Lesson 1
Regulation - Nervous System

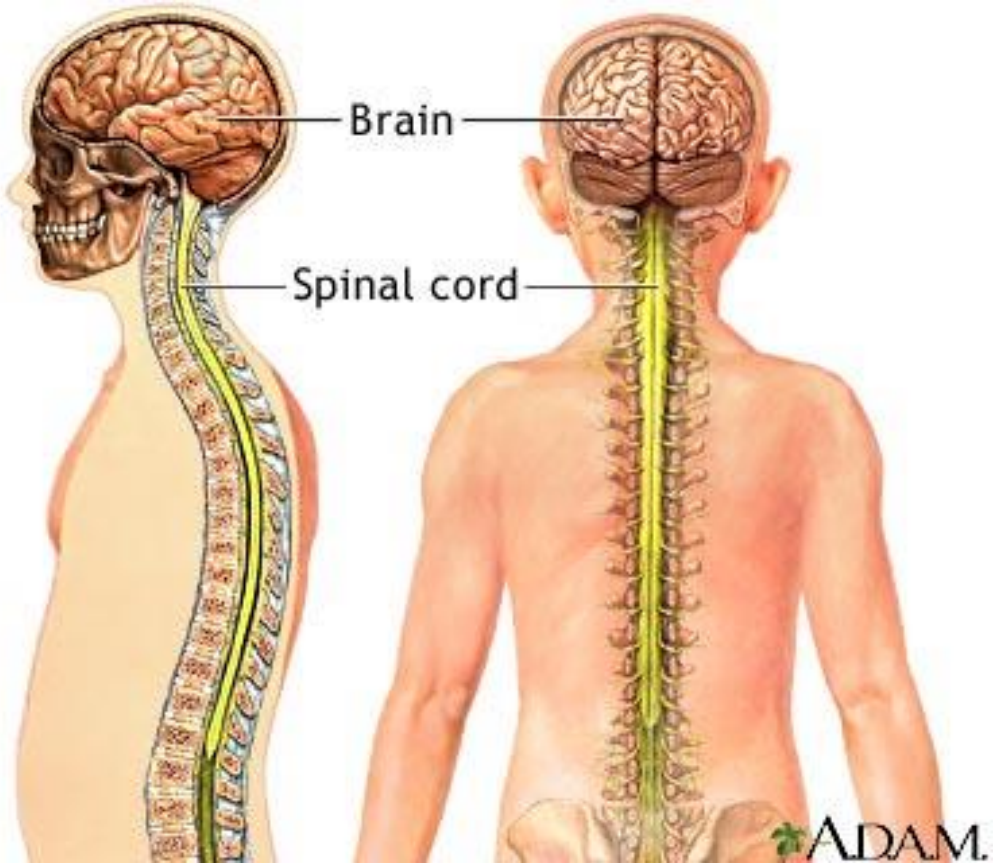
- Stimulus & response
- Main components

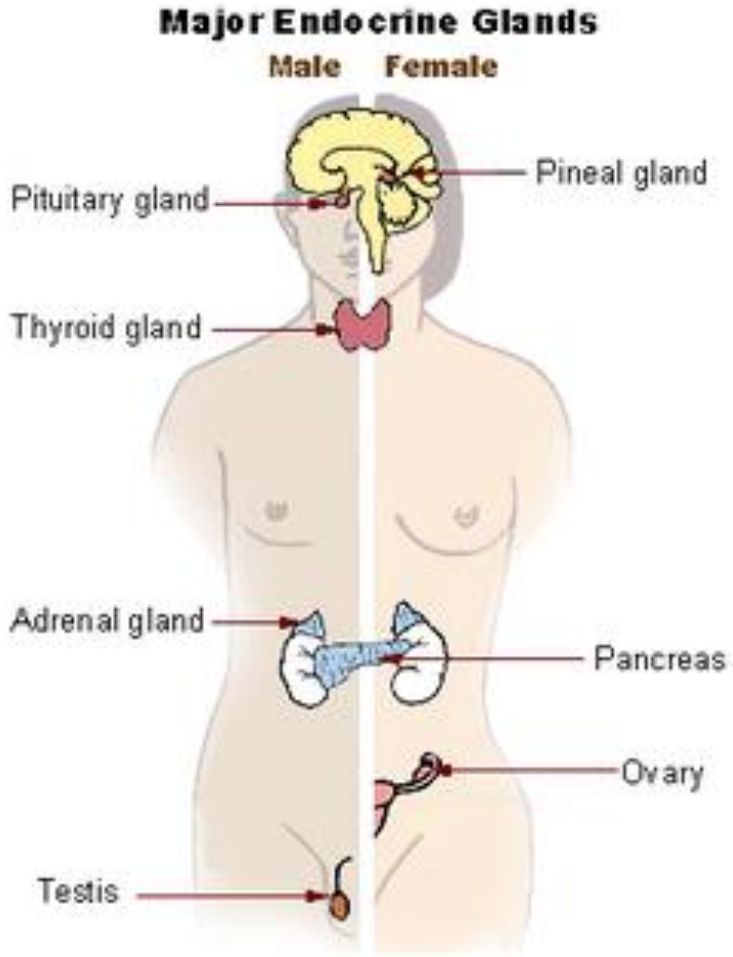
Meditation Exercise

REGULATION

in the human body is performed by the

Nervous and Endocrine Systems





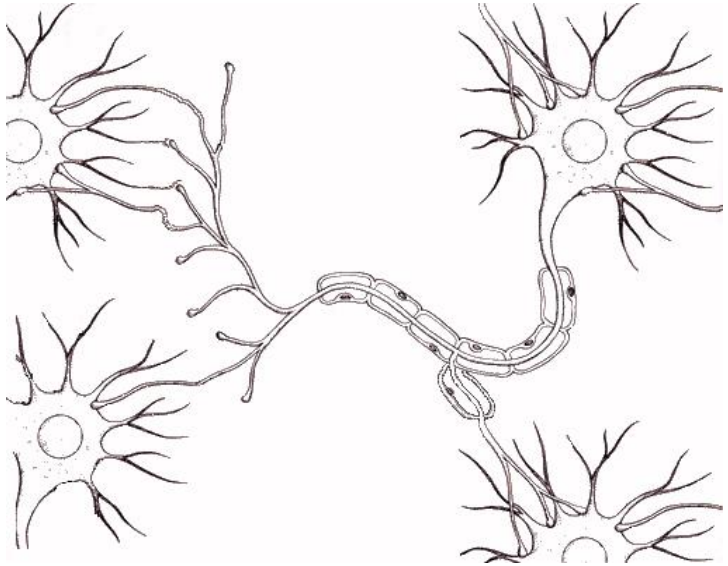
Write in your notebook…
“The Nervous System allows us to_____”

List 3 behaviors!

HOW???

The Nervous System

- controls and coordinates body functions
- responds to internal & external stimuli
- composed of the brain, spinal cord, & nerves



Functional Unit: NEURON

Brainpop - Nervous System

Stimulus and Response

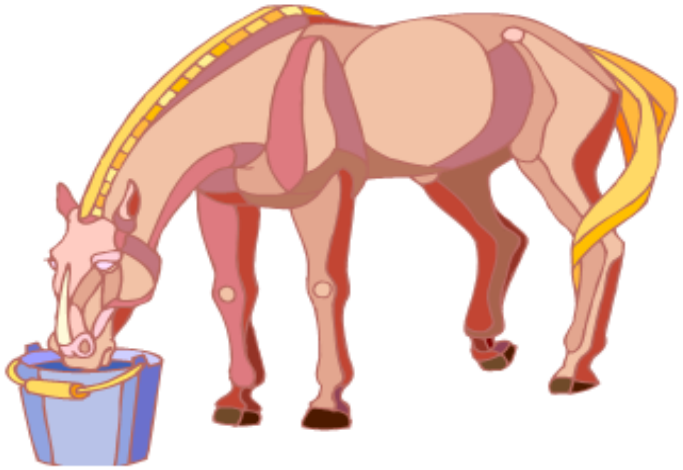
1)

Stimulus: _____

Response: _____

Stimulus: Internal or External

2)



Stimulus: _____

Response: _____

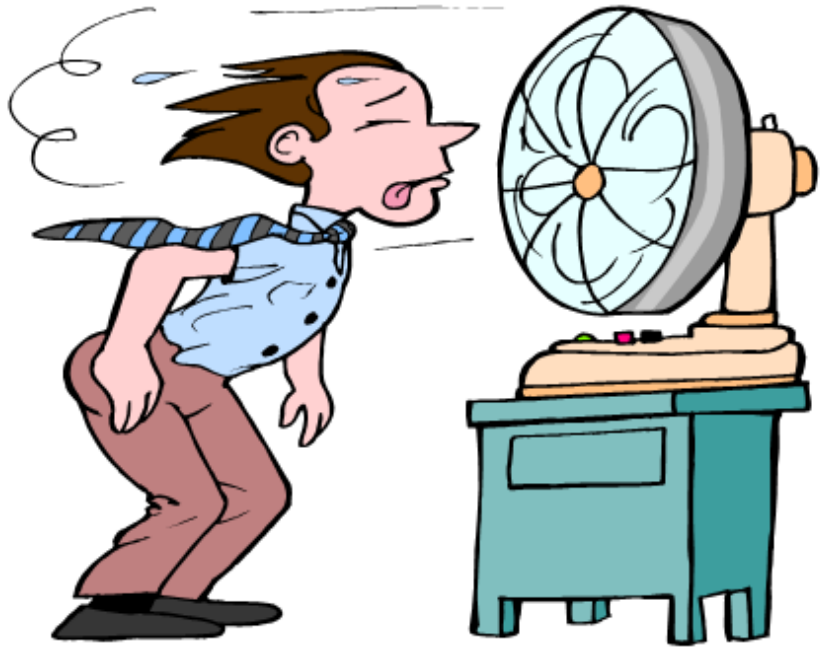
Stimulus: Internal or External

3) 

Stimulus: _____

Response: _____

Stimulus: Internal or External

4) 

Stimulus: _____

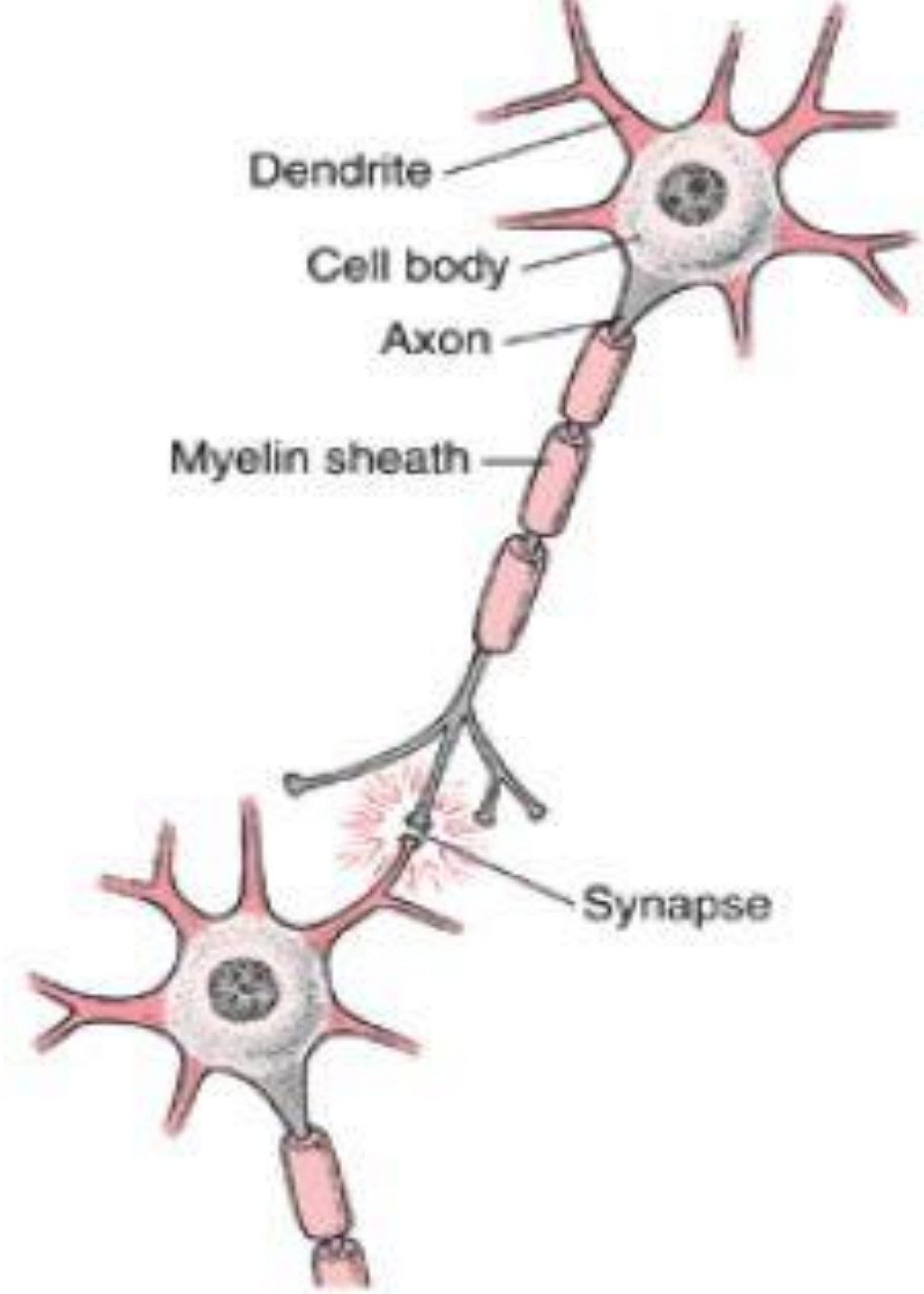
Response: _____

Stimulus: Internal or External

Lesson 2
Regulation - Nervous System

- Neuron Structure & Function

[Brainpop Neurons]



Definitions

- **Nervous System –** controls the body's activities (regulation)
- **Synapse** – gap between two neurons
- **Neurons** – nerve cells that carry an electrical impulse (many neurons = one nerve)
- **Neurotransmitters** – chemical messengers that carry an impulse across the synapse from one neuron to the next
  - Ex. acetylcholine – muscle & brain function
  - Ex. dopamine & seratonin – mood
- **Receptors** – receive chemical message from previous neuron and detect various stimuli in the sense organs

Parts of a Neuron

- Terminal Branches
- Nucleus
- Axon
- Dendrites
- Cell Body / cyton
- Myelin Sheath
- Nodes of Ranvier
- Schwann Cell

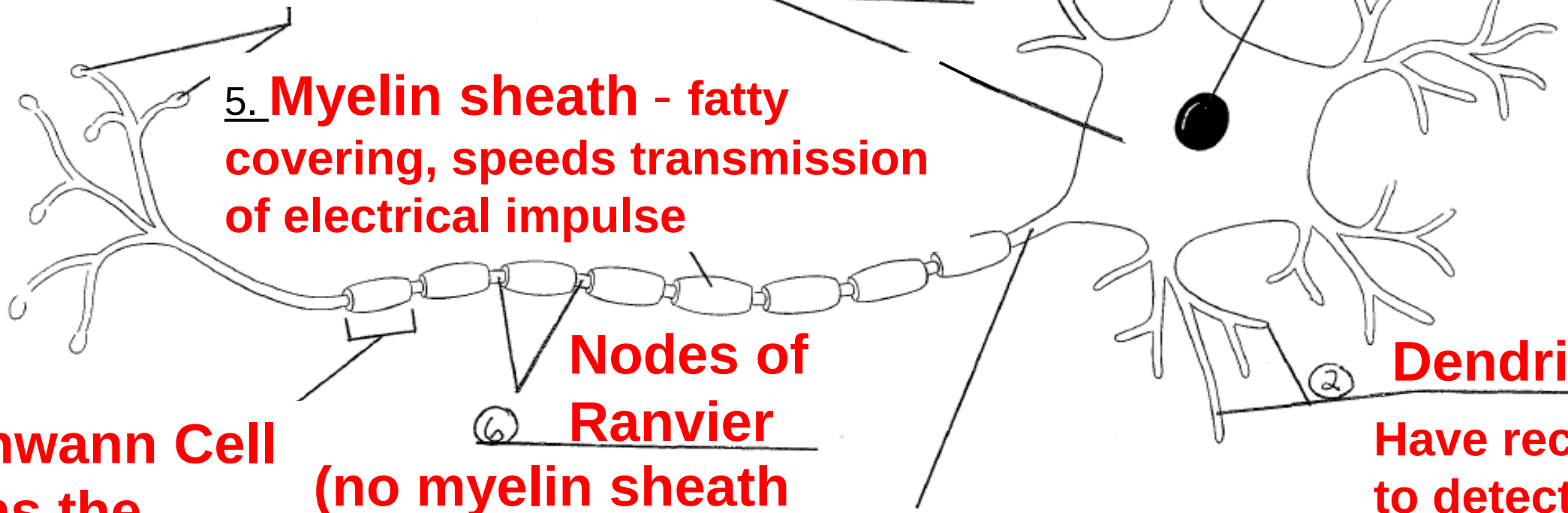
Parts of a Neuron

8. Axon Terminals OR Synaptic Bulbs/Knobs

Release chemical neurotrans-mitters into the synapse

Cell Body / cyton

1 Nucleus



5. **Myelin sheath - fatty covering, speeds transmission of electrical impulse**

Nodes of Ranvier

7. Schwann Cell (forms the Myelin Sheath)

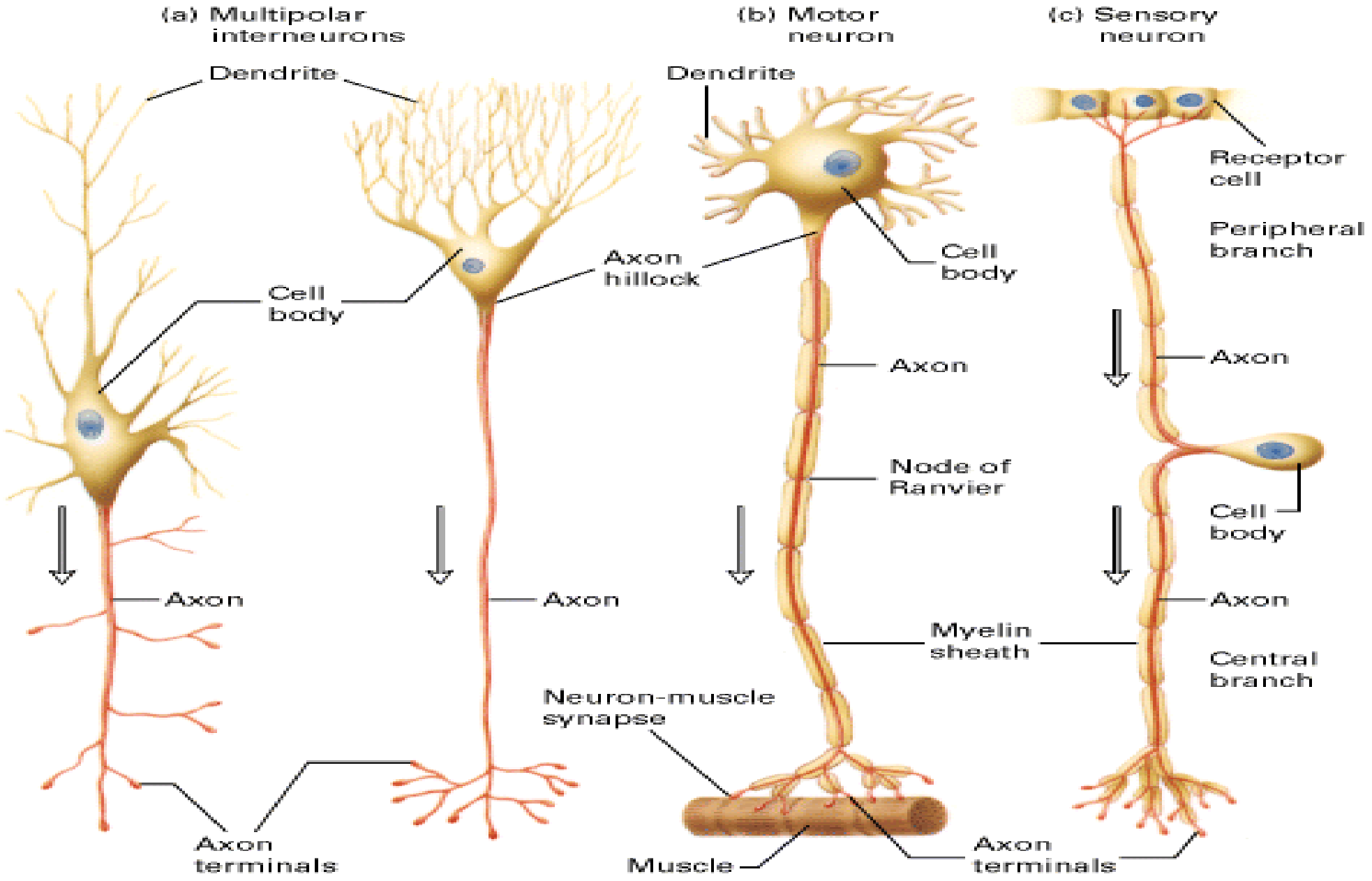
(no myelin sheath on this part of the axon)

