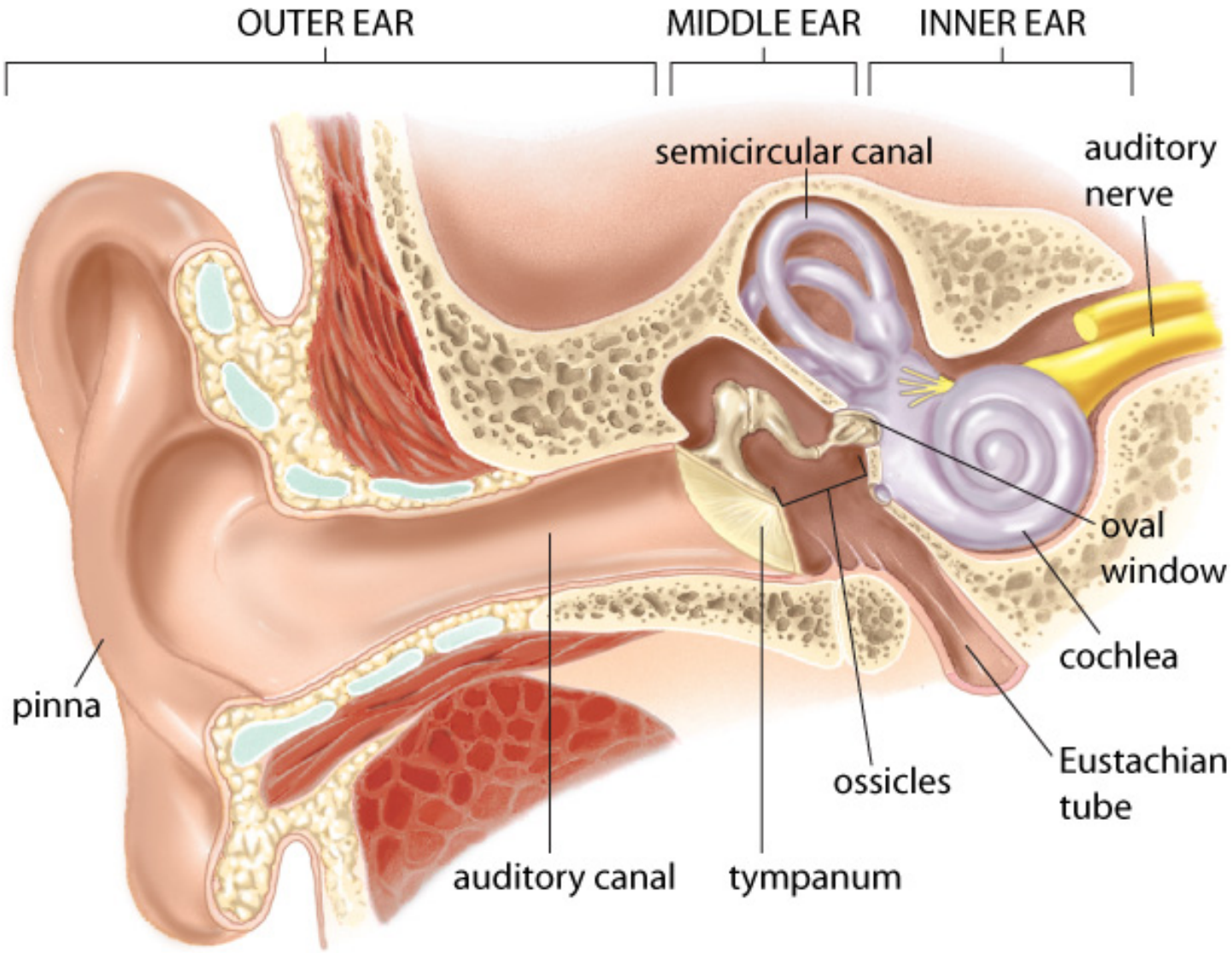


Figure 12.20 The anatomy of the human ear. How are sound waves that arrive at the outer ear amplified as their energy travels to the inner ear?

