



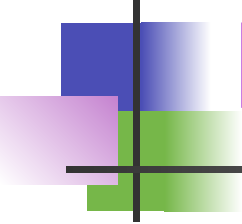
Exploring the World of Science

2026 Anatomy & Physiology (B & C)

Karen Lancour

National Bio Rules

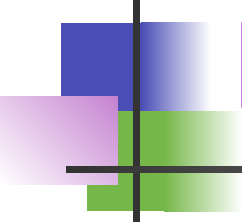
Committee Chairman



Event Rules – 2026

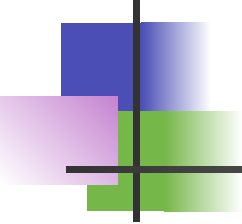
DISCLAIMER

This presentation was prepared using draft rules. There may be some changes in the final copy of the rules. The rules which will be in your Coaches Manual and Student Manuals will be the official rules.



Event Rules – 2026

- **BE SURE TO CHECK THE 2026
EVENT RULES FOR EVENT
PARAMETERS AND TOPICS
FOR EACH COMPETITION
LEVEL**



ROTATION SCHEME

Year 1	Skeletal	Muscular	Integumentary	(2025)
Year 2	Nervous	Sense Organs	Endocrine	(2026)
Year 3	Respiratory	Digestive	Immune	(2027)
Year 4	Cardiovascular	Lymphatic	Excretory	(2028)



ANATOMY & PHYSIOLOGY

Event Content : 2026– YEAR 2 OF 4 YR ROTATION

- **BASIC ANATOMY AND PHYSIOLOGY**
 - ◆ Nervous System
 - ◆ Sense Organs
 - ◆ Endocrine System
 - ◆ Major disorders
 - ◆ Treatment and prevention of disorders
- **PROCESS SKILLS** - observations, inferences, predictions, calculations, data analysis, and conclusions.



TRAINING MATERIALS

- **Training Power Point – content overview**
- **Training Handout – General Overview**
- **Sample Tournament – sample problems with key**
- **Event Supervisor Guide – prep tips, event needs, and scoring tips**
- **Internet Resource & Training PDF's – on the Science Olympiad website at www.soinc.org under Event Information**



Exploring the World of Science

NERVOUS SYSTEM

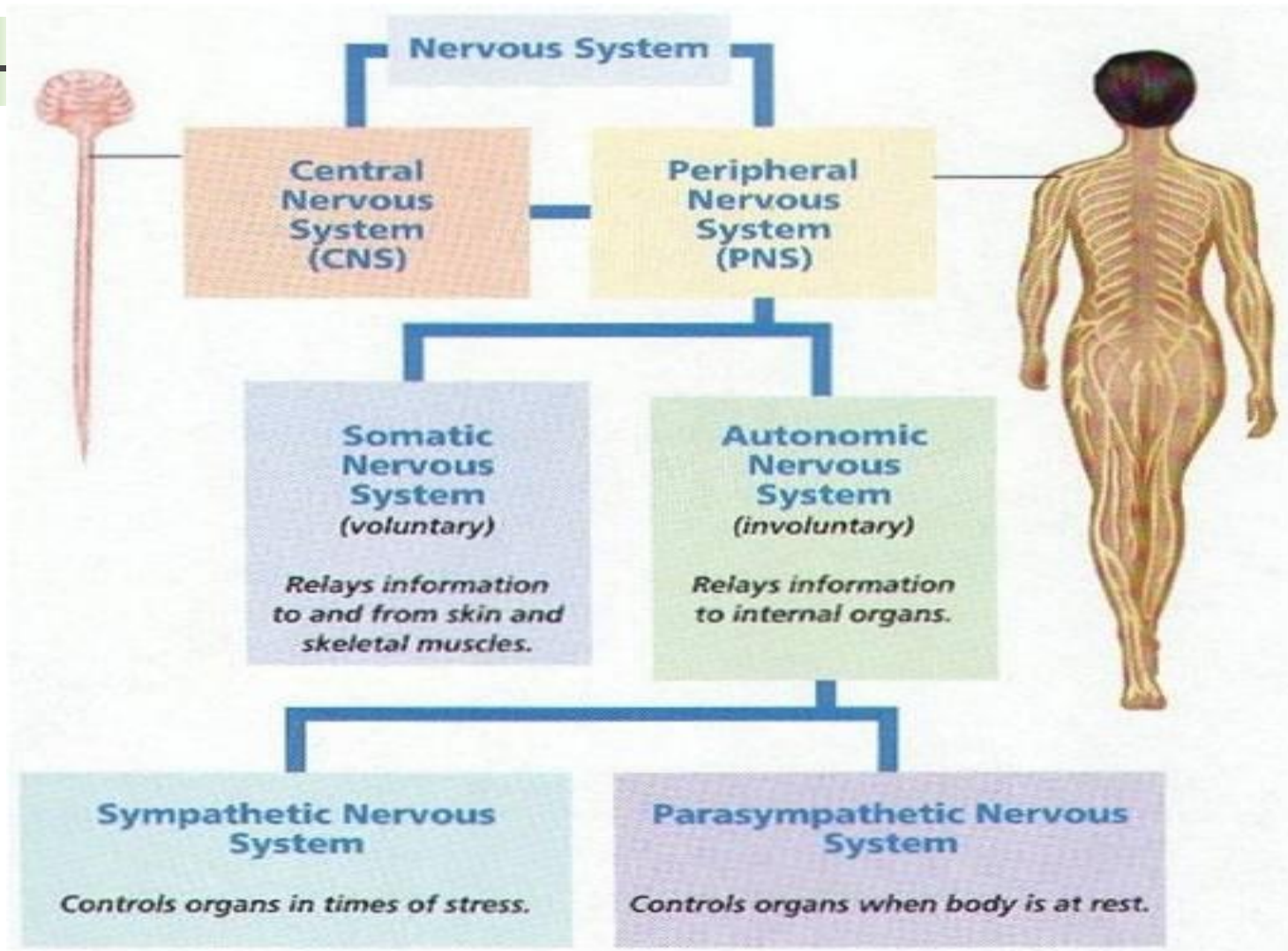
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Divisions of the Nervous System