4 Axon – transmits electrical impulse

2 Dendrites

Have receptors to detect chemical signals

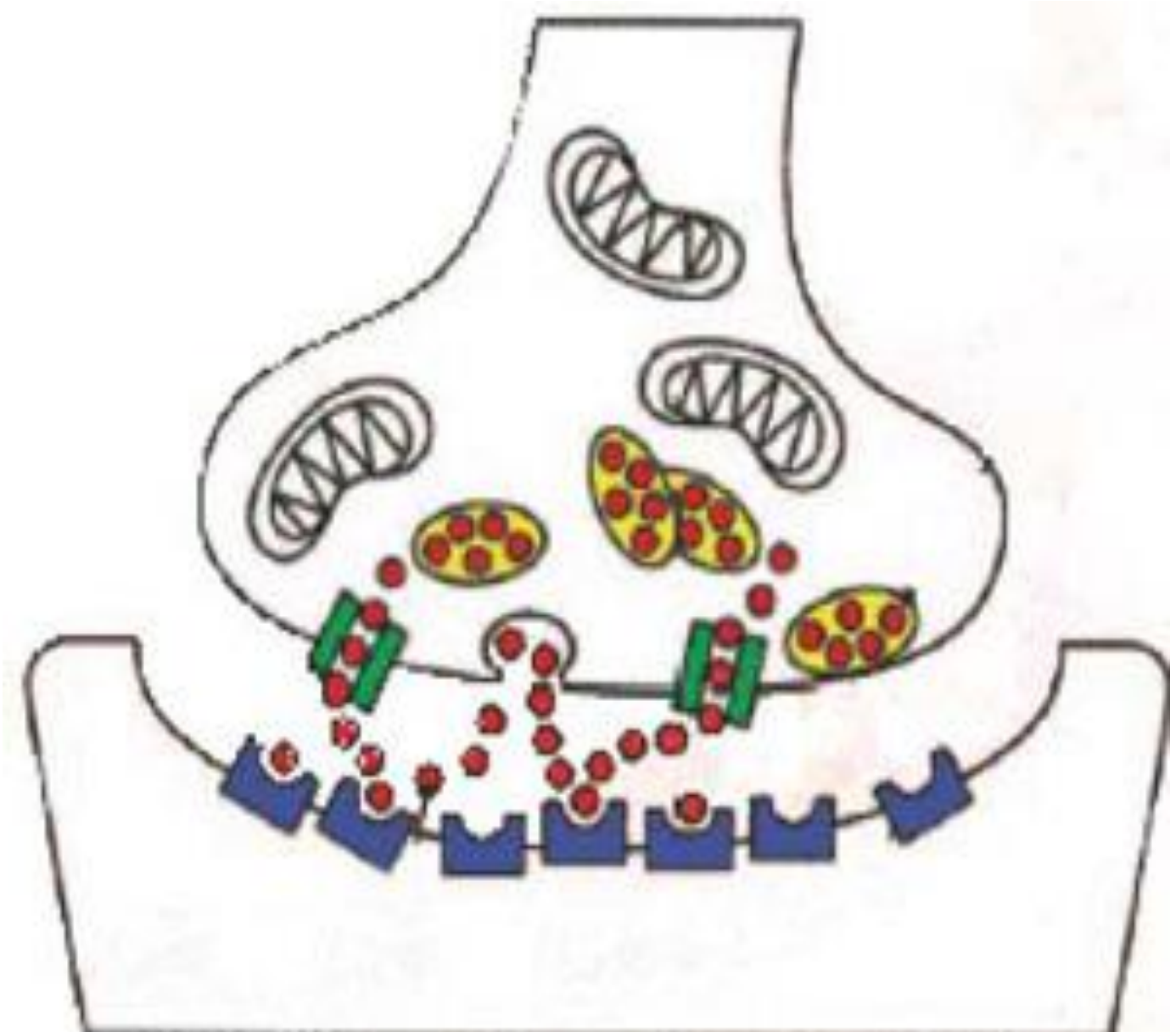
Different Types of Neurons



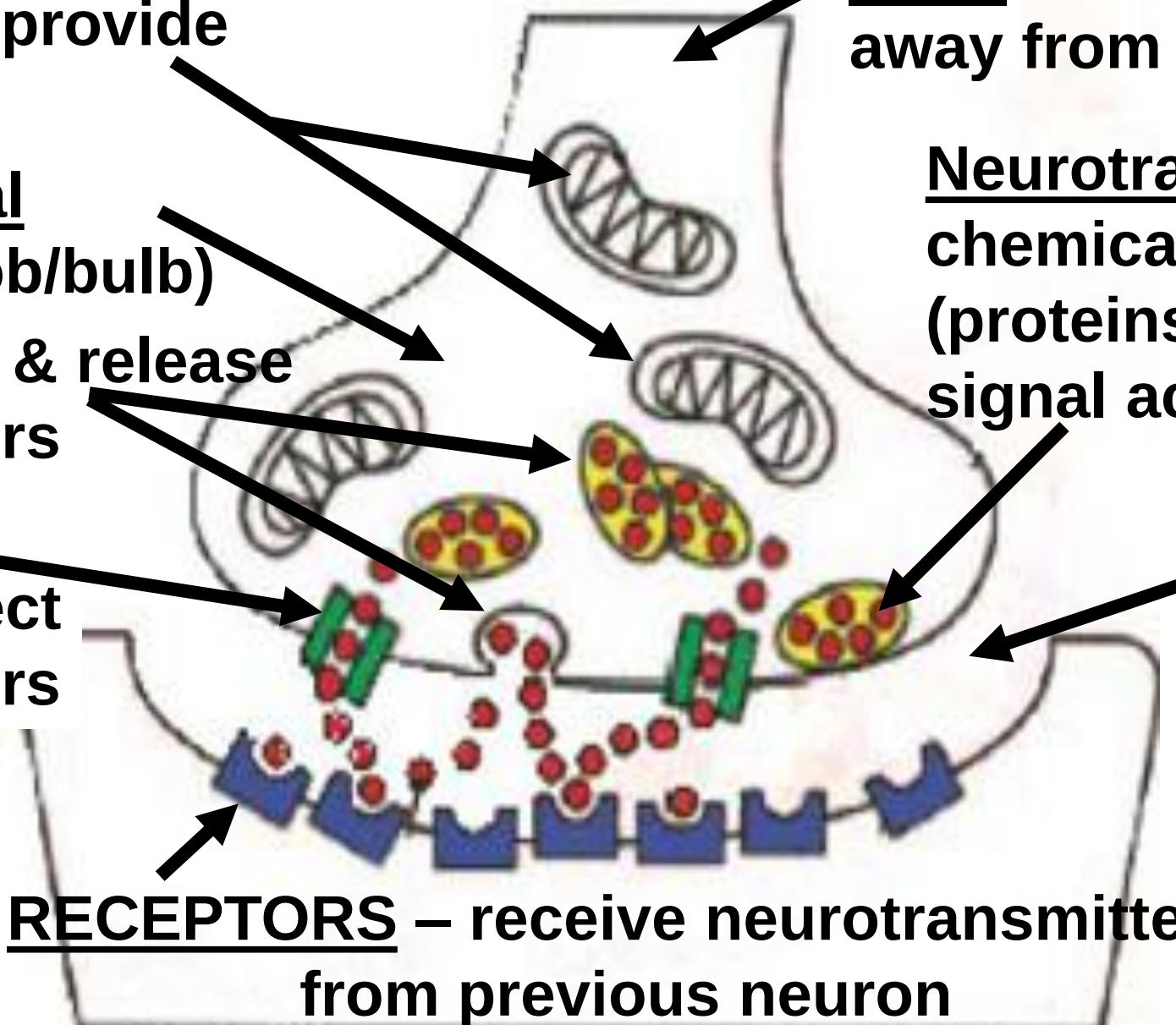
The Synapse – gap between neurons

Neurotransmission Video

How Prozac works (SSRI)



The Synapse – gap between neurons



Axon – conducts impulse away from cell body

Mitochondria – provide ATP for neuron

Axon Terminal (Synaptic knob/bulb)

Vesicles – store & release neurotransmitters

Reuptake Channels - collect neurotransmitters

Neurotransmitters – chemical messengers (proteins) that transmit signal across synapse

Synapse (synaptic cleft) -gap between neurons

RECEPTORS – receive neurotransmitters from previous neuron

The Nerve Impulse

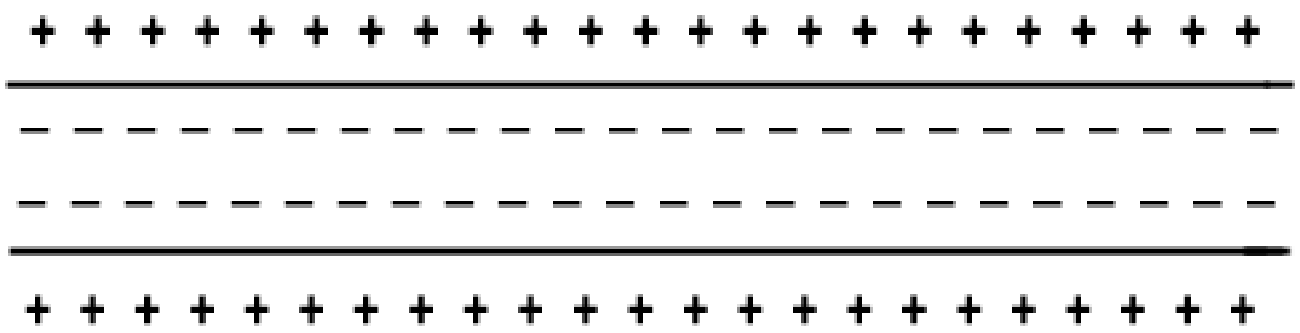
Sodium Potassium Pump (membrane protein channels that actively transport Na+ and K+ ions across the cell membrane)

1. Resting Potential / Polarized neuron (at rest)

- pumps force Na+ outside the cell and K+ inside the cell

Results:

- Outside of cell has net POSITIVE charge
- Inside of cell has net NEGATIVE charge



Section of an axon during the resting potential.

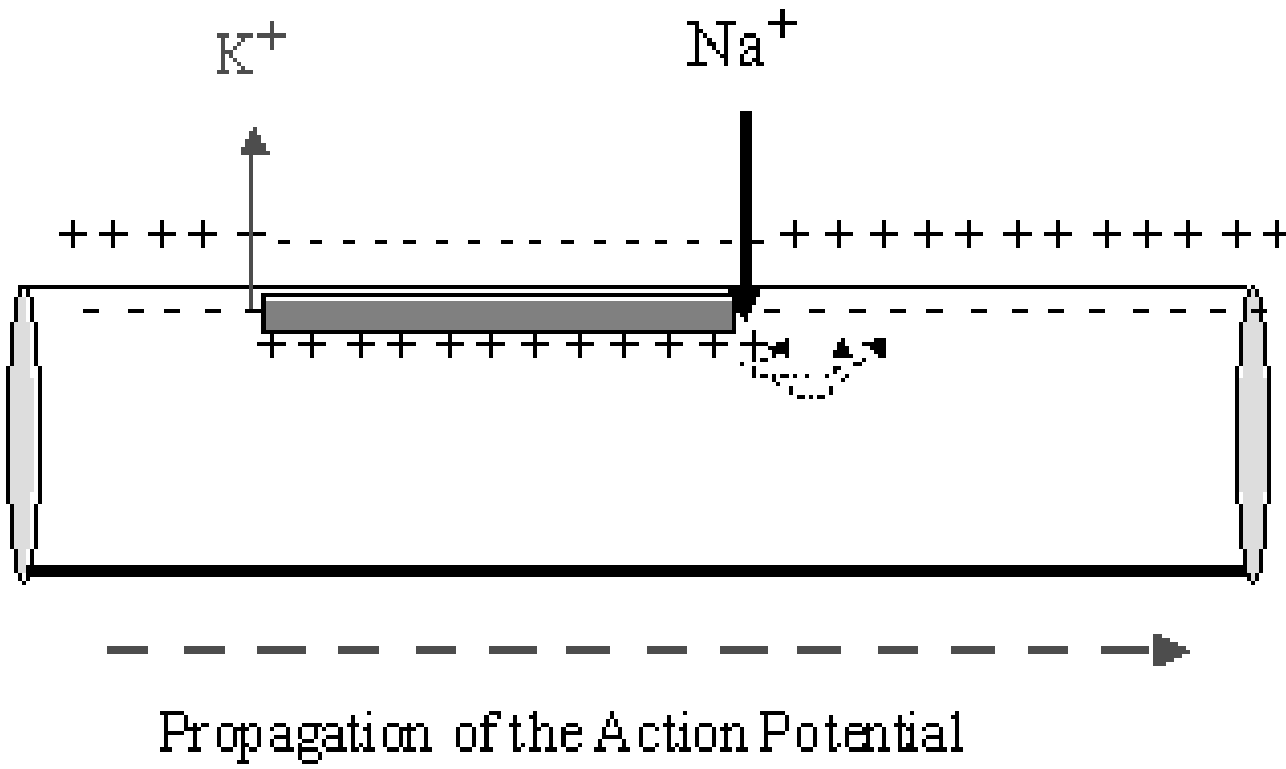
The Nerve Impulse (con't)

2. Action Potential / Depolarized neuron

- Na+ flood INTO the cell

Result:

- Outside of cell has net NEGATIVE charge
- Inside of cell has net POSITIVE charge
- Electrical impulse is transmitted (propagated) along the axon



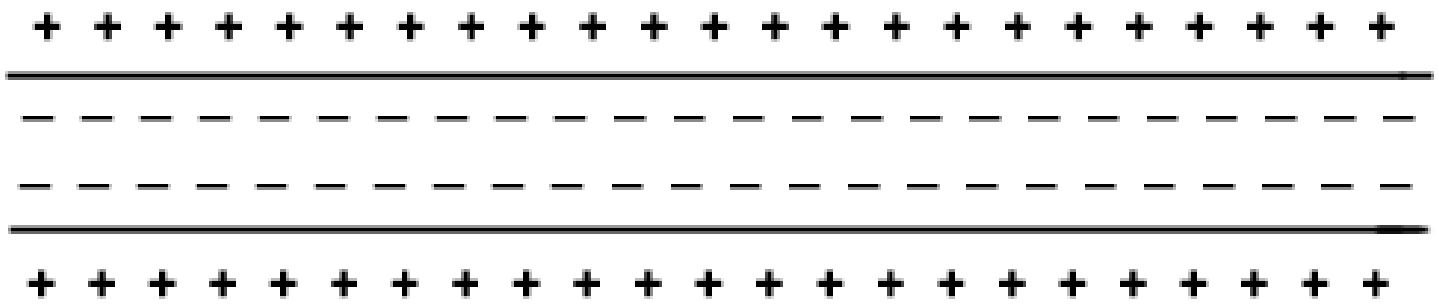
Neurotransmitter Animation

The Nerve Impulse (con't)

Action Potential Animation

3. Repolarization

- neuron returns to resting state
  - Sodium potassium pumps reestablish original concentrations of Na+ and K+ inside and outside the cell

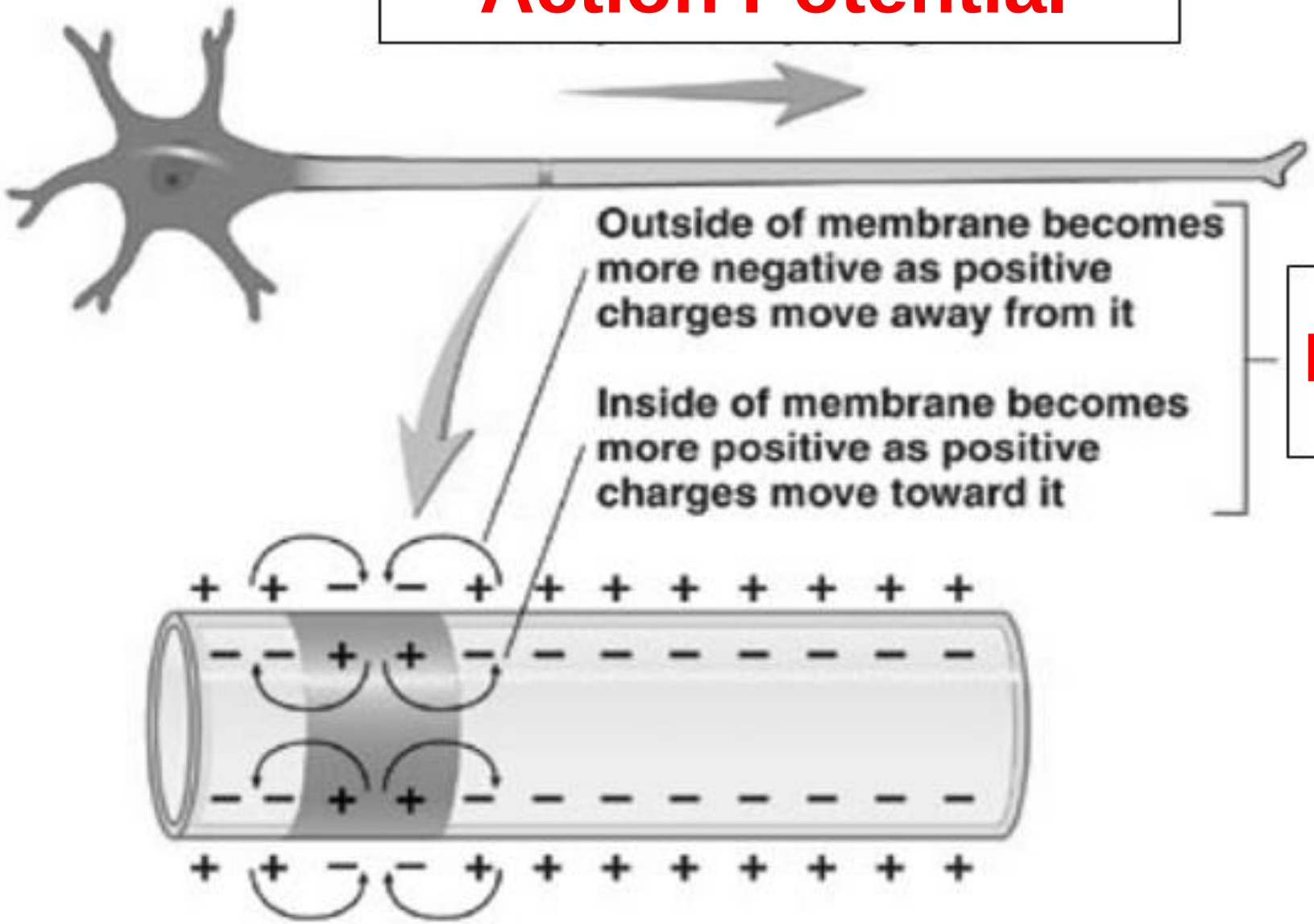


Section of an axon during the resting potential.