Cochlear Structure

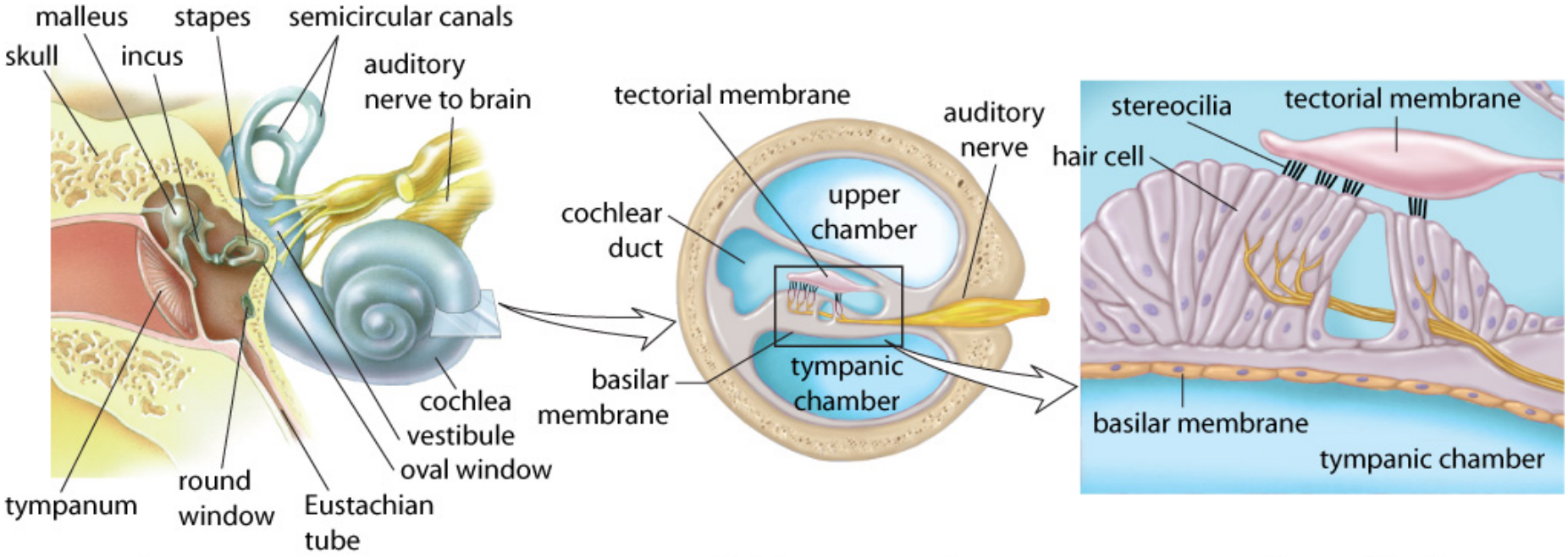


Figure 12.21 The structure of the cochlea. Notice how membranes separate its three fluid-filled chambers, the upper chamber, cochlear duct, and tympanic chamber. Since fluids cannot be compressed, the round window bulges out as pressure waves move through the inside of the cochlea.

Equilibrium

- Static/Gravitational Equilibrium (head position) – contains 2 fluid filled sacs that contain hair receptors. The sacs are the saccule and utricle. The sacs contain **otoliths** (tiny stones) so when we move our head, the stones move and bend hairs which stimulate sensory nerves to the brain

- Dynamic/Rotational Equilibrium (body position) – fluid filled **semi circular canals**. The movement of the fluid causes hair cells to move and therefore initiates nerve impulses to the brain. Motion sickness is the continuous movement of fluid.