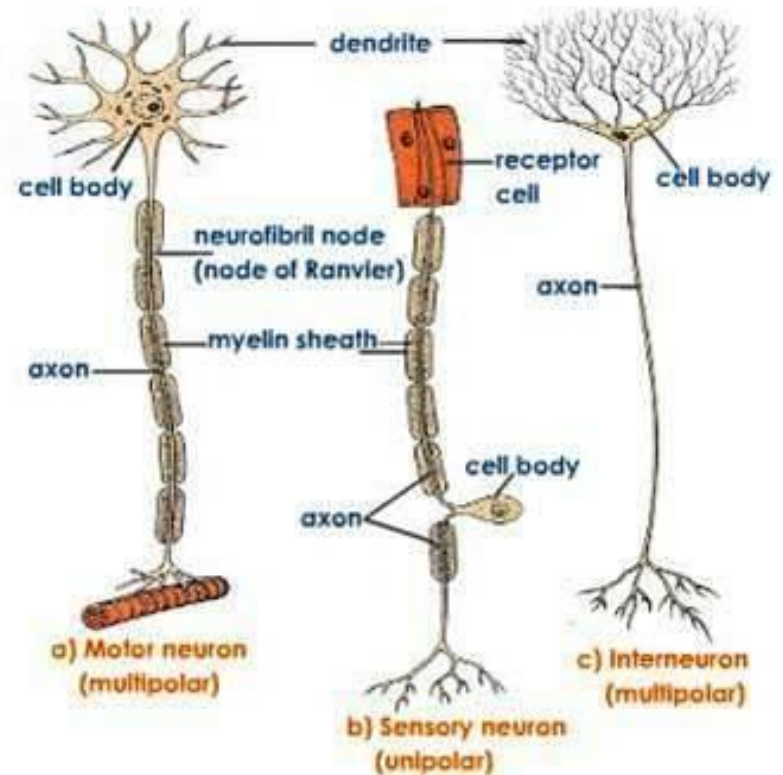
Brain
&
Spine



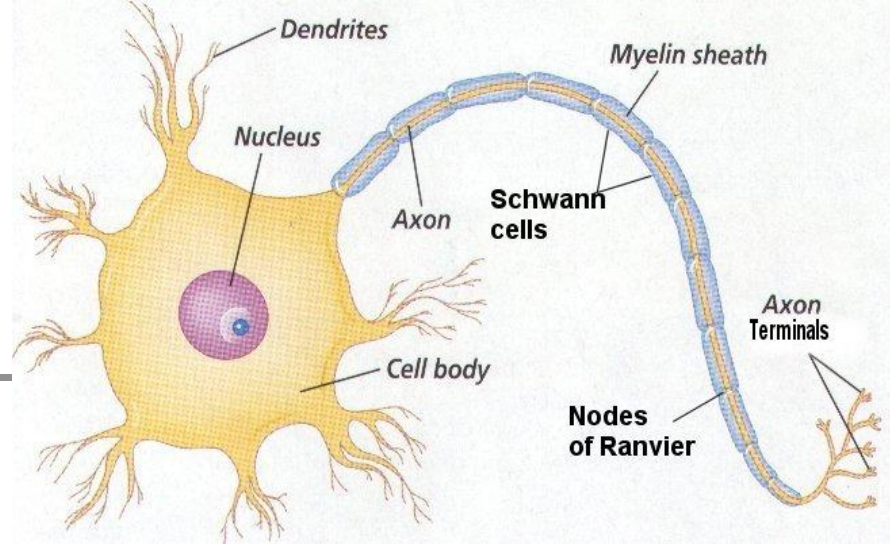
Rest
of
Body

Neuron

- Basic functional cell of nervous system
- Transmits impulses
- Three types
 - Sensory neurons – bring messages to CNS
 - Motor neurons - carry messages from CNS
 - Interneurons – between sensory & motor neurons in the CNS