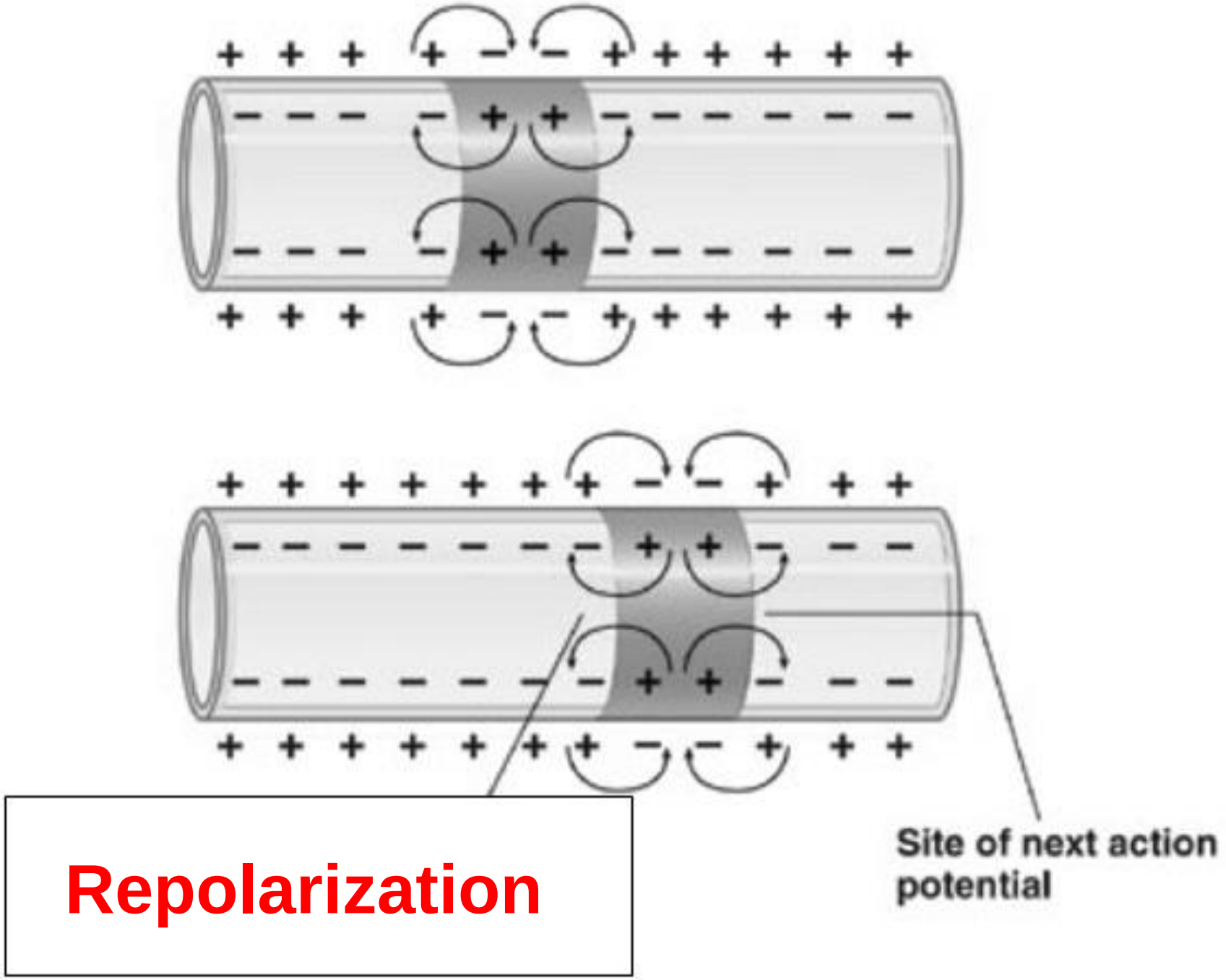
Threshold – minimum strength of stimulus needed for a neuron to fire and produce a response

Firing a Nerve Impulse

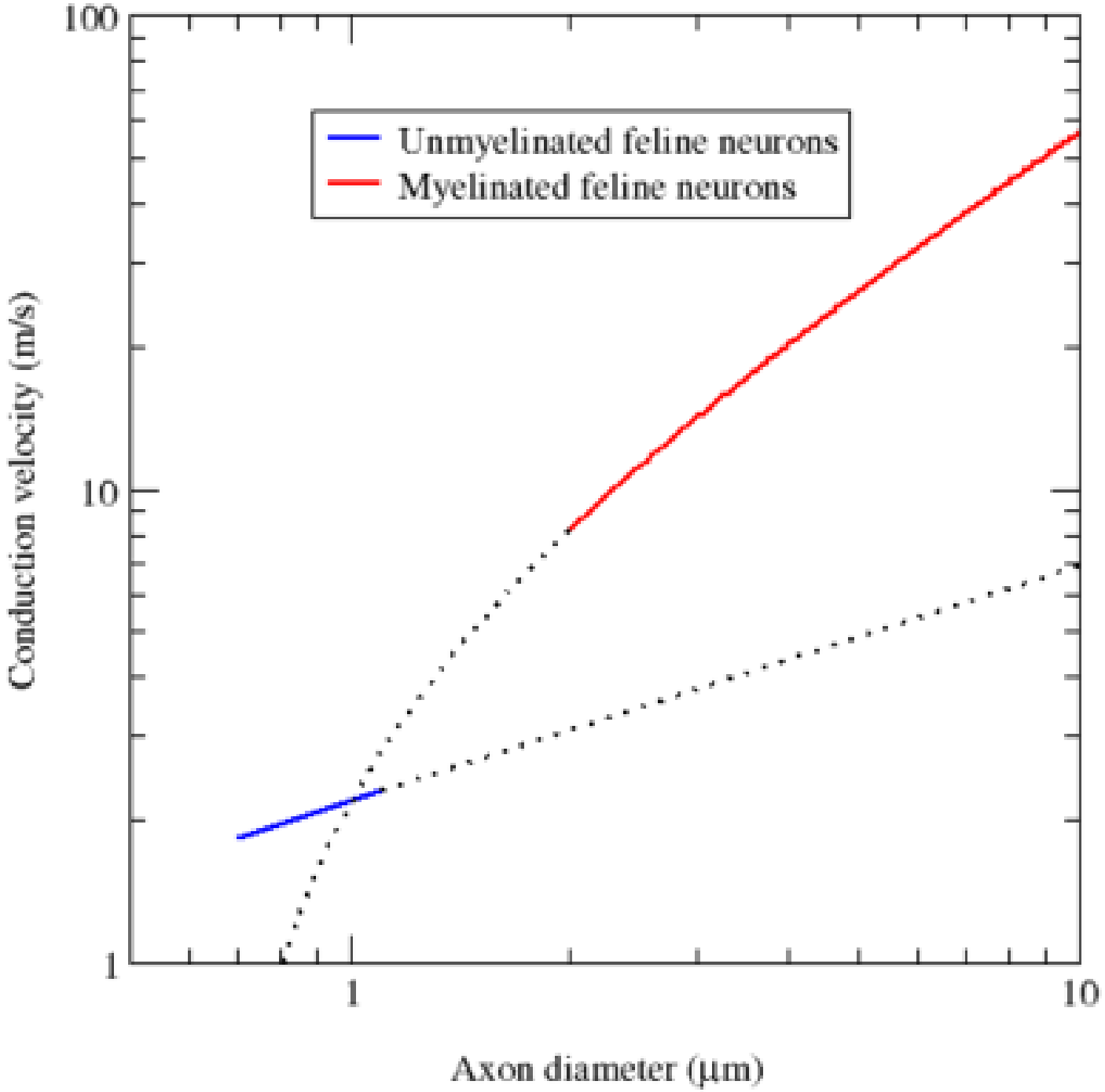
Action Potential



Depolarization



Repolarization



What can you think of that must be insulated in order to work properly?

Which substances are secreted at the endings of nerve cells?

1) antibodies
2) antigens
3) neurotransmitters
4) lipids

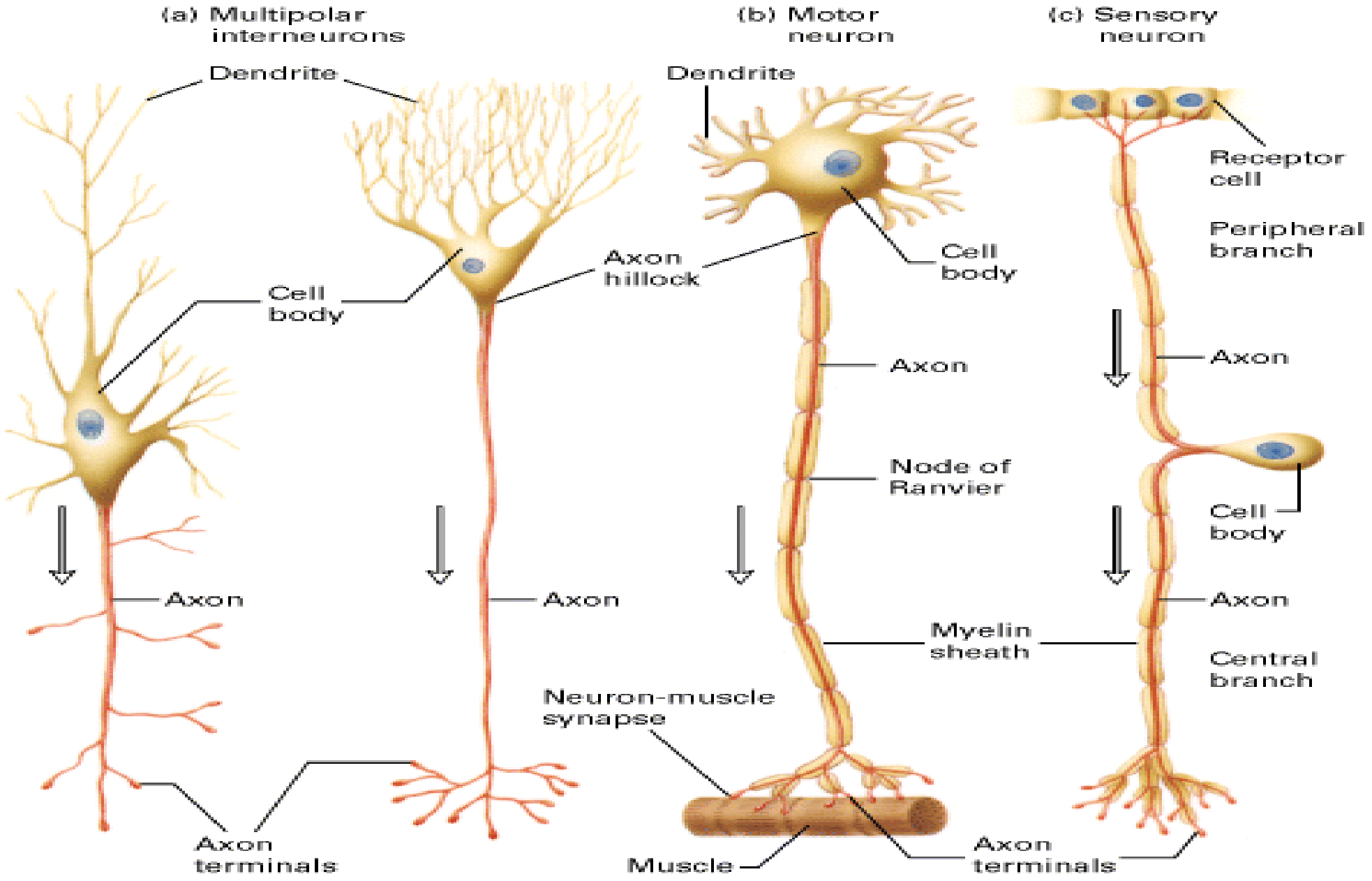
Lesson 3

Types of Neurons (Sensory, Inter, Motor)

Reflex Arc

Video: Reflexes & Reaction Time of NHL Goalie

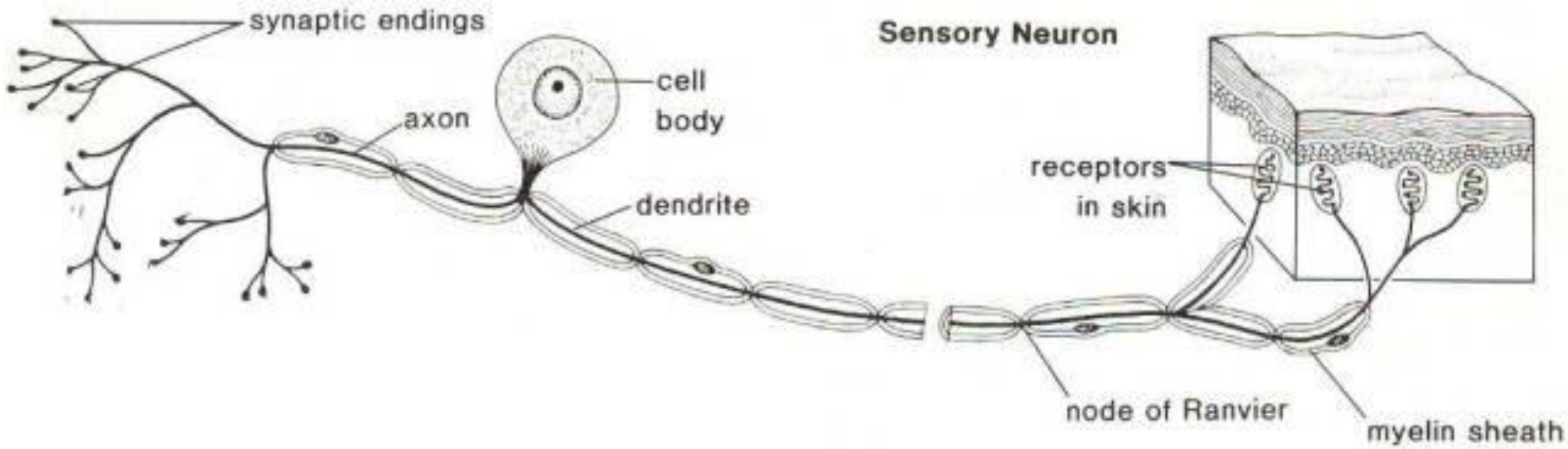
Different Types of Neurons



3 Types of Neurons

1 – **S**ensory neurons

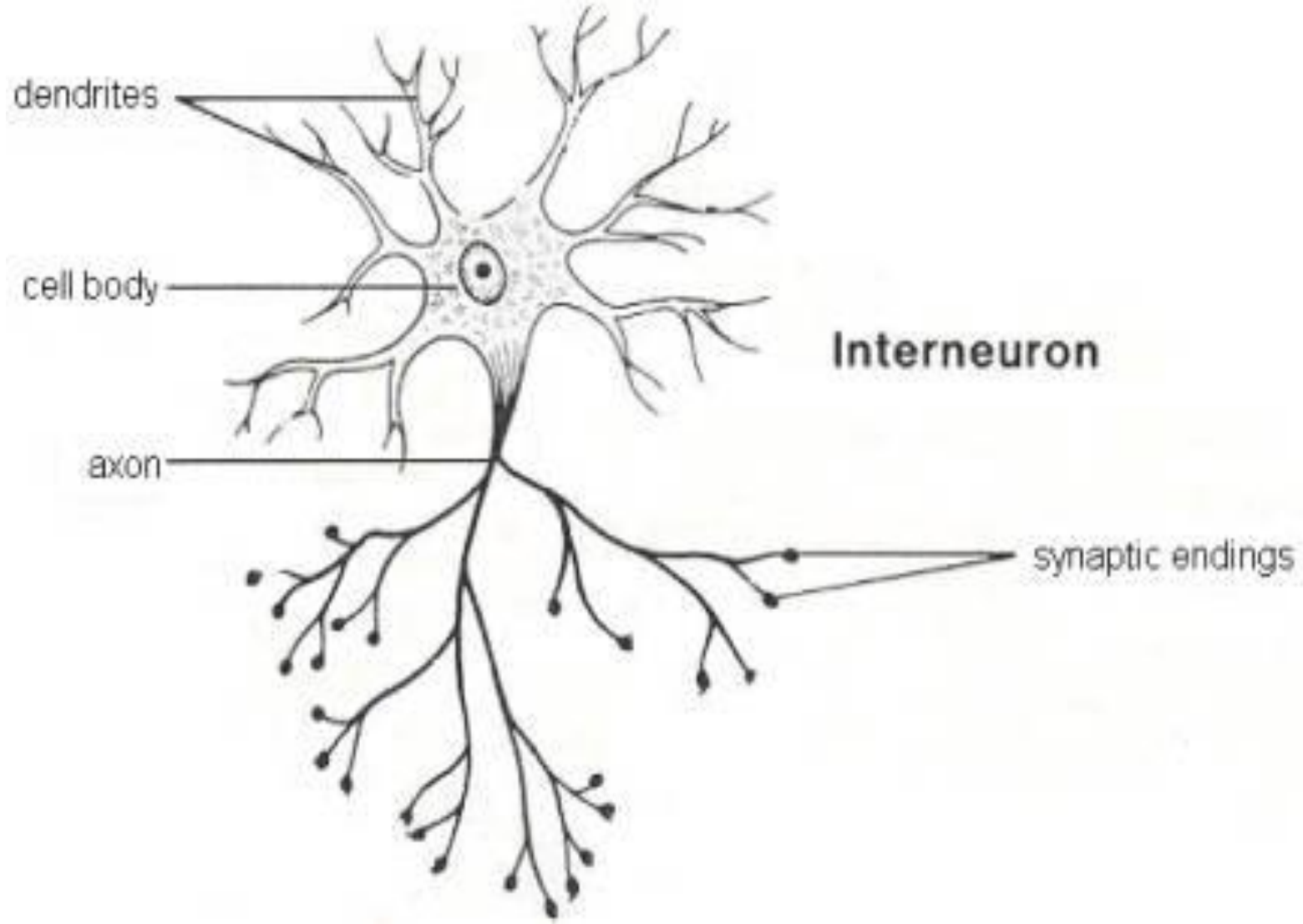
- found in 5 sense organs (eyes, ears, tongue, nose, skin)
- have receptors (nerve endings) to detect stimuli (no dendrites on cell body)
- transmit impulses from receptors in sense organs to the brain and/or spinal cord



3 Types of Neurons

2 – Interneurons

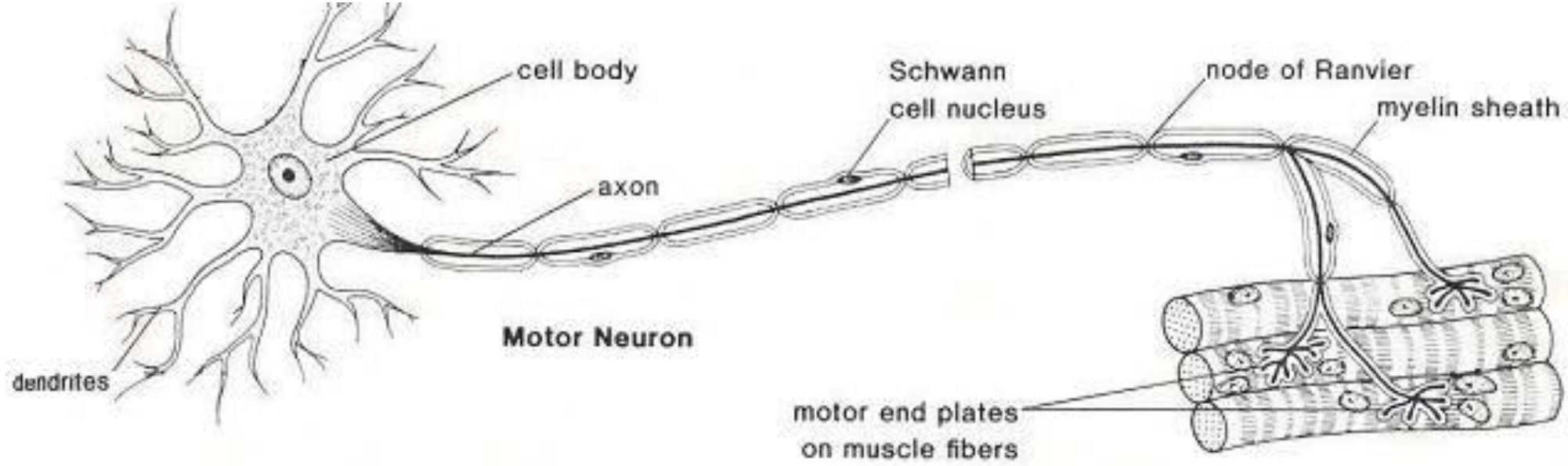
- found in the brain & spinal cord
- interpret and relay messages between sensory and motor neurons
- have short axons