Equilibrium

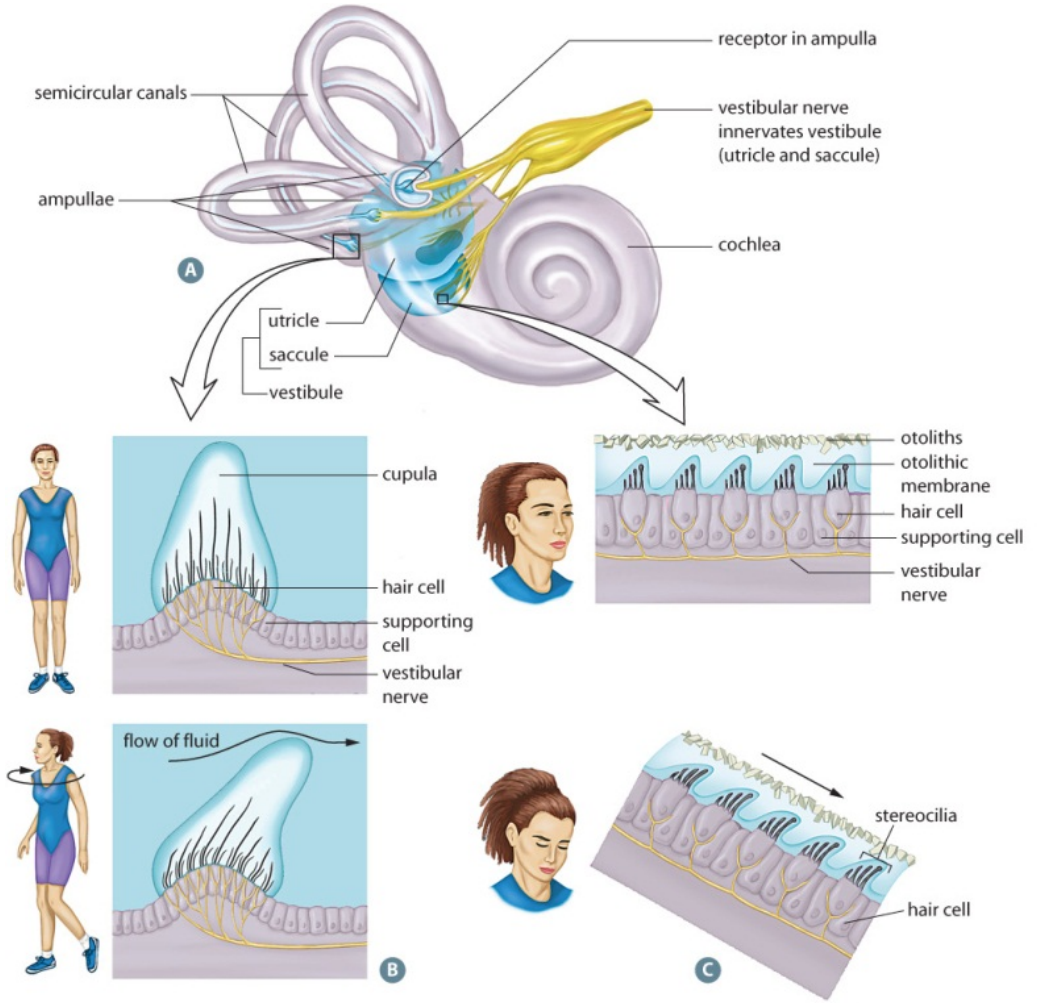


Figure 12.24 **(A)** The organs of balance: the semicircular canals, utricle, and saccule. Each semicircular canal ends in a bulge called an *ampulla*. **(B)** Rotational equilibrium. Rotating fluid bends the stereocilia in the cupula, and the hair cells send a message through the vestibular nerve to the brain. **(C)** Gravitational equilibrium. The hair cells of the utricle and saccule bend in response to head position.

Multiple Choice #28

Use the following information to answer the next question.

In a research study on the detection of odours, individuals were asked to smell gradually decreasing concentrations of specific familiar chemicals. Women of reproductive age were more able to detect weak odours than were men, children, and postmenopausal women. The researchers concluded that female sex hormones might increase sensitivity to familiar odours.