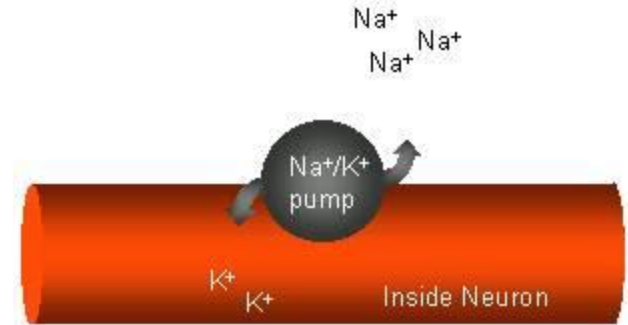


Neuron



- **Dendrite** – receive stimulus and carries it impulses toward the cell body
- **Cell Body with nucleus** – nucleus & most of cytoplasm
- **Axon** – fiber which carries impulses away from cell body
- **Schwann Cells-** cells which produce myelin or fat layer
- **Myelin sheath** – lipid layer around the axon
- **Node of Ranvier** – gaps or nodes in the myelin sheath
- **Impulses travel from dendrite to cell body to axon**

Impulses

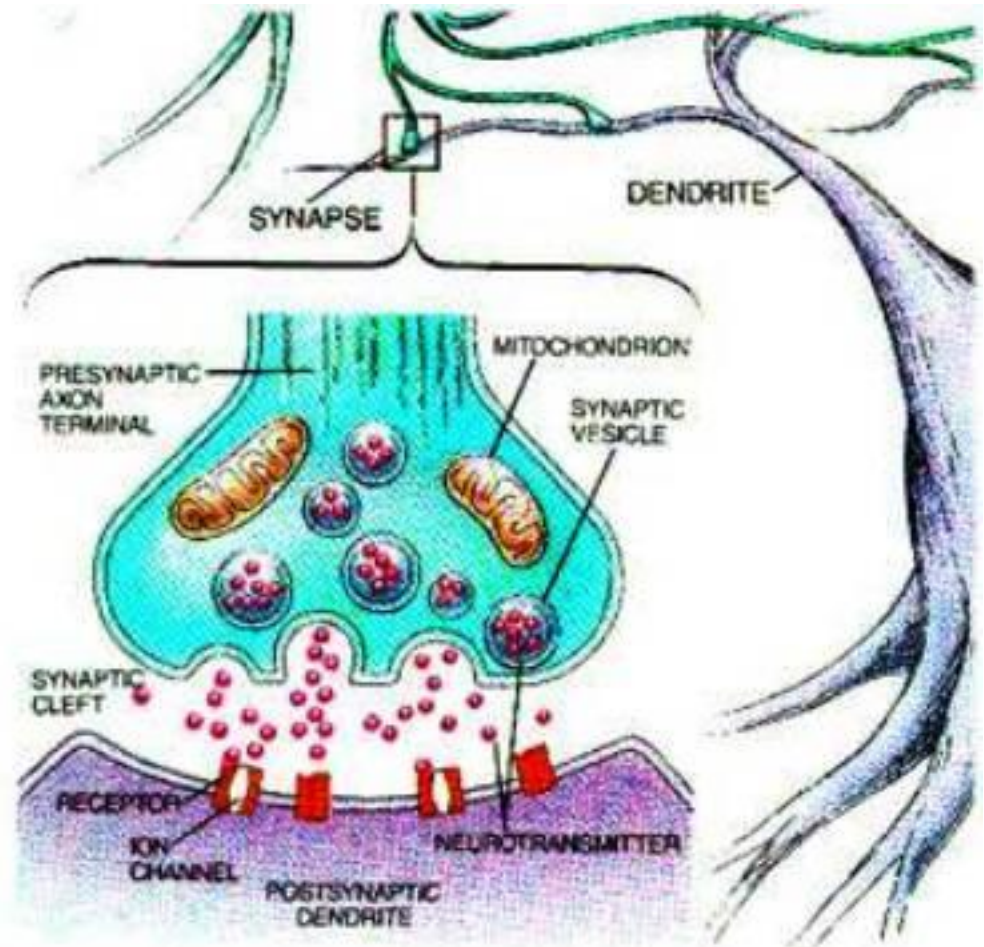


Impulse

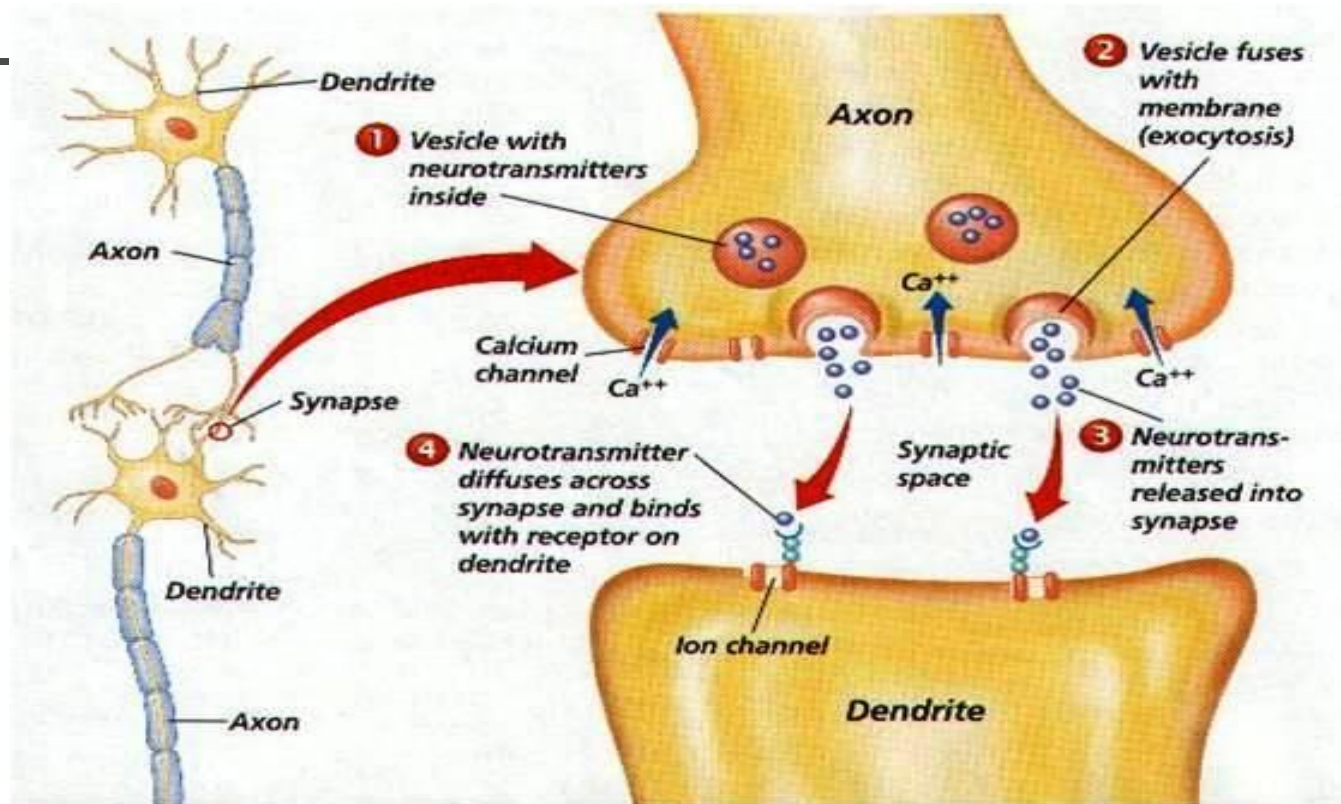
- Self propagating
- Mechanism – Na⁺ K⁺ pump