3 Types of Neurons

3 – **M**otor neurons

- carry impulses from the brain & spinal cord to effectors (muscles & glands being acted on)
- cause the response
  - arm muscle pulls your hand away from a hot stove
  - gland releases a hormone to stimulate alertness



Pathway of a Nerve Impulse

S I M – order of neurons an impulse travels

Stimulus

Receptors (ex. In Ear)

Sensory Neuron

Interneuron(s)

Central Nervous System (brain & spinal cord)

Interneuron(s)

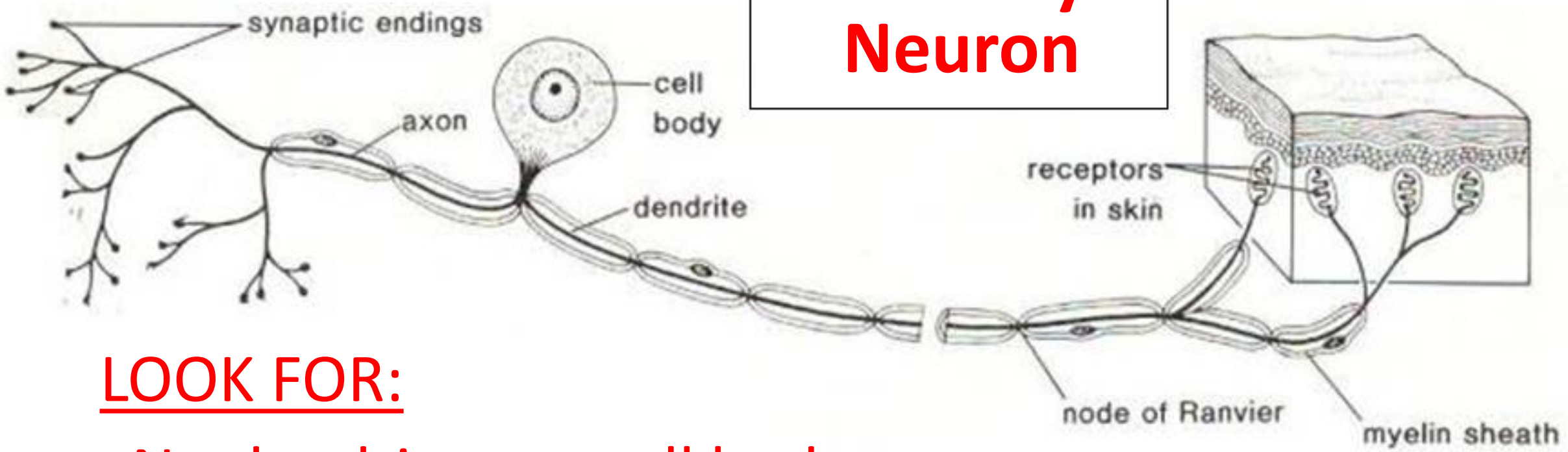
Motor Neuron

Effector (muscle or gland)

Response (turn your head)

3 Types of Neurons

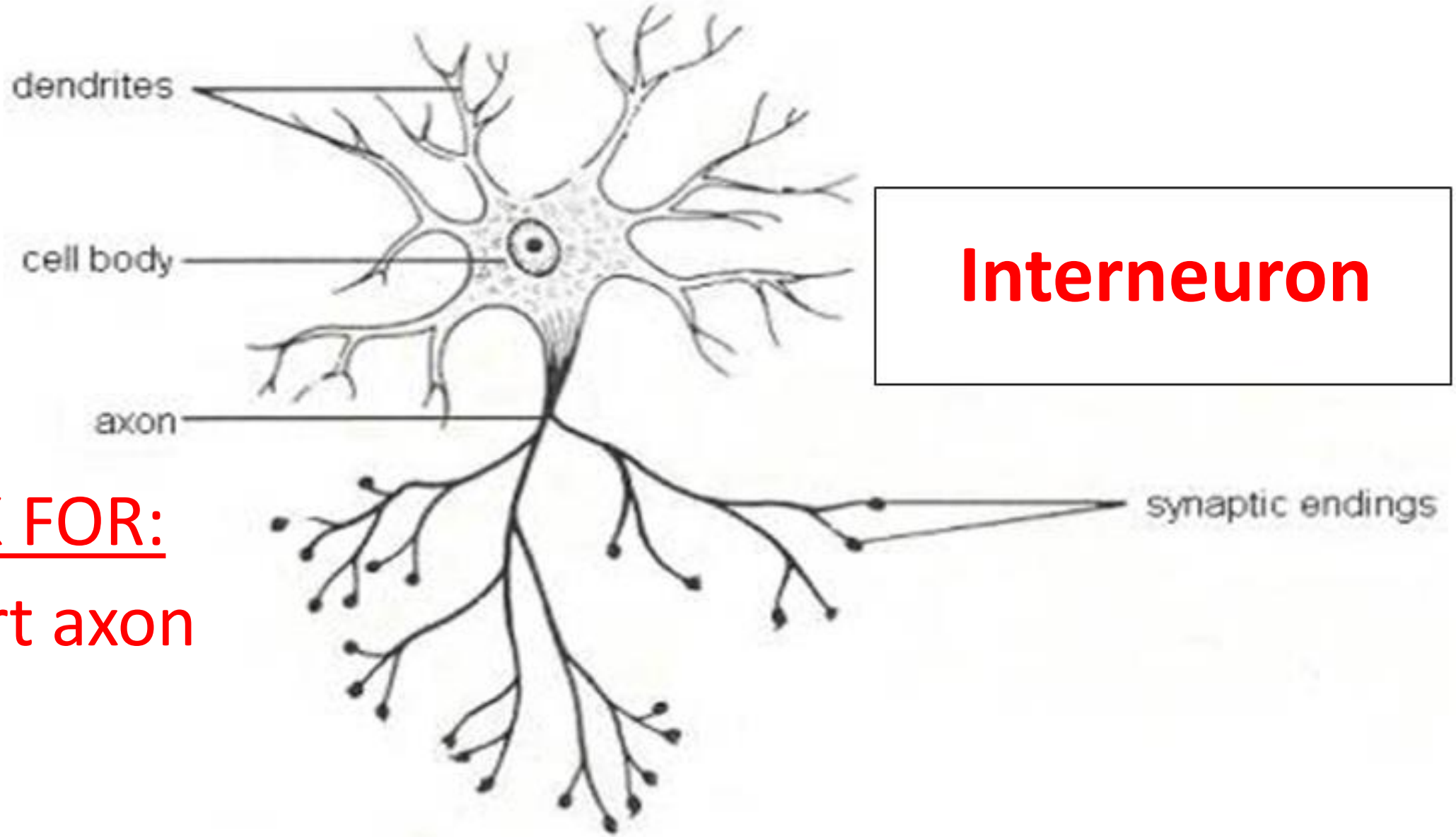
Sensory Neuron



LOOK FOR:

- No dendrites on cell body
- Receptors in sense organ

3 Types of Neurons (cont.)

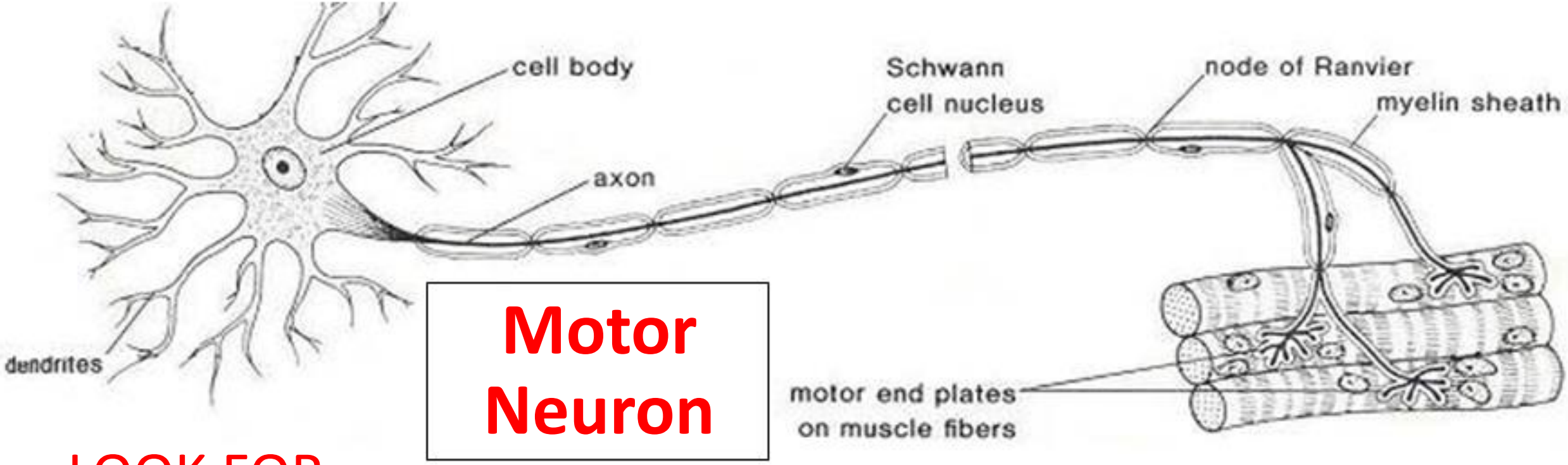


Interneuron

LOOK FOR:

- Short axon

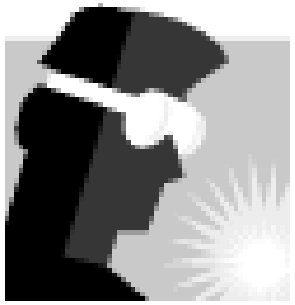
3 Types of Neurons (cont.)



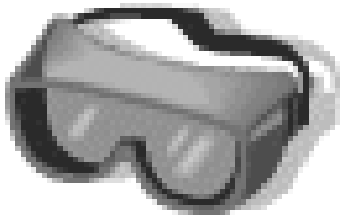
Motor Neuron

LOOK FOR:

- Dendrites on cell body
- Long axon
- Synapses w/ muscle fibers



To Blink or Not to Blink...
That is the Question!



Materials needed: partner, goggles, sponge

Directions:
Work with a partner. One person should put on the goggles. The other person will gently toss the sponge at the eyes of the partner who is wearing goggles (for safety). Count the number of times out of 10 trials that your partner blinks when having the sponge tossed at him or her. If time allows, switch roles. Record your data below, then answer the questions that follow.

Name: _____
# of times I blinked out of 10 tosses: _____

Partner's Name: _____
# of times my partner blinked out of 10 tosses: _____

Summary Questions:

1) What causes a person to blink during this activity?

a reflex action

2) Reflex actions are inborn. This means that they are VOLUNTARY or INVOLUNTARY (circle the correct choice).

involuntary

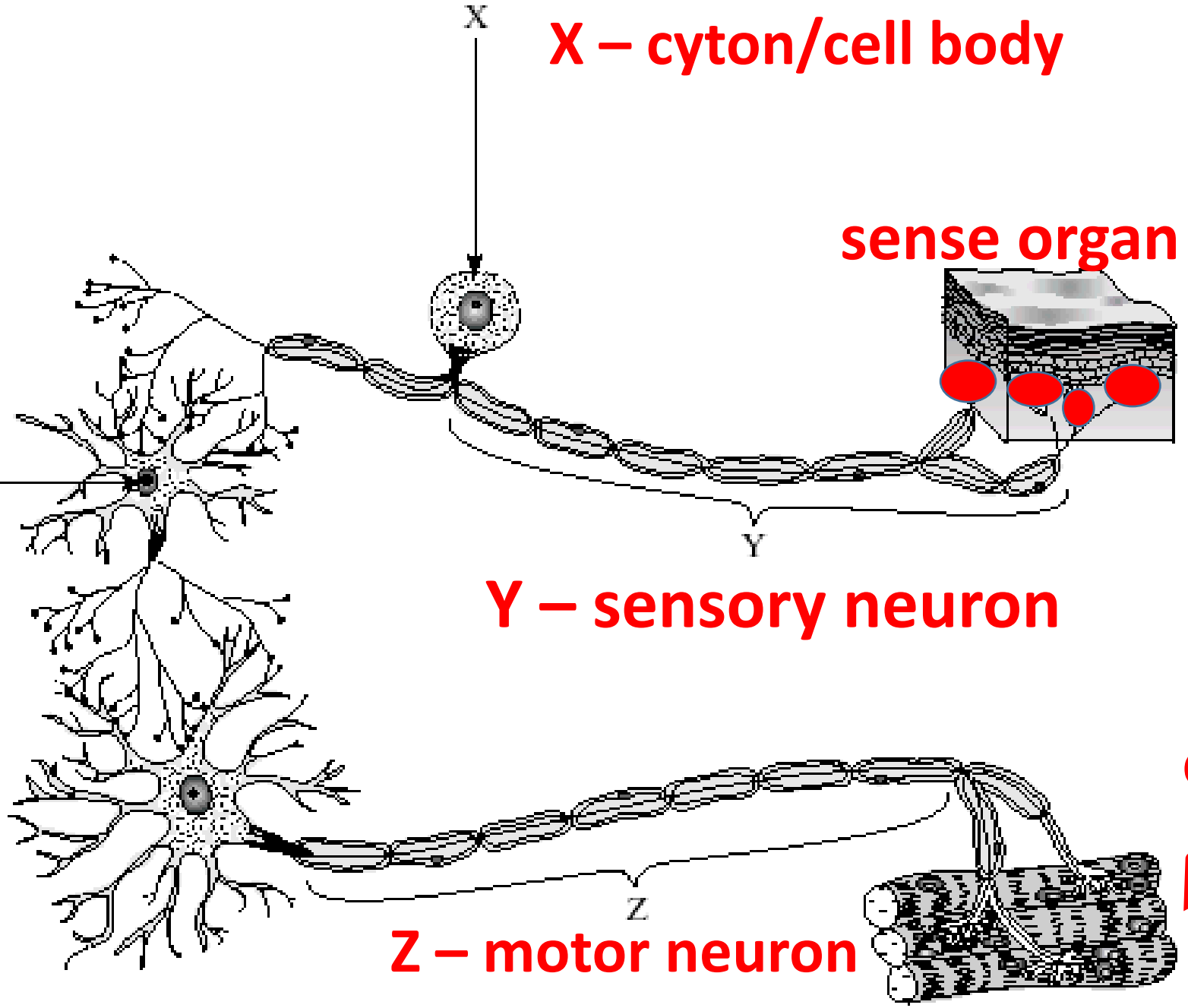
3) The pathway of 3 different types of neurons over which these uncontrollable impulses travel is called a **reflex arc**.

4) List the letters of the following components of a reflex action in the appropriate order in which they occur, from start to finish.

A - Effector
B - Interneurons
C - Motor neuron
D - Receptor
E - Response
F – Sensory neuron
G - Stimulus

1. **G** 2. **D** 3. **F** 4. **B** 5. **C** 6. **A** 7. **E**

Reflex Arc



X – cyton/cell body

sense organ = skin

receptors

W – inter-neuron

Y – sensory neuron

effector

Z – motor neuron

How are impulses sent throughout the body?

1) Normal Process

Impulses pass through the brain and spinal cord to produce a response

2) Reflex Process

Impulses pass through the spinal cord only, in order to produce a <u>FASTER</u> response

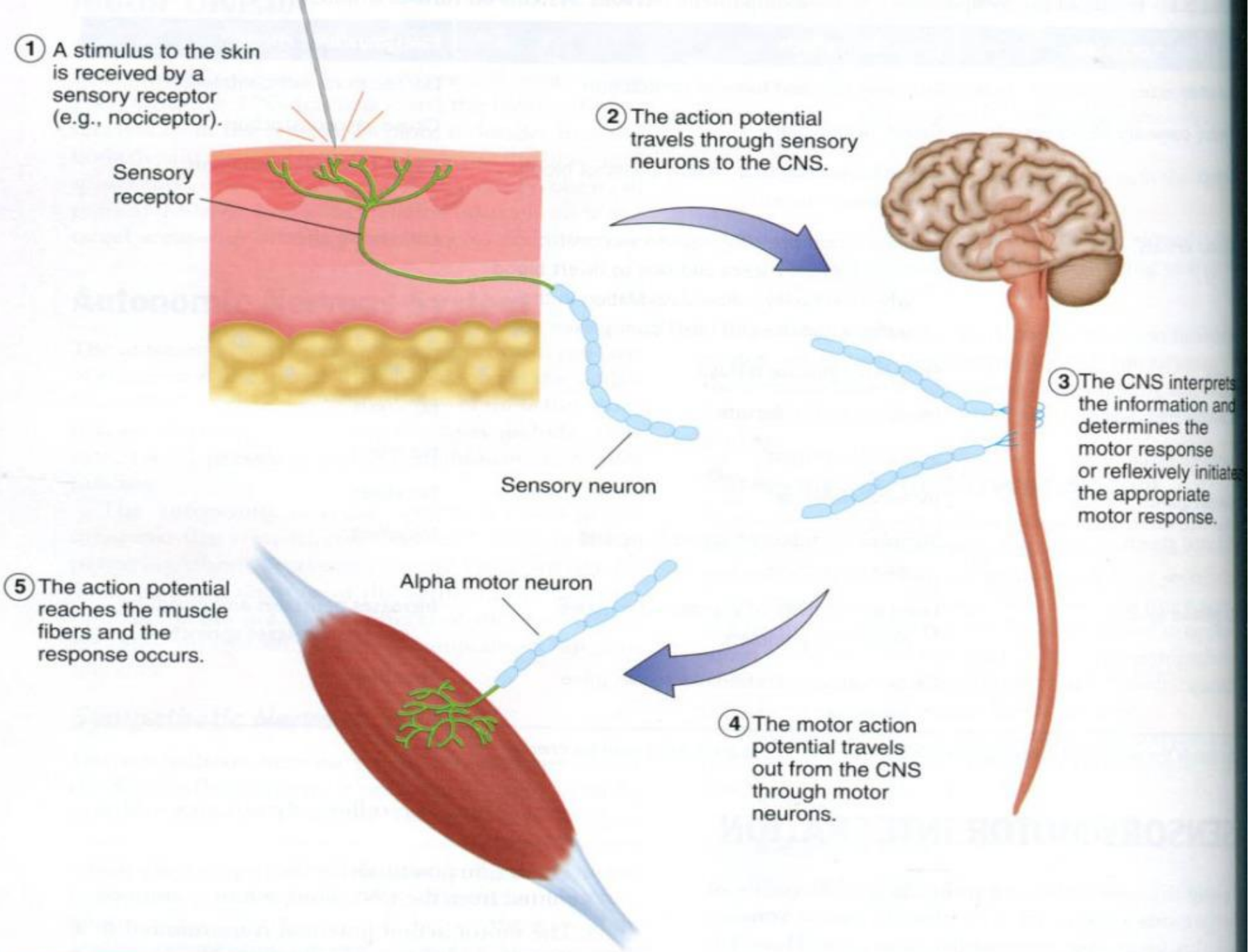


Figure 3.7 The sequence of events in sensory-motor integration.