The **most likely** inference that can be made from this study is that, in comparison with men, children, and postmenopausal women, women of reproductive age have

A. more receptors for odour detection
B. a lower threshold level for familiar odours
C. the ability to interpret odours more quickly
D. the ability to adapt to familiar odours more quickly

Multiple Choice #29

Symptoms of vision loss in individuals with Refsum disease include cataracts and impaired night vision. Which of the following rows identifies the structure of the eye that is affected by cataracts and the cells that, when damaged, result in night vision loss?

Row	Cataracts	Night Vision Loss
A.	Retina	Rod cells
B.	Lens	Rod cells
C.	Lens	Cone cells
D.	Retina	Cone cells

Numerical Response #5

Use the following information to answer the next question.

Structures of Sensory Perception

1	Optic nerve
2	Proprioceptor
3	Photoreceptor
4	Occipital lobe
5	Temporal lobe
6	Auditory nerve

After light enters the eye, the structures of sensory perception listed above that are stimulated are _____, _____, and _____.

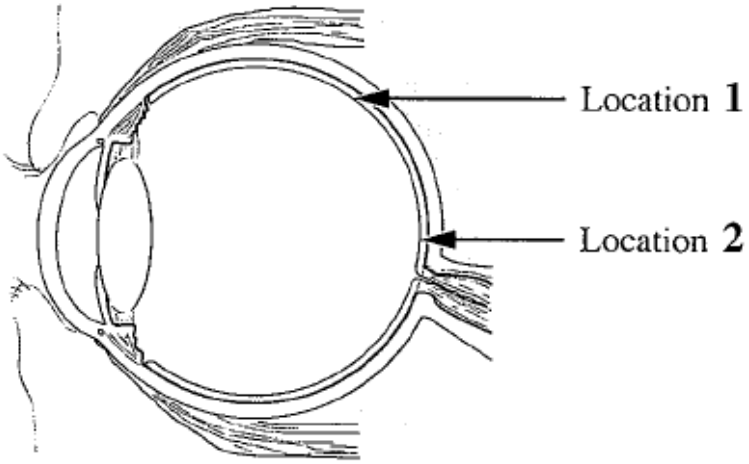
(Record all **three digits** of your answer **in lowest-to-highest numerical order** in the numerical-response section on the answer sheet.)

Multiple Choice #30

Use the following information to answer the next question.

Erectile dysfunction, which is defined as the inability to maintain an erection, can sometimes be treated with the drug sildenafil citrate. A side effect of sildenafil citrate is that it can result in temporary difficulties in distinguishing between the colours blue and green.

The Human Eye



The cells in the eye that are affected by sildenafil citrate and the primary location of these cells, as labelled above, are, respectively,

A. rod cells and location 1
B. rod cells and location 2
C. cone cells and location 1
D. cone cells and location 2

Numerical Response #6

Use the following information to answer the next question.

Researchers have linked the release of airbags in cars to impaired hearing. When an airbag is released, there is a rapid increase in air pressure, which can damage the inner ear.

Structures of the Human Ear

1 Ossicles
2 Cochlea
3 Auditory canal
4 Tympanic membrane

The sequence in which the highly compressed pressure waves created by the release of an airbag travel through the structures of the human ear is _____, _____, _____, and _____.

(Record all **four digits** of your answer in the numerical-response section on the answer sheet.)

Multiple Choice #31

Use the following information to answer the next three questions.

The Norwegian military has developed a Personal Active Radio/Audio Terminal (PARAT) earpiece that blocks unwanted noise while allowing other sound to come through clearly. The PARAT is contained in a sealed unit that physically blocks most sound while the tiny computer inside the unit analyzes which sounds it will filter through into the ear.