Synapse

- Junction between neurons
- Neurotransmitters



Synapse



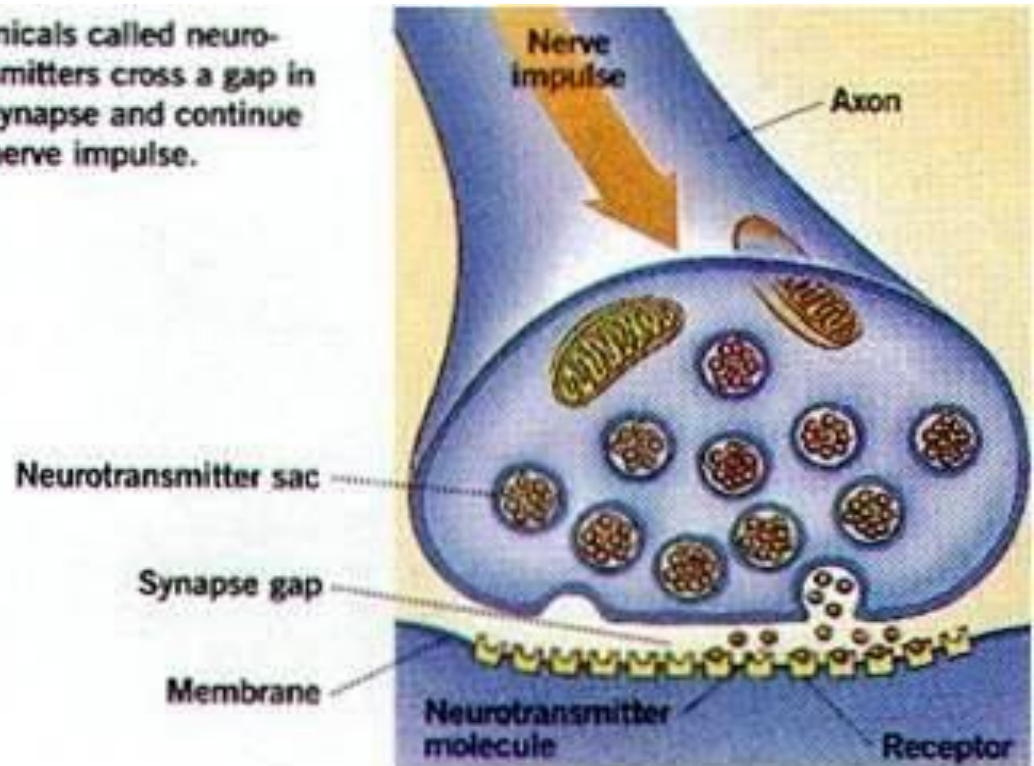
Junction between neurons

**The neurons do not actually touch at the synapse
Neurotransmitters used to restart impulse in
dendrite of 2nd neuron**

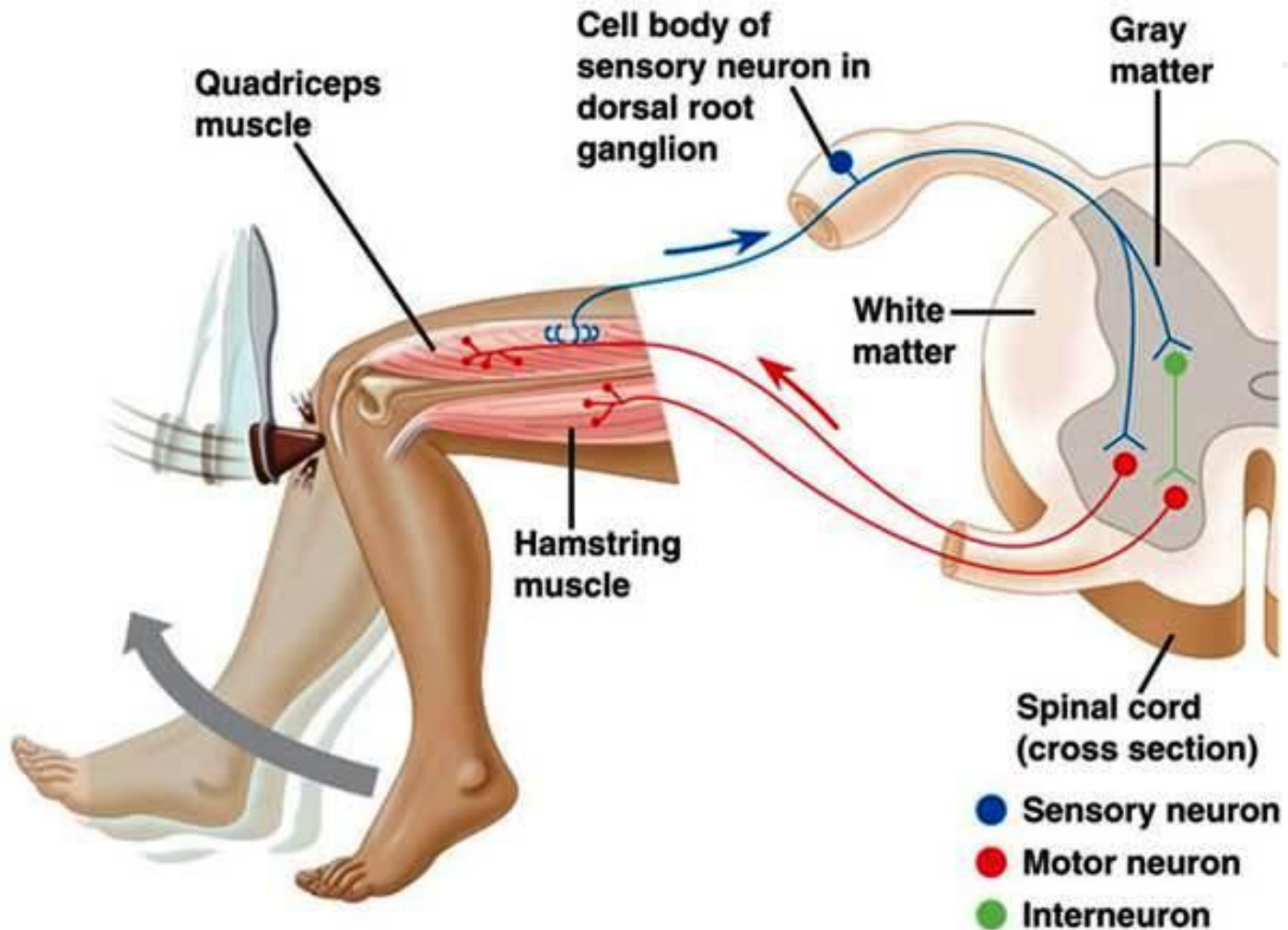
Neurotransmitters

■ **Chemicals in the junction which allow impulses to be started in the second neuron**

Chemicals called neurotransmitters cross a gap in the synapse and continue the nerve impulse.