- **Accommodation reflex** — coordinated changes in vergence, lens shape and pupil size when looking at a distant object after a near object.
- **Acoustic reflex** or **stapedius reflex** or **attenuation reflex** — contraction of the stapedius and tensor tympani muscles in the middle ear in response to high sound intensities.
- **Ankle jerk reflex** — jerking of the ankle when the Achilles tendon is hit with a tendon hammer while the foot is relaxed, stimulating the S1 reflex arc.
- **Arthrokinetic reflex** — muscular activation or inhibition in response to joint mobilization
- **Asymmetric tonic neck reflex** (ATNR) or **tonic neck reflex** — in infants up to four months of age, when the head is turned to the side, the arm on that side will straighten and the contralateral arm will bend.
- **Babinski reflex** — in infants up to one year of age, and also in older individuals with neurological damage, a spreading of the toes and extension of the big toe in response to stroking the side of the foot.
- **Baroreflex** or **baroreceptor reflex** — homeostatic countereffect to a sudden elevation or reduction in blood pressure detected by the baroreceptors in the aortic arch, carotid sinuses, etc.
- **Bezold-Jarisch reflex**
- **Biceps reflex** — a jerking of the forearm when the biceps brachii tendon is struck with a tendon hammer, stimulating the C5 and C6 reflex arcs.
- **Blushing** — a reddening of the face caused by embarrassment, shame, or modesty.
- **Brachioradialis reflex** — a jerking of the forearm when the brachioradialis tendon is hit with a tendon hammer while the arm is resting, stimulating the C5 and C6 reflex arcs.
- **Cervico-collic reflex**
- **Cervico-Spinal reflex**
- **Churchill cope reflex**
- **Corneal reflex** — blinking of both eyes when the cornea of either eye is touched.
- **Cough reflex** — a rapid expulsion of air from the lungs after sudden opening of the glottis, and usually following irritation of the trachea.
- **Cremasteric reflex** — elevation of the scrotum and testis elicited by stroking of the superior and medial part of the thigh.

Babinski Reflex - YouTube

Video - Patellar Reflex Instruction

Video - Pupillary Reflex

- **Crossed extensor reflex** — a contraction of a limb in response to sensation of pain in the contralateral limb.
- **Galant reflex** — in infants up to four months of age, a rotation of the upper body towards one or other side of the back when that side is stroked.
- **Glabellar reflex**
- **Golgi tendon reflex**
- **Knee jerk** or **patellar reflex** — a kick caused by striking the patellar tendon with a tendon hammer just below the patella, stimulating the L4 and L3 reflex arcs.
- **Mammalian diving reflex**
- **Moro reflex** — only in all infants/newborns up to 4 or 5 months of age: a sudden symmetric spreading of the arms, then unspreading and crying, caused by an unexpected loud noise or the sensation of being dropped. It is the only unlearned fear in humans.
- **Palmar grasp reflex** — in infants up to six months of age, a closing of the hand in response to an object being placed in it.
- **Photic sneeze reflex** — a sneeze caused by sudden exposure to bright light.
- **Plantar reflex** — in infants up to 1 year of age, a curling of the toes when something rubs the ball of the foot.
- **Pupillary accommodation reflex** — a reduction of pupil size in response to an object coming close to the eye.
- **Pupillary light reflex** — a reduction of pupil size in response to light.
- **Rooting reflex** — turning of an infant's head toward anything that strokes the cheek or mouth.
- **Shivering** — shaking of the body in response to early hypothermia in warm-blooded animals.
- **Sneeze** or **sternutation** — a convulsive expulsion of air from the lungs normally triggered by irritation of the nasal mucosa in the nose.
- **Startle reflex** — see Moro reflex above.
- **Sternutation** — see Sneeze above.
- **Suckling reflex** — sucking at anything that touches the roof of an infant's mouth.
- **Stretch reflex**
- **Triceps reflex** — jerking of the forearm when the triceps tendon is hit with a tendon hammer, stimulating the C7 and C6 reflex arcs.
- **Vagovagal reflex** — contraction of muscles in the gastrointestinal tract in response to distension of the tract following consumption of food and drink.
- **Vestibulo-collic reflex**
- **Vestibulo-spinal reflex**
- **Vestibulo-ocular reflex** — movement of the eyes to the right when the head is rotated to the left, and vice versa

Lesson 4

Central Nervous System

Brain

Spinal Cord

Reflex Actions

Why does a reflex only get transmitted to the spinal cord and not all the way to the brain?

A shorter path = a faster response! (Reflexes are protective!)

stimulus (triggers the impulse)

↓

receptors (detect stimuli in sense organs)

↓

sensory neuron

↓

inter neuron in spinal cord

↓

motor neuron

↓

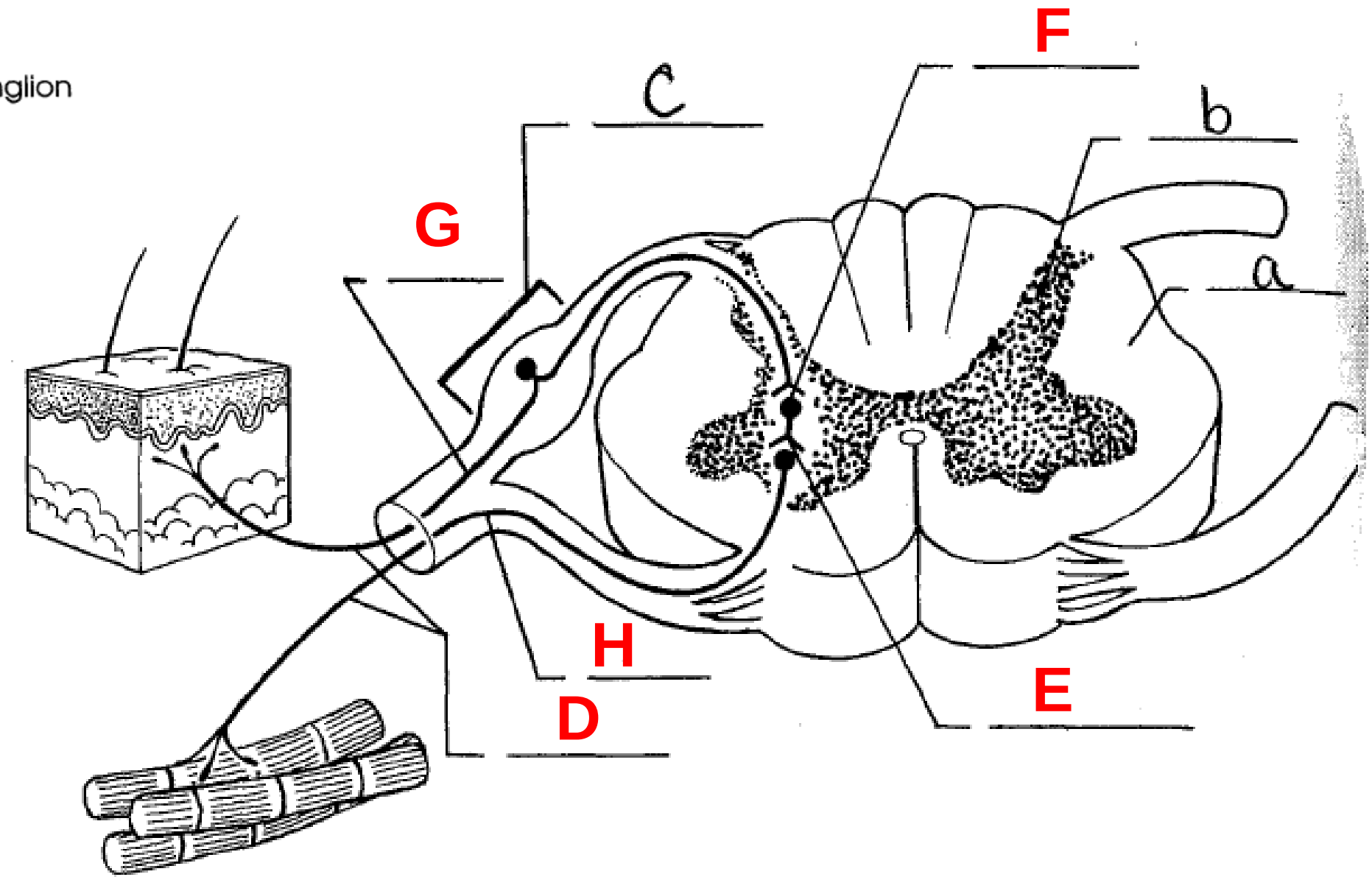
effector (muscle or gland)

↓

response (result)

Spinal Cord Cross Section

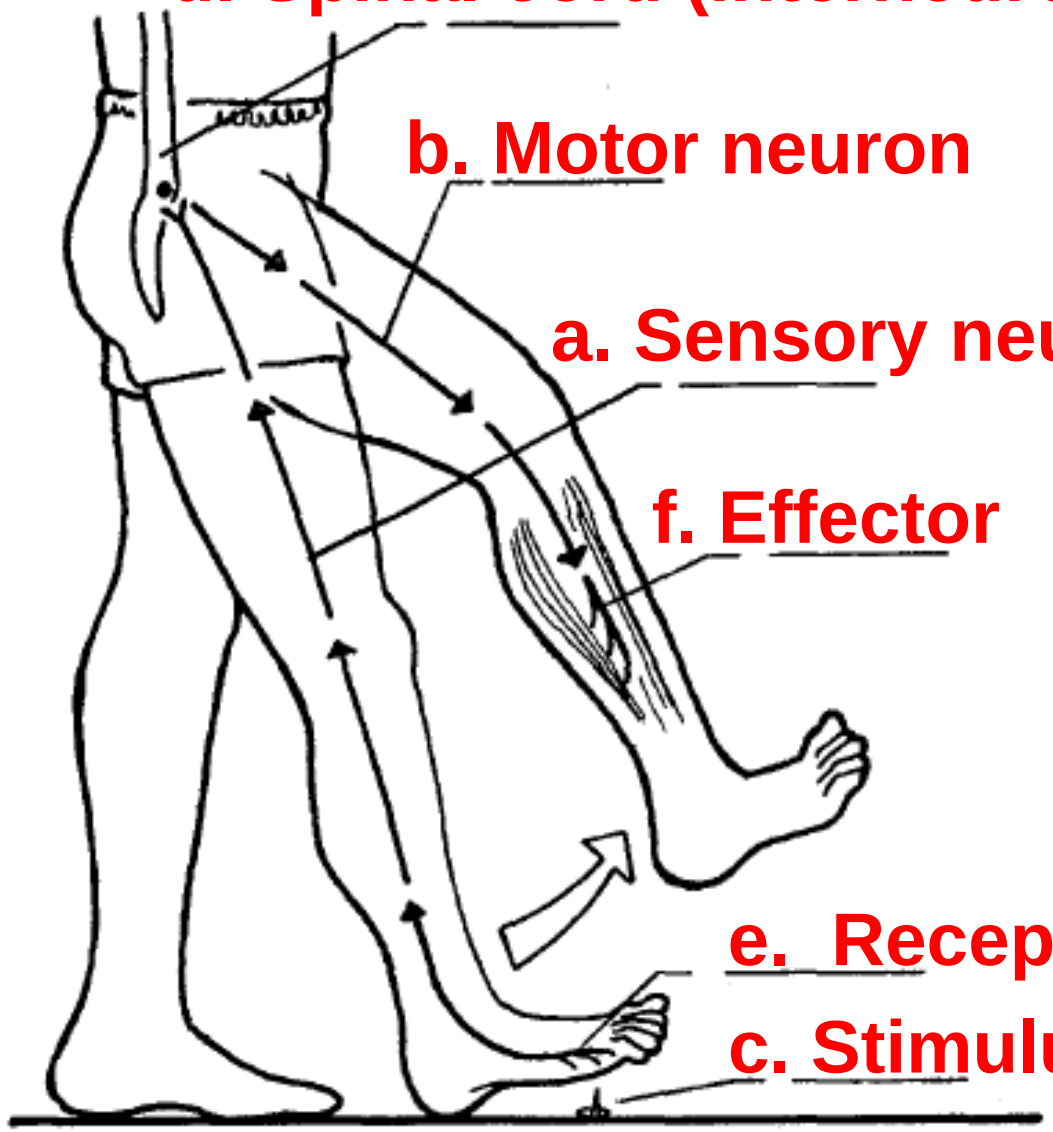
a. white matter
b. grey matter
c. dorsal root ganglion
d. nerve fibers
e. interneuron
f. synapse
g. sensory neuron
h. motor neuron



Reflex Act

Label the following parts of a reflex act on the diagram of a boy stepping on a tack and jerking his leg away.

a. sensory neuron
b. motor neuron
c. stimulus
d. spinal cord
e. receptor (in skin)
f. effector (muscle)



d. Spinal cord (interneurons)

b. Motor neuron

a. Sensory neuron

f. Effector

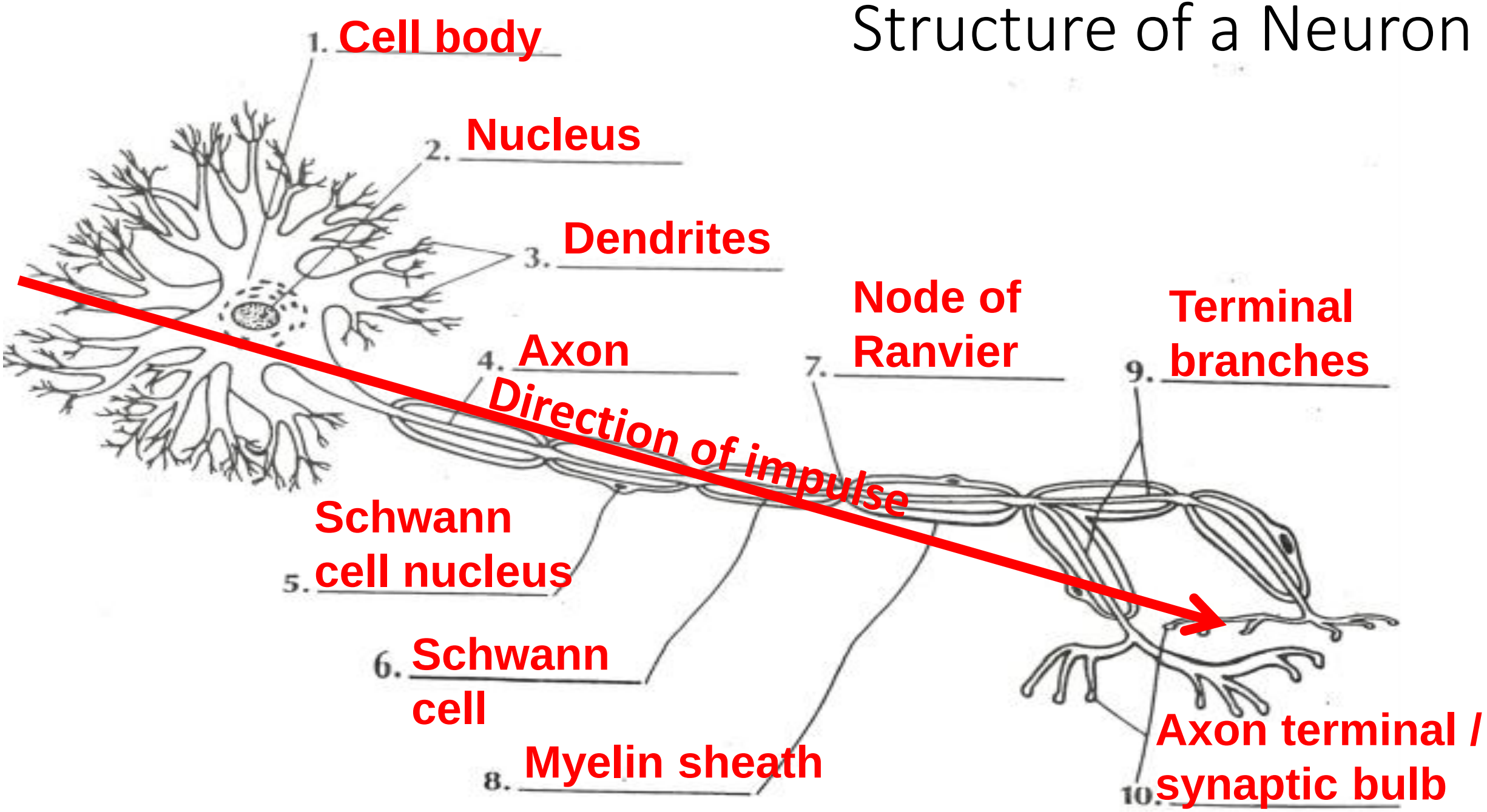
e. Receptor

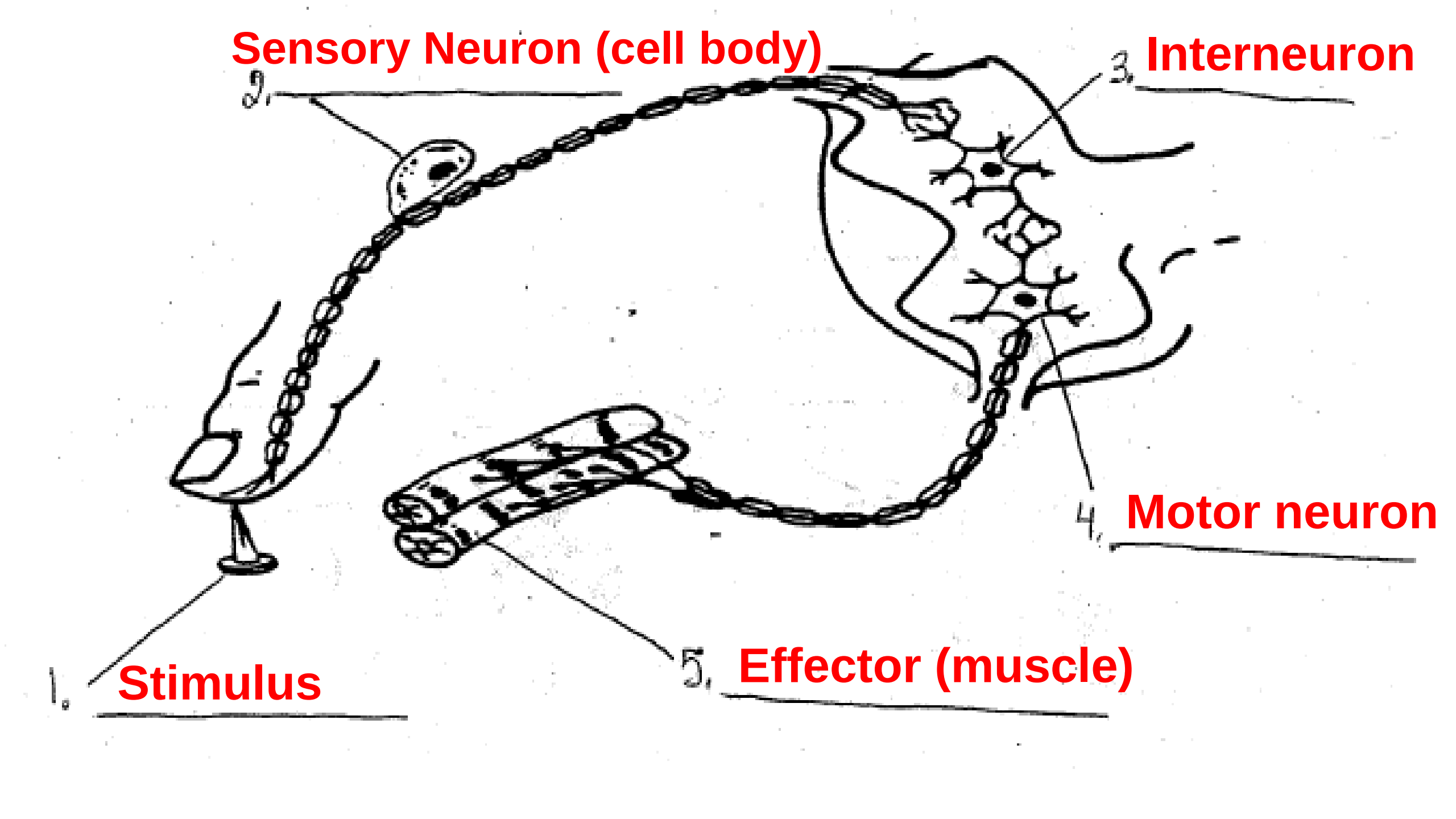
c. Stimulus

Fill in the blanks with the correct answers.