The structure of the ear that converts the vibrations transmitted by the PARAT into electrochemical impulses and the structure that carries these impulses to the brain are, respectively, the

A. cochlea and the optic nerve
B. cochlea and the auditory nerve
C. semicircular canals and the optic nerve
D. semicircular canals and the auditory nerve

Multiple Choice #32

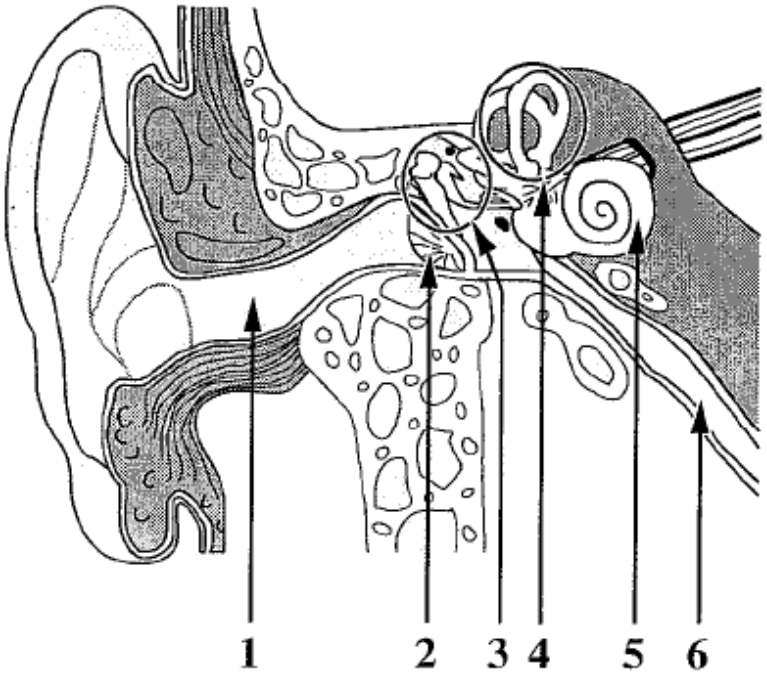
The sound transmitted to the ear by the PARAT earpiece is **first** analyzed by the brain in the

A. frontal lobe
B. parietal lobe
C. temporal lobe
D. occipital lobe

Numerical Response #7

Use the following additional information to answer the next question.

The Human Ear



In the diagram above, the four structures of the ear through which sound vibrations pass as they travel from the PARAT to the sensory nerve are _____, _____, _____, and _____.

(Record all **four digits** of your answer **in lowest-to-highest numerical order** in the numerical-response section on the answer sheet.)

Multiple Choice #33

In the human ear, sounds are translated into nerve impulses in the

A. ossicles
B. oval window
C. organ of Corti
D. semicircular canals

Numerical Response #8

Use the following information to answer the next question.

Using various mixtures of nutrients and other growth factors, scientists can encourage stem cells to differentiate into any type of cell. Neuroreceptor disorders could potentially be treated with cells produced from stem cells. Listed below are some cell types and some neuroreceptor disorders.

Some Cell Types

1 Rod cells
2 Cone cells
3 Olfactory cells
4 Taste receptor cells
5 Basilar membrane cells
6 Semi-circular canal hair cells

Neuroreceptor Disorders and Descriptions

Anosmia—the inability to detect odours as a result of injury to the nasal cavity
Colourblindness—a genetic disorder that results in the inability to detect certain colours of light
Neural Deafness—the inability to detect sound as a result of damage to sensory structures in the inner ear
Permanent vertigo—a severe balance disorder that usually results from physical trauma to the ear

Match four of the cell types numbered above with the disorder that the cell could treat, as given below.

Cell Type:	_____	_____	_____	_____
Neuroreceptor Disorder:	**Anosmia**	**Colourblindness**	**Neural deafness**	**Permanent vertigo**

(Record all **four digits** of your answer in the numerical-response section on the answer sheet.)

Unit A
Nervous and Endocrine Systems

- Questions?
- Comments?
- Ready to continue to Unit B (Reproduction and Development?)