Reflex Arch



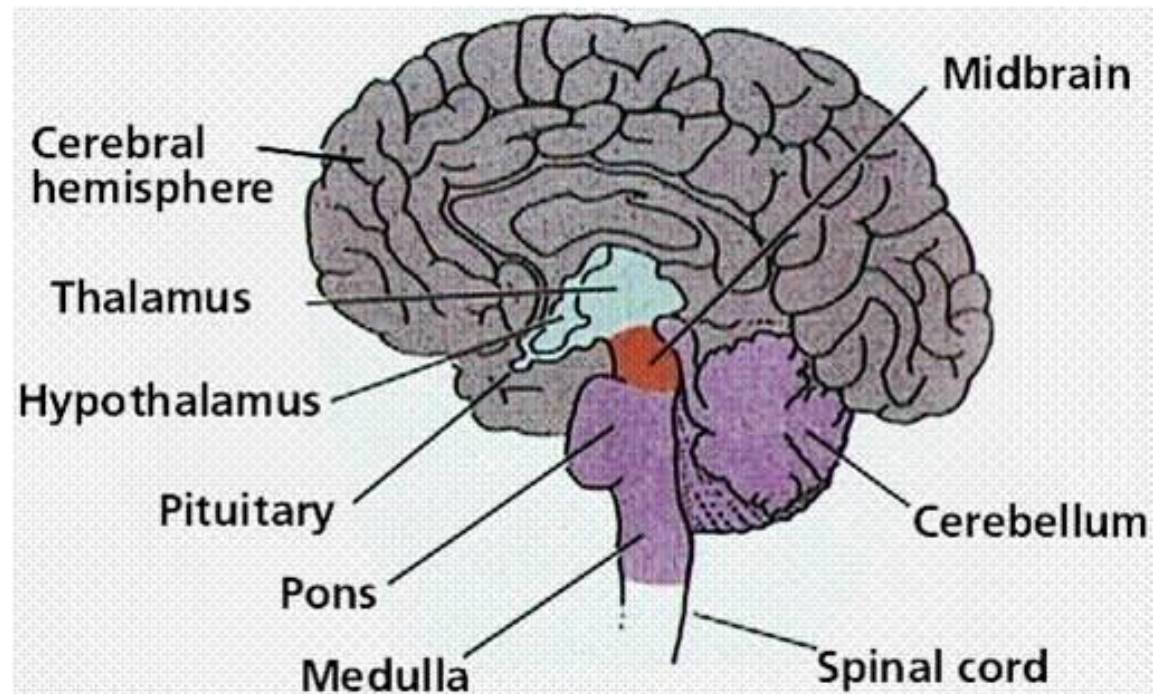
Central Nervous System

- **Brain**

- **Brain stem**
medulla, pons, midbrain
- **Diencephalon**
thalamus & hypothalamus
- **Cerebellum**
- **Cerebrum**

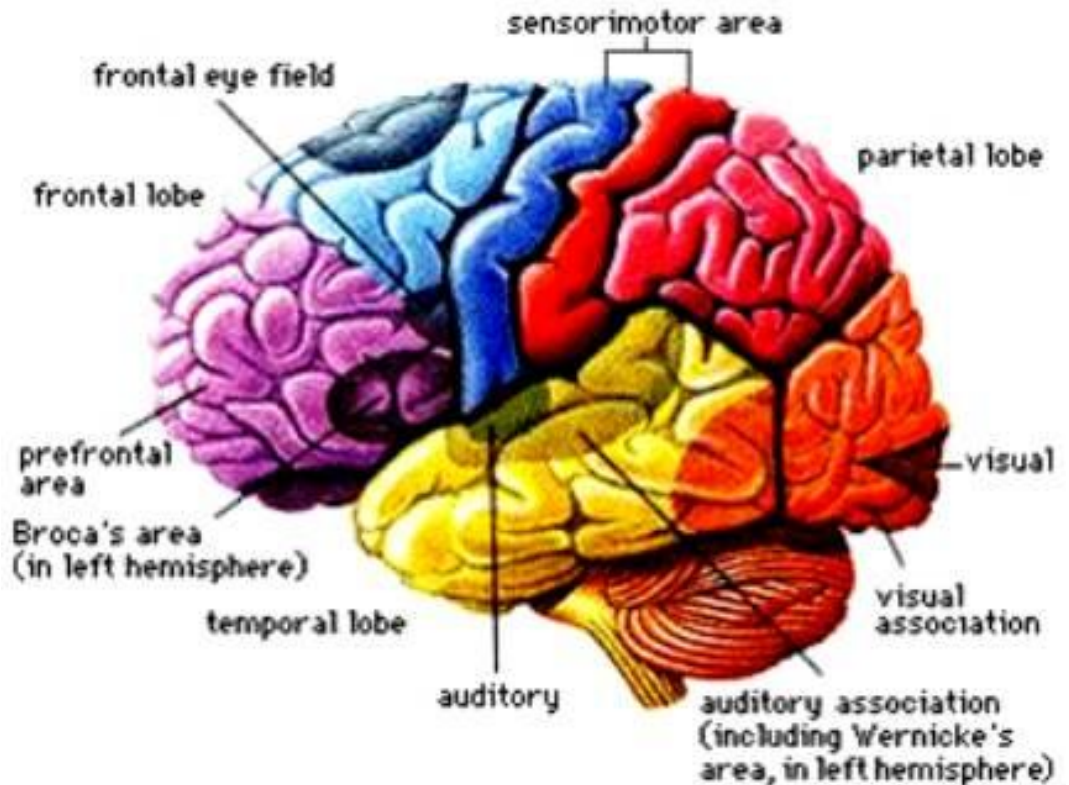
- **Spine**

- **Spinal Cord**



Cerebrum Regions

- **Lobes of the Cerebrum**
 - **Frontal**
 - **Parietal**
 - **Temporal**
 - **Occipital**
- **Special regions**
 - **Broca's area**
 - **Wernicke's area**
 - **Limbic System**