Suppose you stepped on a tack. You jerked your leg away ___before___ you were aware of what happened. The impulse traveled from the ___receptors___ in the skin, along a(an) ___sensory___ neuron into the ___spinal cord___. The impulse jumped across a(an) ___synapse___ to a(an) ___interneuron___; then across another synapse to a ___motor___ neuron. The impulse traveled along this nerve to a muscle, ___effector___, in your leg. You jerked your leg away. Only a fraction of a second later, a(an) ___impulse___ traveled up your ___spinal cord___ to your ___brain___. But you had ___already___ reacted. This kind of reaction is known as a(an) ___reflex___. Reflex acts occur without thinking.

Structure of a Neuron




2. Sensory Neuron (cell body)
3. Interneuron
4. Motor neuron
1. Stimulus
5. Effector (muscle)

Review Questions

1. Name the gap between 2 neurons _____ **synapse**

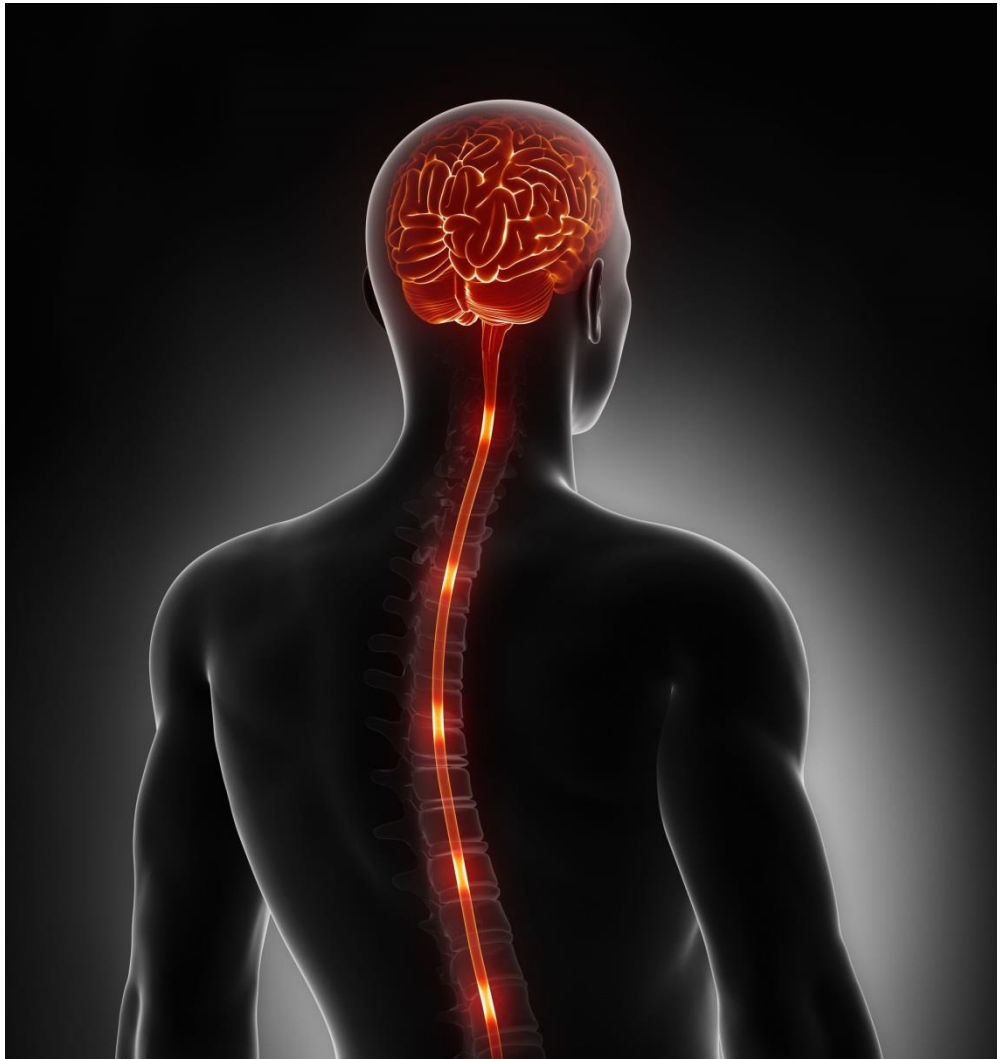
2. Identify the chemical released by a neuron into the gap _____ **neurotransmitters**
   a. List some examples of these chemicals **acetylcholine, dopamine, serotonin**
3. Brain structure that controls involuntary activities _____ **medulla**

4. Brain structure involved with balance & coordination _____ **cerebellum**

5. Brain structure responsible for thought, memories, senses, emotions, language **cerebrum**

The Central Nervous System (CNS)

- made up of the brain and spinal cord



The Spinal Cord

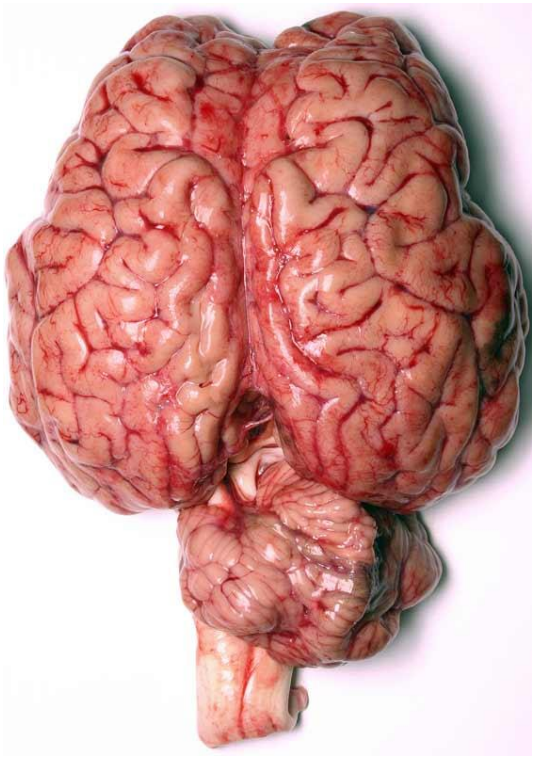
- protected by vertebrae (bones)
- coordinates activity between the brain and the rest of the body
- center for reflex actions

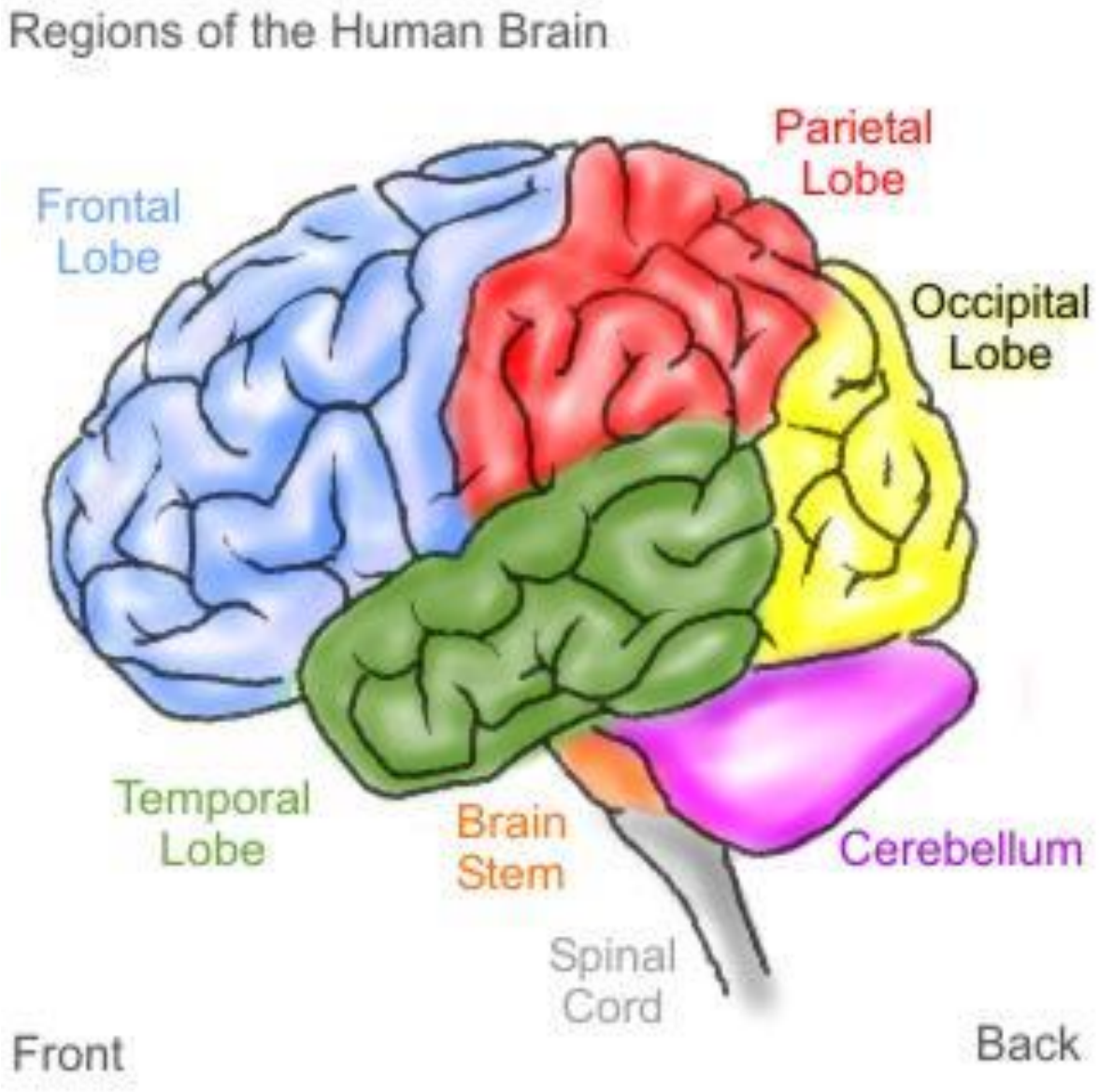
Your Brain is Plastic!

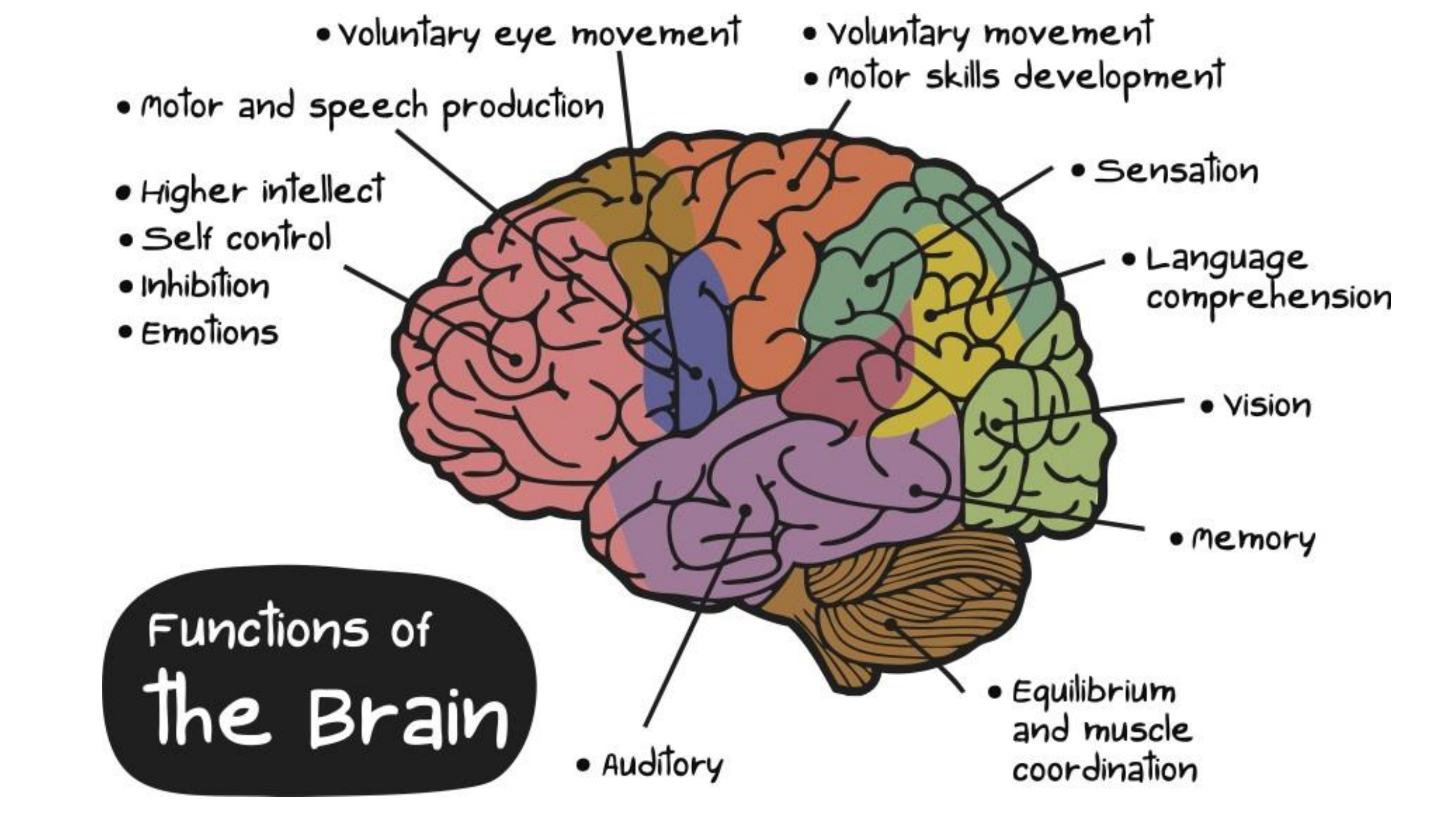
True or False?

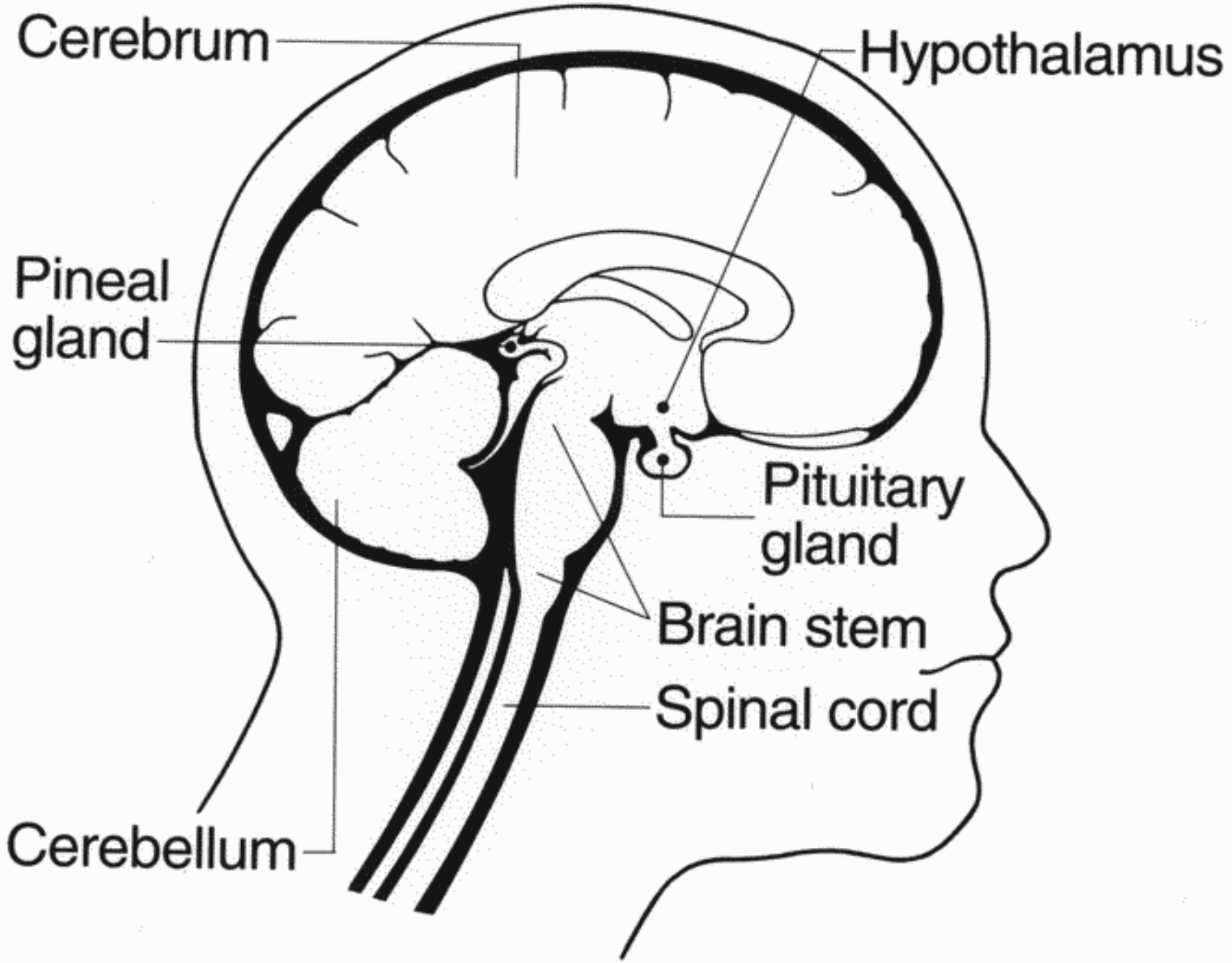
Plasticity

The Brain

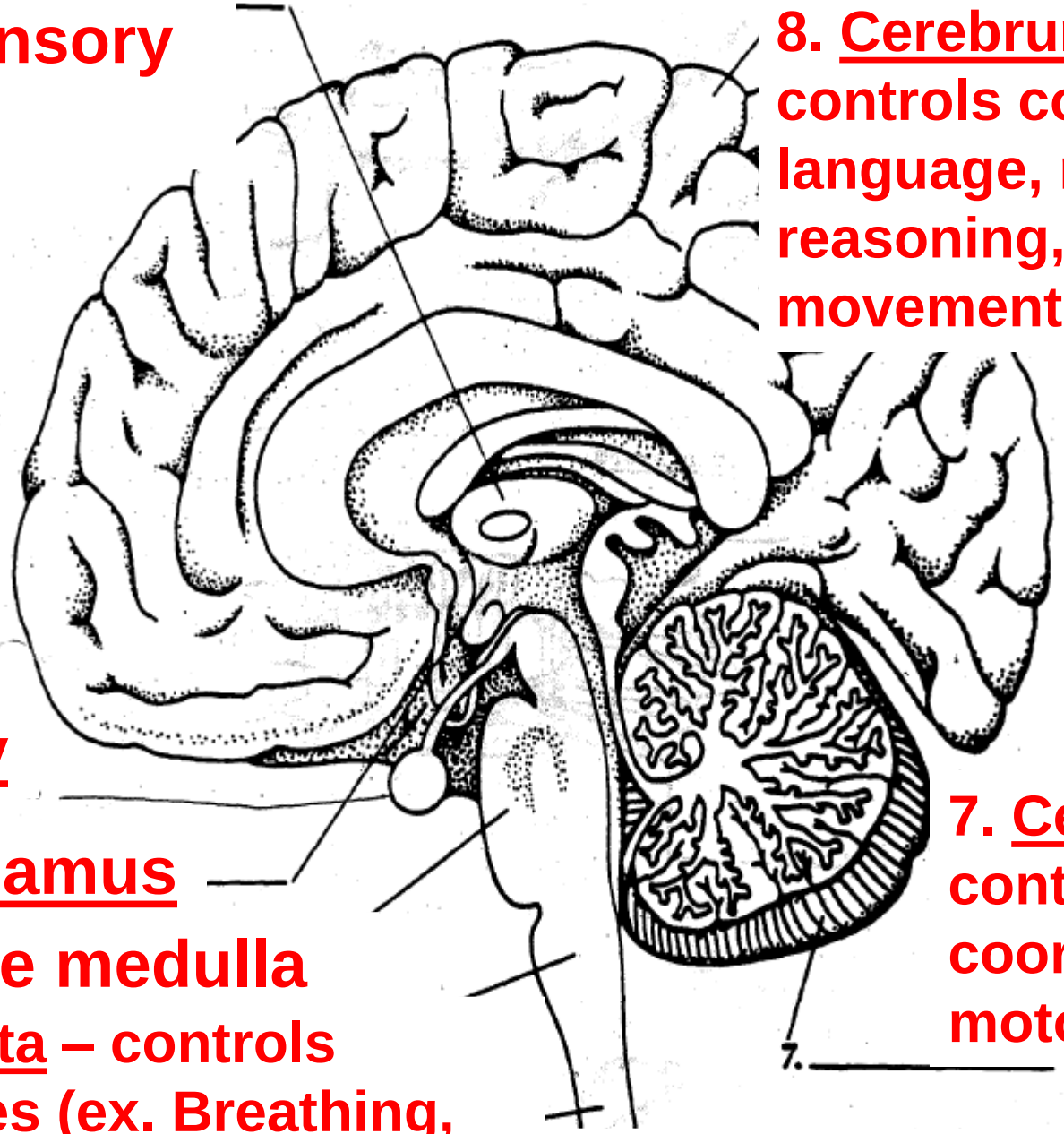



Regions of the Human Brain
Parietal Lobe
Frontal Lobe
Occipital Lobe
Temporal Lobe
Brain Stem
Cerebellum
Spinal Cord
Front
Back