Four Categories of Brain Wave Patterns



Beta (14-30 Hz)

Concentration, arousal, alertness, cognition
Higher levels associated with anxiety, disease, feelings of separation, fight or flight



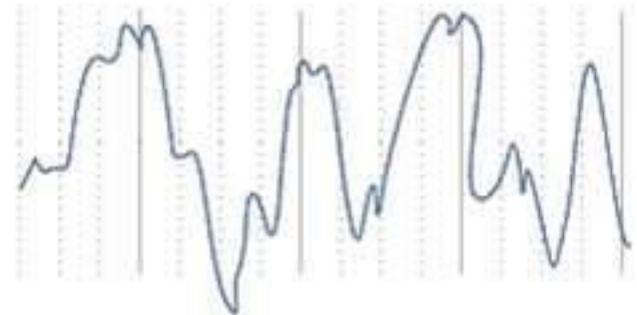
Alpha (8-13.9 Hz)

Relaxation, superlearning, relaxed focus, light trance, increased serotonin production
Pre-sleep, pre-waking drowsiness, meditation, beginning of access to unconscious mind



Theta (4-7.9 Hz)

Dreaming sleep (REM sleep)
Increased production of catecholamines (vital for learning and memory), increased creativity
Integrative, emotional experiences, potential change in behavior, increased retention of learned material
Hypnagogic imagery, trance, deep meditation, access to unconscious mind

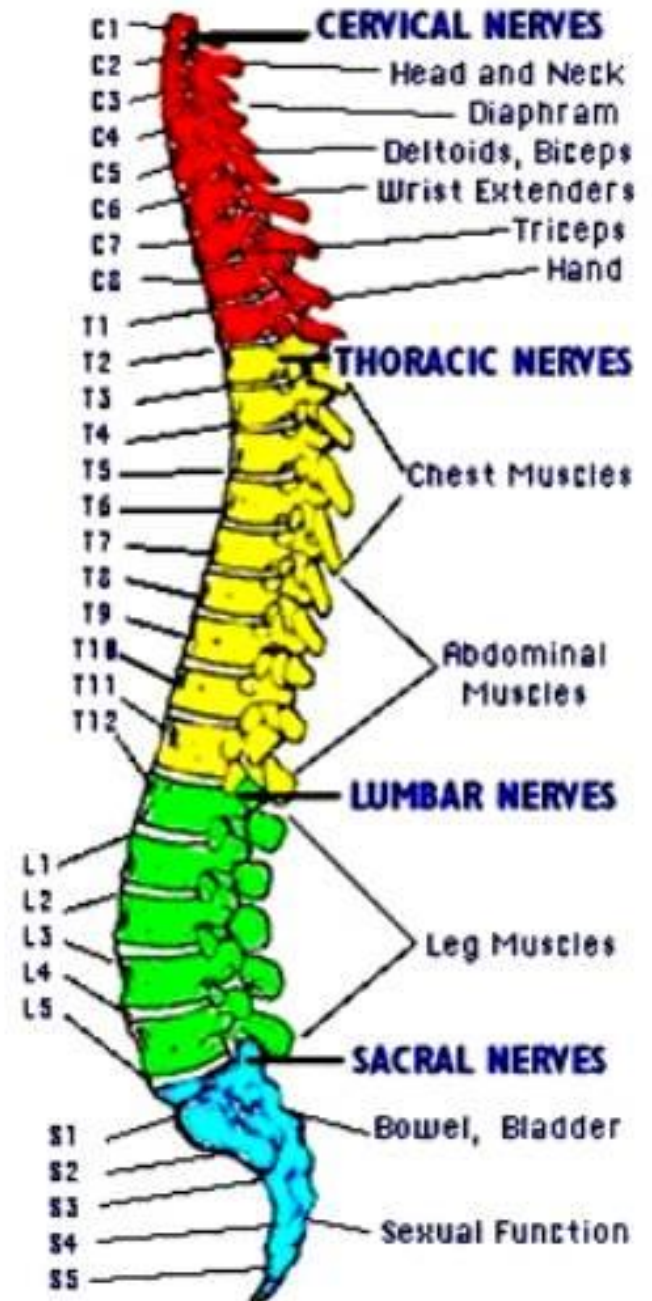


Delta (1-3.9 Hz)

Dreamless sleep
Human growth hormone released
Deep, trance-like, non-physical state, loss of body awareness
Access to unconscious and "collective unconscious" mind, greatest "push" to brain when induced with Holosync®