• Voluntary eye movement
• Voluntary movement
• Motor skills development
• Motor and speech production
• Higher intellect
• Self control
• Inhibition
• Emotions
• Sensation
• Language comprehension
• Vision
• Memory
Functions of the Brain
• Auditory
• Equilibrium and muscle coordination


Cerebrum
Hypothalamus
Pineal gland
Pituitary gland
Brain stem
Spinal cord
Cerebellum

1. Thalamus - sensory "relay station"



8. Cerebrum / Cerebral Cortex – controls conscious thought, language, memory, emotions, reasoning, 5 senses, voluntary, movement

2. Pituitary

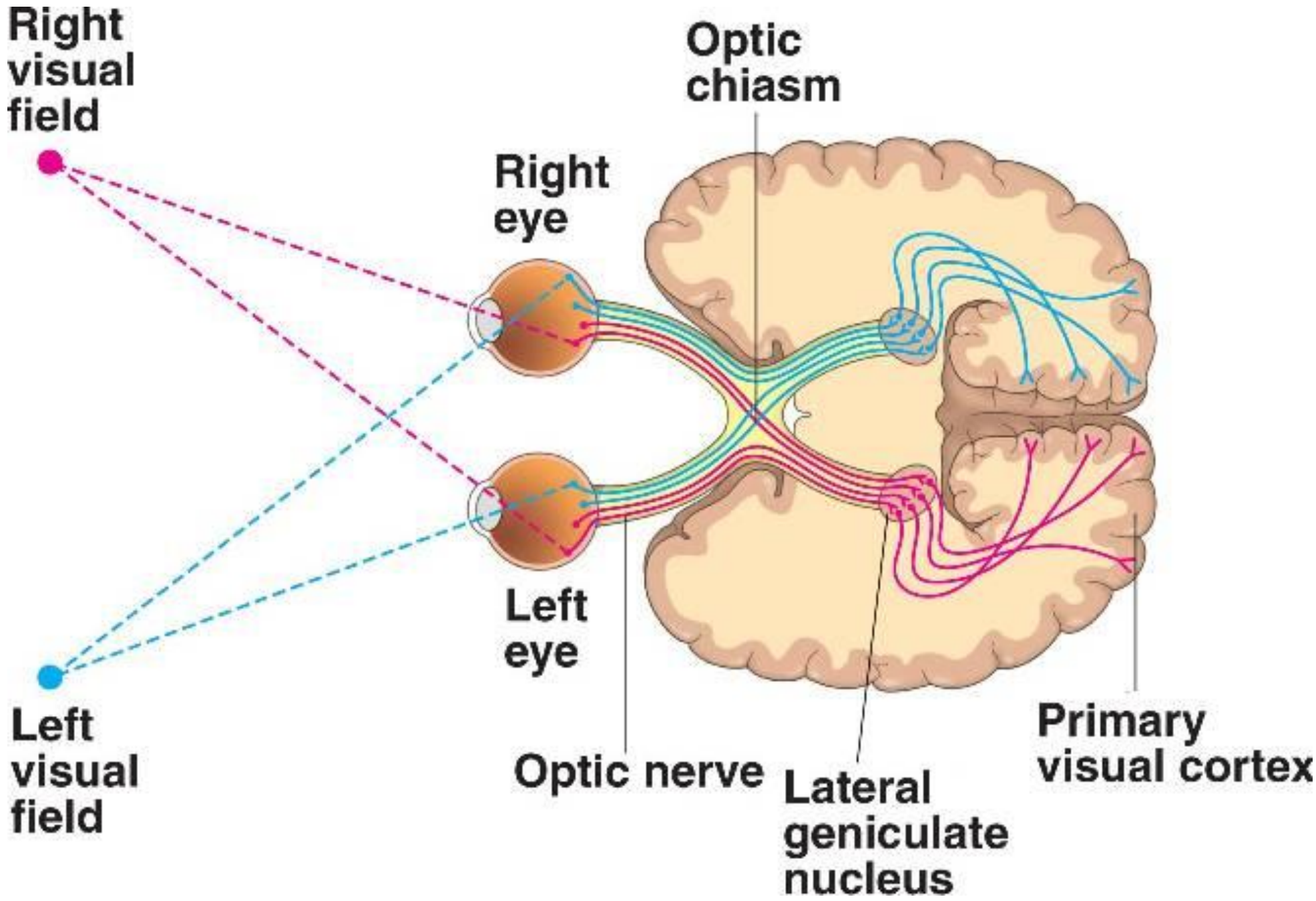
3. Hypothalamus

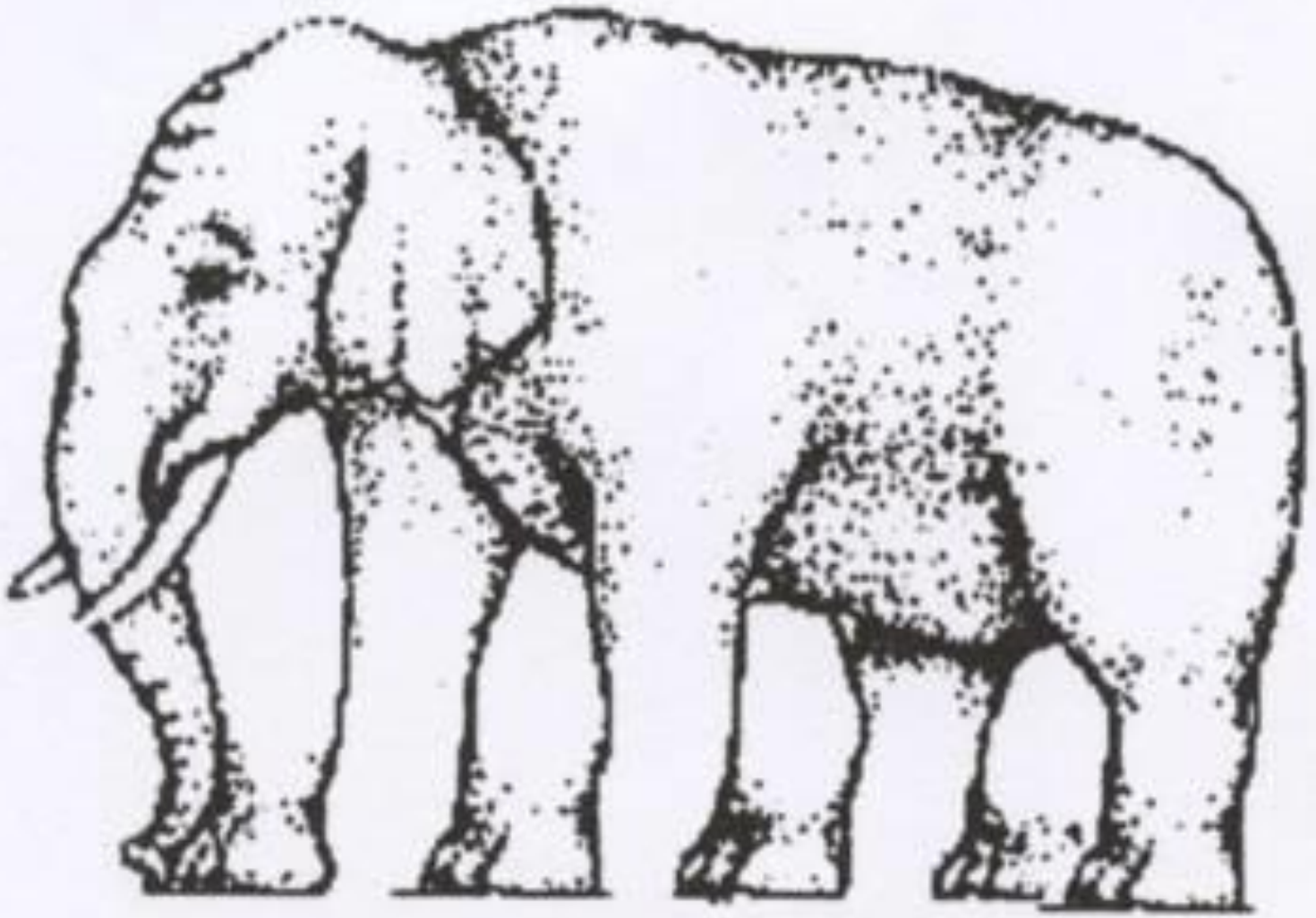
4. Pons – aids the medulla

5. Medulla Oblongata – controls involuntary activities (ex. Breathing, heart rate, digestion)

7. Cerebellum – controls balance and coordination (fine motor activity)

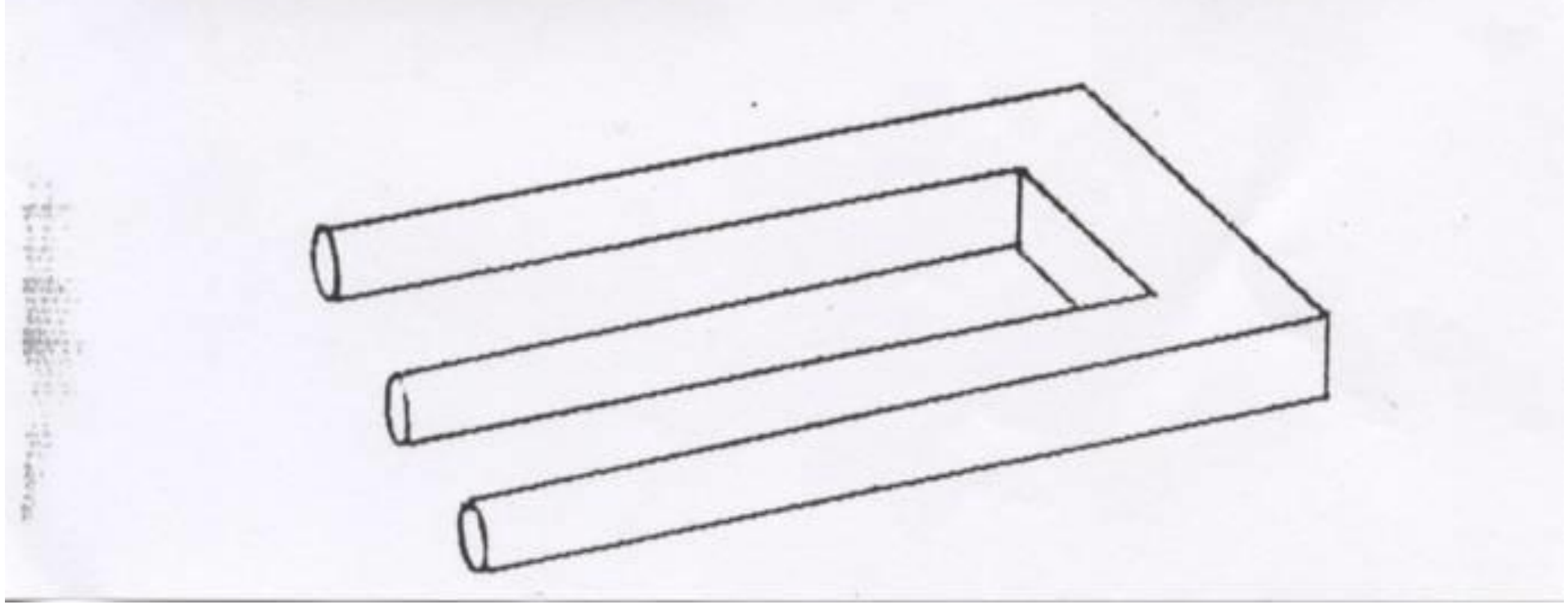
6. Spinal Cord – controls reflexes


Right visual field
Optic chiasm
Right eye
Left eye
Left visual field
Optic nerve
Lateral geniculate nucleus
Primary visual cortex

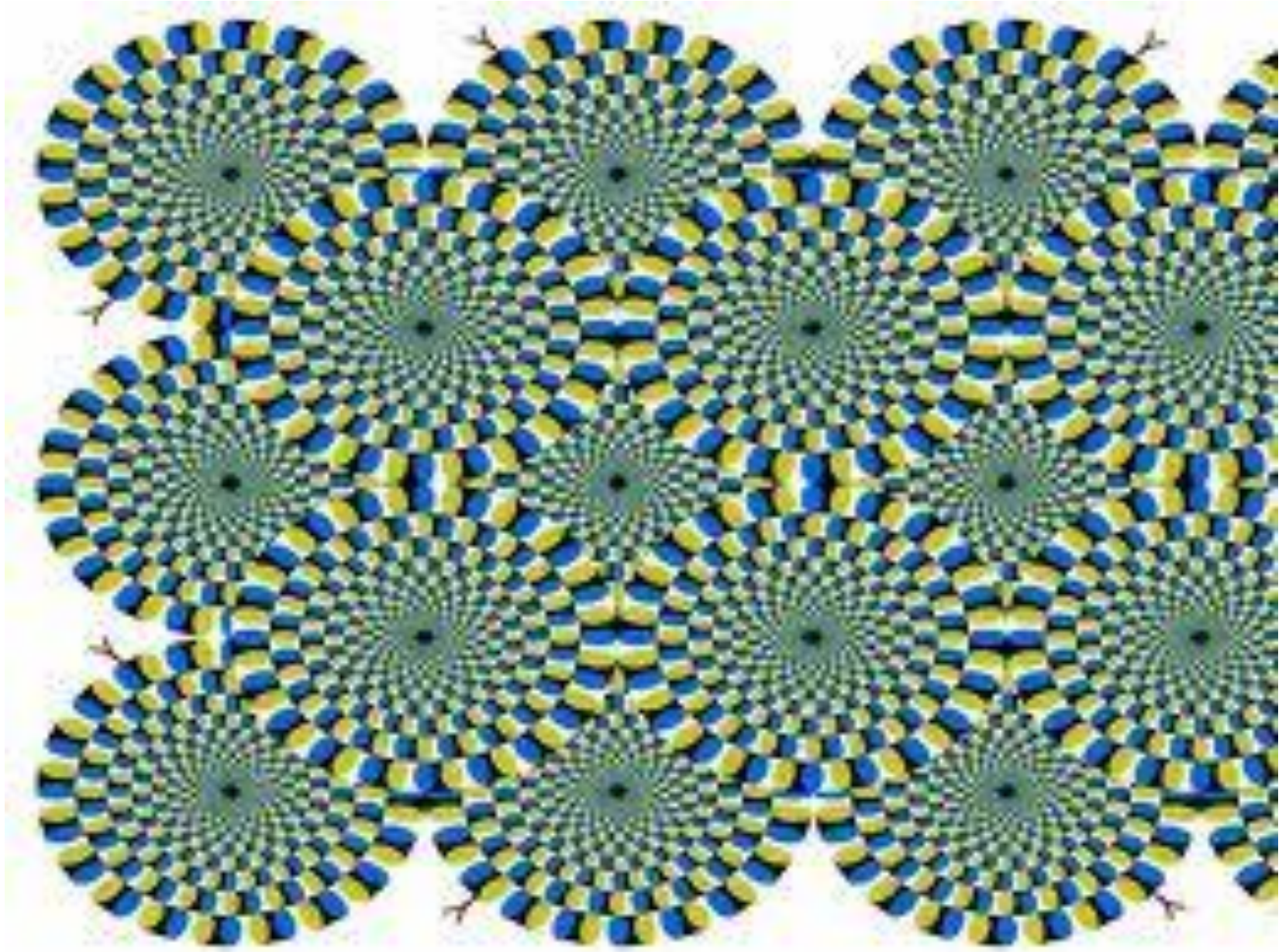


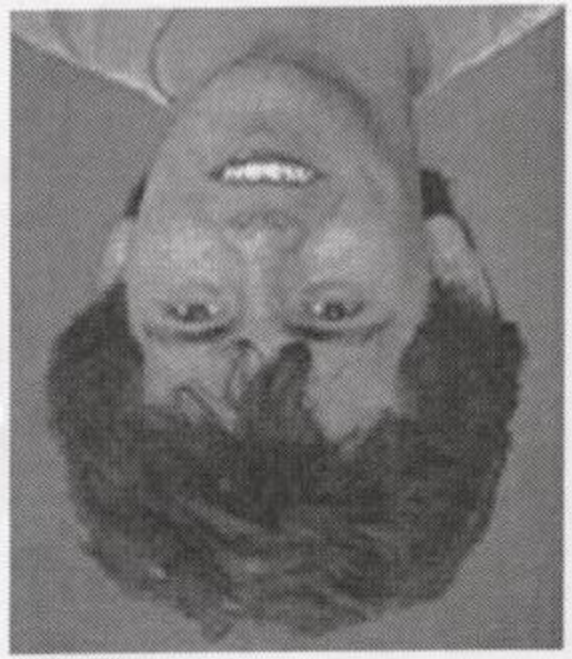
How many legs does this elephant have?

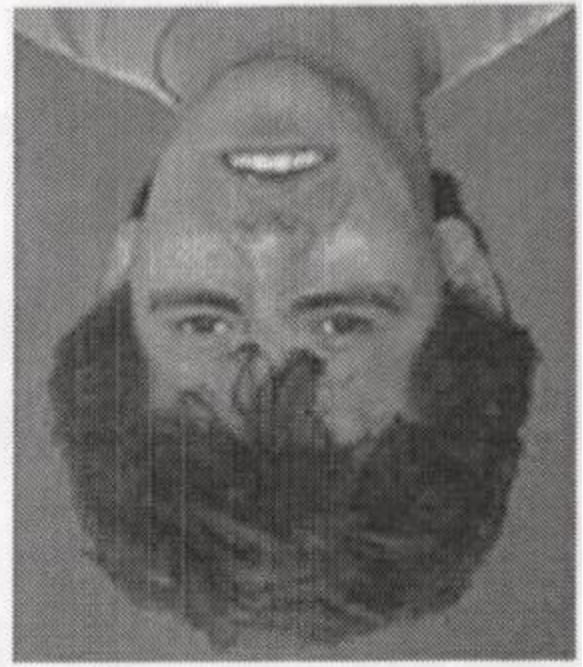
What does YOUR brain see?



Does this make sense?





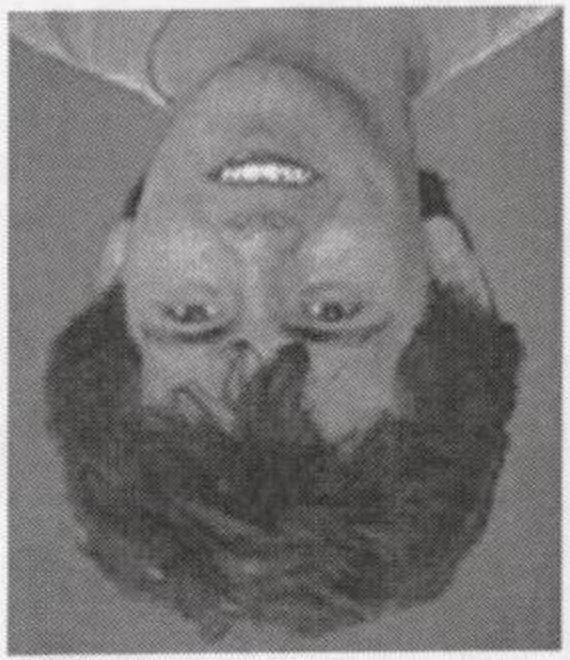


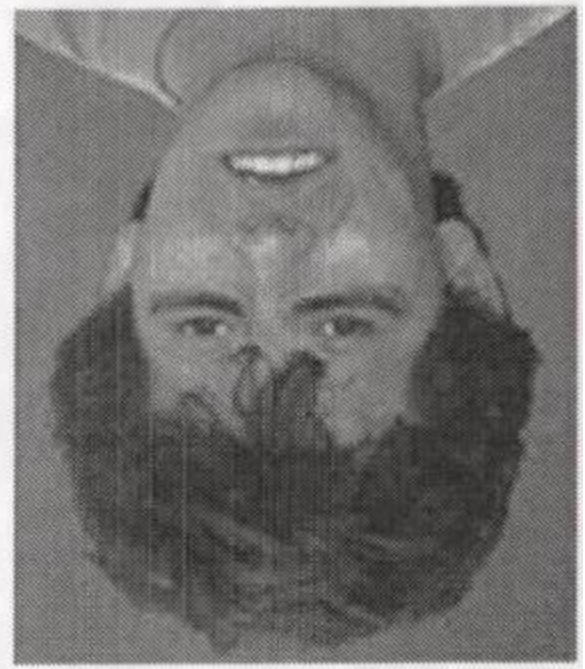
These two photos appear the same.
Do you see any differences between them?
If so, list the differences.

_____

_____

Now flip the page, and examine the pictures.





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If so, list the differences.

_____

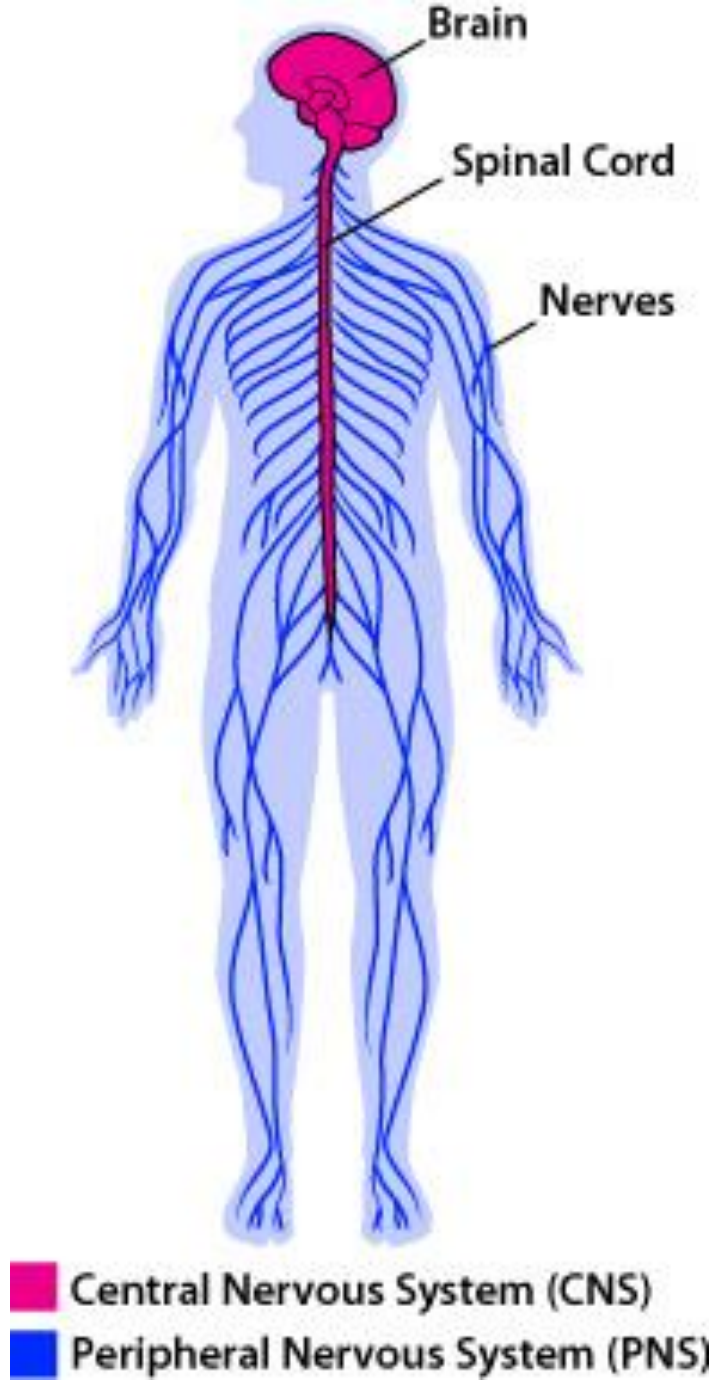
_____

Now flip the page, and examine the pictures.

Video - Depression & Drug Effects on the Brain

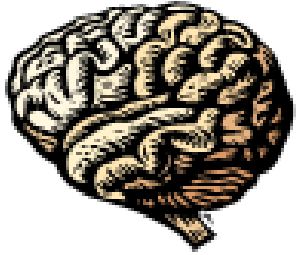
Lesson 5

- Peripheral Nervous System
  - Somatic
  - Autonomic
    - Sympathetic
    - Parasympathetic
- Malfunctions


Brain
Spinal Cord
Nerves
Central Nervous System (CNS)
Peripheral Nervous System (PNS)

Your Brain, By the Numbers

Somehow, the brain is greater than the sum of its parts



By Laura Helmuth
Smithsonian magazine, July-August 2012

Choices: 1 2 10 20 50 80 95 100 100 283 303

100: a) Number, in billions, of neurons in a human brain

100: b) Estimated number, in terabytes, of information it can store

1: c) Number, in terabytes, of information a typical desktop computer can store

2: d) Percentage of the body's weight represented by the brain

20: e) Percentage of the body's energy used by the brain

95: f) Number of diagnoses in the 1952 DSM-I, the first edition of psychiatry's manual for diagnosing mental illnesses

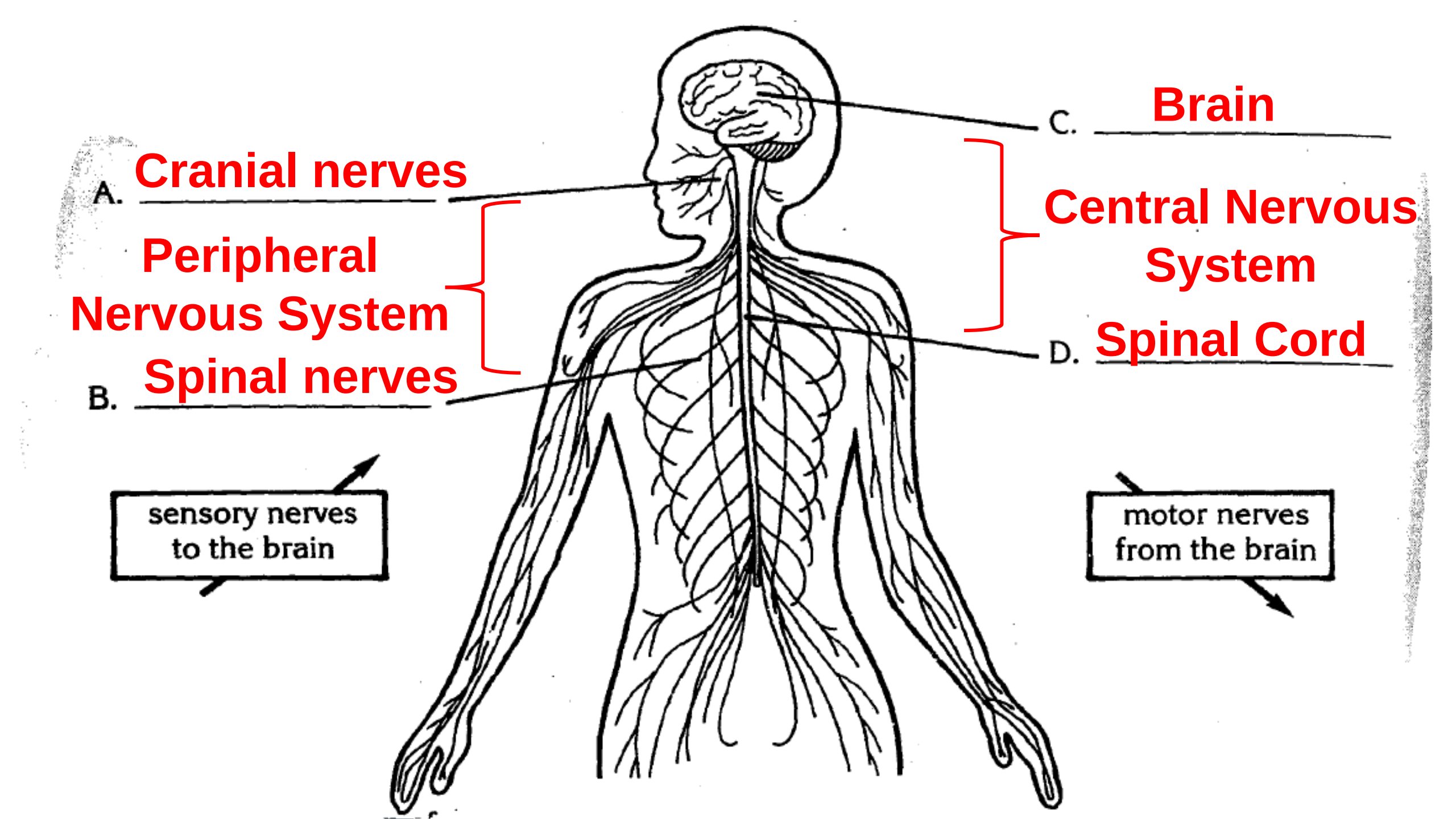
283: g) Number of diagnoses in the 2011 DSM-IV-TR, the most recent edition

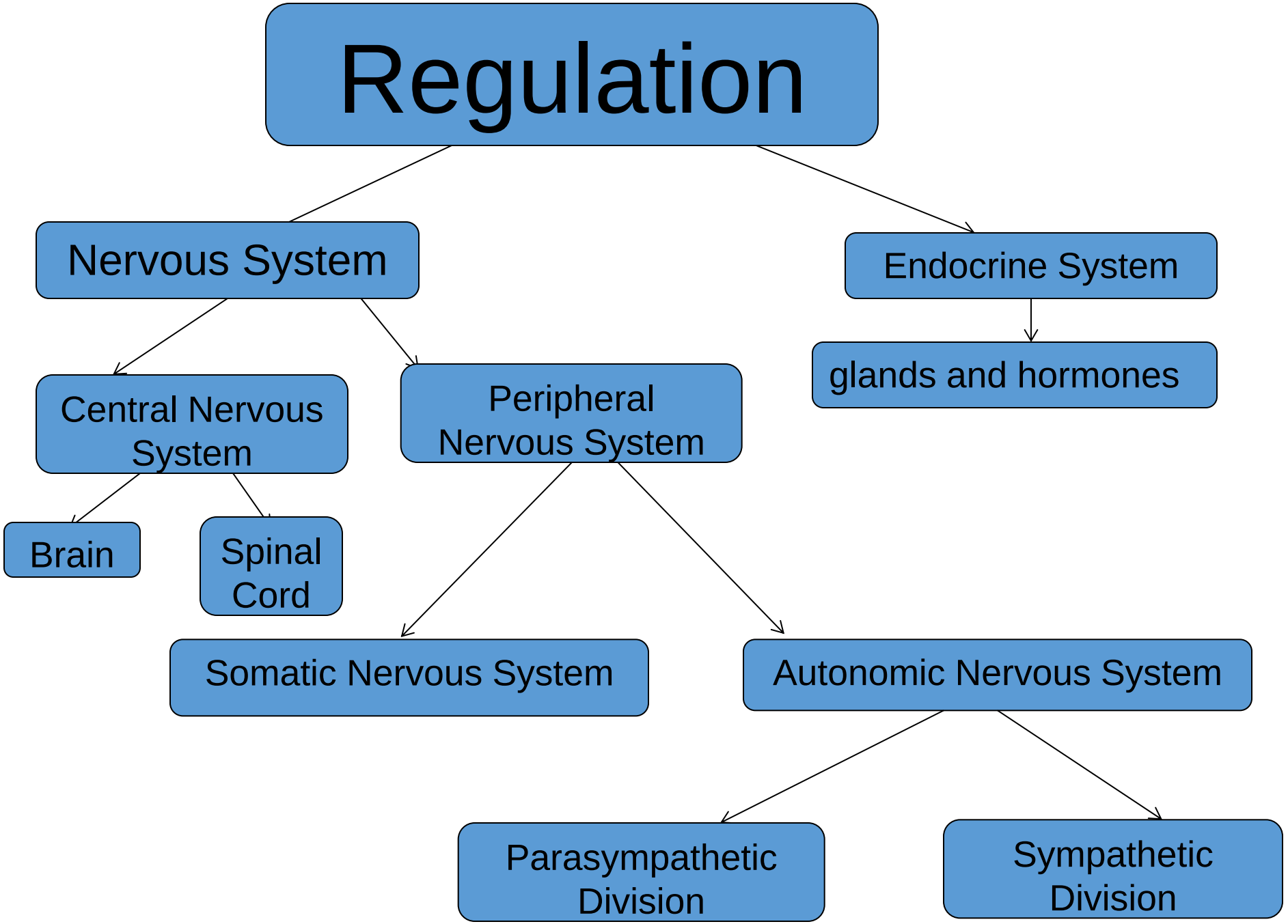
303: h) Highest number of random digits memorized at the 2012 USA Memory Championship, a record

10: i) Approximate percentage drop, in one study, in the accurate recall of random letters as a result of chewing gum

50: j) Percentage of times that human volunteers successfully recalled a sequence of five numbers presented briefly on a computer screen

80: k) Percentage of times that a chimpanzee named Ayumu succeeded at the same task


A. Cranial nerves
Peripheral Nervous System
B. Spinal nerves
C. Brain
Central Nervous System
D. Spinal Cord
sensory nerves to the brain
motor nerves from the brain


Regulation
Nervous System
Endocrine System
glands and hormones
Central Nervous System
Peripheral Nervous System
Brain
Spinal Cord
Somatic Nervous System
Autonomic Nervous System
Parasympathetic Division
Sympathetic Division

Peripheral Nervous System

- nerves extending throughout the entire body, branching from brain & spinal cord
- can be separated into 2 subdivisions:

Somatic Nervous System

- nerves that control the voluntary actions (moving skeletal muscles)

Autonomic Nervous System

- nerves that control involuntary action (cardiac muscle, glands, and smooth muscle)

Autonomic Nervous System (cont.)
- can be further separated into 2 subdivisions

Sympathetic Nervous System

- prepares the body for “fight or flight”
- ex. Creepy guy in dark alley response

Parasympathetic Nervous System

- “resting and digesting” system
- functions when body is NOT preparing for “fight or flight” response
- ex. Normal body functioning

When you become stressed about something your body reacts immediately to meet the challenge:

- Your pupils dilate to improve your vision.
- Your breathing and heart rates increase, pumping more oxygen to the brain for clear thinking and to muscles for rapid movement.
- Your blood drains from your hands and feet to the internal organs.
- All your senses are fine-tuned, ready to hear, feel, see or smell whatever danger is stressing you.
- Epinephrine (adrenaline) is released, preparing your body for flight or fight.
- Many people do their best work under stress, but stress is harmful when it becomes a way of life. Too much stress is linked to peptic ulcers, high blood pressure, clogged arteries, impotency and reduced immune function.

Nervous System Malfunctions

NAME OF CONDITION	CAUSE	SYMPTOMS
Paralysis	Break in the spinal cord	Inability to move appendages
Meningitis- Bacterial or viral infection in the membrane that surrounds the brain and the spinal cord		Headache, fever, chills, stiffness of neck and pains in the back
Cerebral Palsy	Damage to the motor center of the brain	**Poor coordination of muscles, difficulty of speech**
Stroke- Damage to the nerve cells of a region of the brain due to blocked or ruptured blood vessels in the brain.		Paralysis of body parts, loss of some mental functions such as memory or speech
Polio	Viral infection of the spinal cord	Atrophy and paralysis of the muscles

Inside the Brain: Unraveling the Mystery of Alzheimer's Disease [HQ] - YouTube

Case Study #1

1. Frank had always been a healthy individual. He was active his whole childhood and remained active well into his adult years. In fact, he recently started working a second job at the local fast food restaurant. While at work, Frank found himself nibbling on food during his shifts. One night, after work, Frank began to feel ill. He went to sleep that night with a severe headache. In the morning when he woke, he was feeling even worse. His symptoms now included a fever and chills in addition to his pounding headache. As the day wore on, his neck became stiff and he started to suffer from back pain. At Frank's doctor, what would be your diagnosis? Explain

Case Study #2

2. Bob and June Smith were a happily married couple who were eagerly awaiting the birth of their first child. It seemed like forever, but finally the day arrived. The delivery went smoothly and Bob and June became the parents of a little girl. At first, Amanda seemed to be a healthy child: however, after a few months the Smiths began to think that something was wrong. When she was five months of age, Amanda still could not lift her head up by herself. The when all of the other babies her age were starting to crawl, Amanda wasn't. If you were Amanda's pediatrician, what would be your diagnosis of Amanda's condition?

Case Study #3

3. Jack was an active 50-year-old man. He was a happily married man who had two children. One night he woke up suddenly which in turn startled his wife awake. She noticed he was drooling and his left eye was droopy. When she asked him what was wrong, she could not understand him because his speech was slurred. His wife then called 911 and an ambulance took Jack to the hospital. If you were the doctor who saw Jack in the emergency room, what would you suspect was wrong with Jack?

Case Study #4

4. Jill came into the emergency room after falling down the stairs. She was very distraught. She liked to play soccer, lacrosse, and volleyball. In the past few months she had noticed a decline in her performance and eventually she stopped playing all together. She had also been having trouble walking and moving her legs. You diagnose her with muscle atrophy (reduction in muscle size, tone, and power) and the start of paralysis. What malfunction of the nervous system is Jill suffering from? Explain.

Case Study #5

5. Sam rode his mountain bike everywhere. He rode it to work, to see his friends and to run errands. One day, a kitten darted in front of his bike. Sam swerved to avoid the kitten and lost control of his bike and ended up hitting a large oak tree. When the paramedics arrived at the scene, they asked Sam if he could move his arms and legs. He couldn't. The paramedics put Sam on a backboard and secured his neck in a neck brace. If you were the doctor who examined Sam, what would your diagnosis be?

Malfunctions of the Nervous System

1) **Cerebral Palsy** congenital (born with) diseases characterized by a disturbance of motor functions, speech, but intelligence falls in the normal range. Causes are varied, usually due to complications in utero.
2) **Meningitis** Caused by a bacteria or virus that causes inflammation of the membranes surrounding the brain and spinal cord (meninges).
3) **Stroke** Caused by a burst blood vessel (cerebral hemorrhage) or a blood clot in a blood vessel of the brain may result in brain damage
4) **Polio** caused by a virus that attacks the CNS. May result in paralysis – preventable through immunization
5) **Paralysis** Caused by damage to neurons in the spinal cord