Peripheral Nervous System

- **Cranial nerves**
 - 12 pair
 - Attached to undersurface of brain
- **Spinal nerves**
 - 31 pair
 - Attached to spinal cord





Autonomic Nervous System

- **Regulates bodies involuntary responses**
- **Two divisions**
 - **Sympathetic nervous system**
 - **Emergency response**
 - **Fight or flight**
 - **Parasympathetic nervous system**
 - **Normal everyday conditions**

Autonomic Nervous System

Parasympathetic nervous system

Contracts pupils

Stimulates salivation

Contracts bronchi

Slows heartbeat

Stimulates digestive activity

Stimulates gallbladder

Contracts bladder

Sympathetic nervous system

Dilates pupils

Inhibits salivation

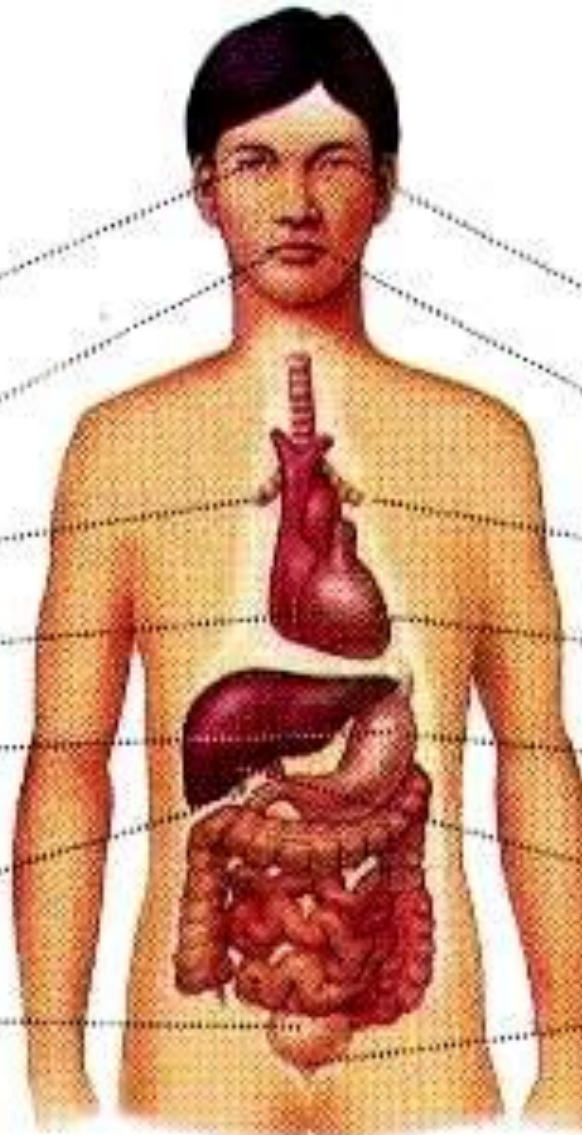
Relaxes bronchi

Accelerates heartbeat

Inhibits digestive activity

Stimulates glucose release by liver

Relaxes bladder





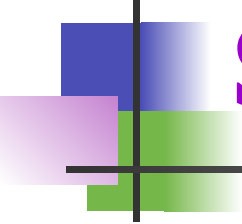
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SENSE ORGANS

Karen Lancour

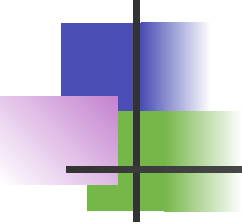
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Sense Receptors

- receive input
- generate receptor potentials and with enough summation
- generate action potentials in the neurons they are part of or synapse with

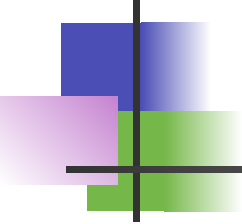


5 Types of Sensory Receptors

Based on the type of stimuli they detect:

- **Mechanoreceptors** - pressure receptors, stretch receptors, and specialized mechanoreceptors involved in movement and balance.
- **Thermoreceptors** - skin and viscera, respond to both external and internal temperature
- **Pain receptors** - stimulated by lack of O_2 , chemicals released from damaged cells and inflammatory cells
- **Chemoreceptors** - detect changes in levels of O_2 , CO_2 , and H^+ ions (pH) as well as chemicals that stimulate taste and smell receptors
- **Photoreceptors** - stimulated by light

Distribution of Receptors in the body



Special Senses

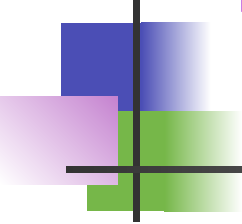
- mediated by relatively complex sense organs of the head, innervated by cranial nerves
- eg. vision, hearing, equilibrium, taste and smell

General (somesthetic, somatosensory)

- receptors widely distributed in skin, muscles, tendons, joints, and viscera
- they detect touch, pressure, stretch, heat, cold and pain, blood pressure and chemistry

The Senses

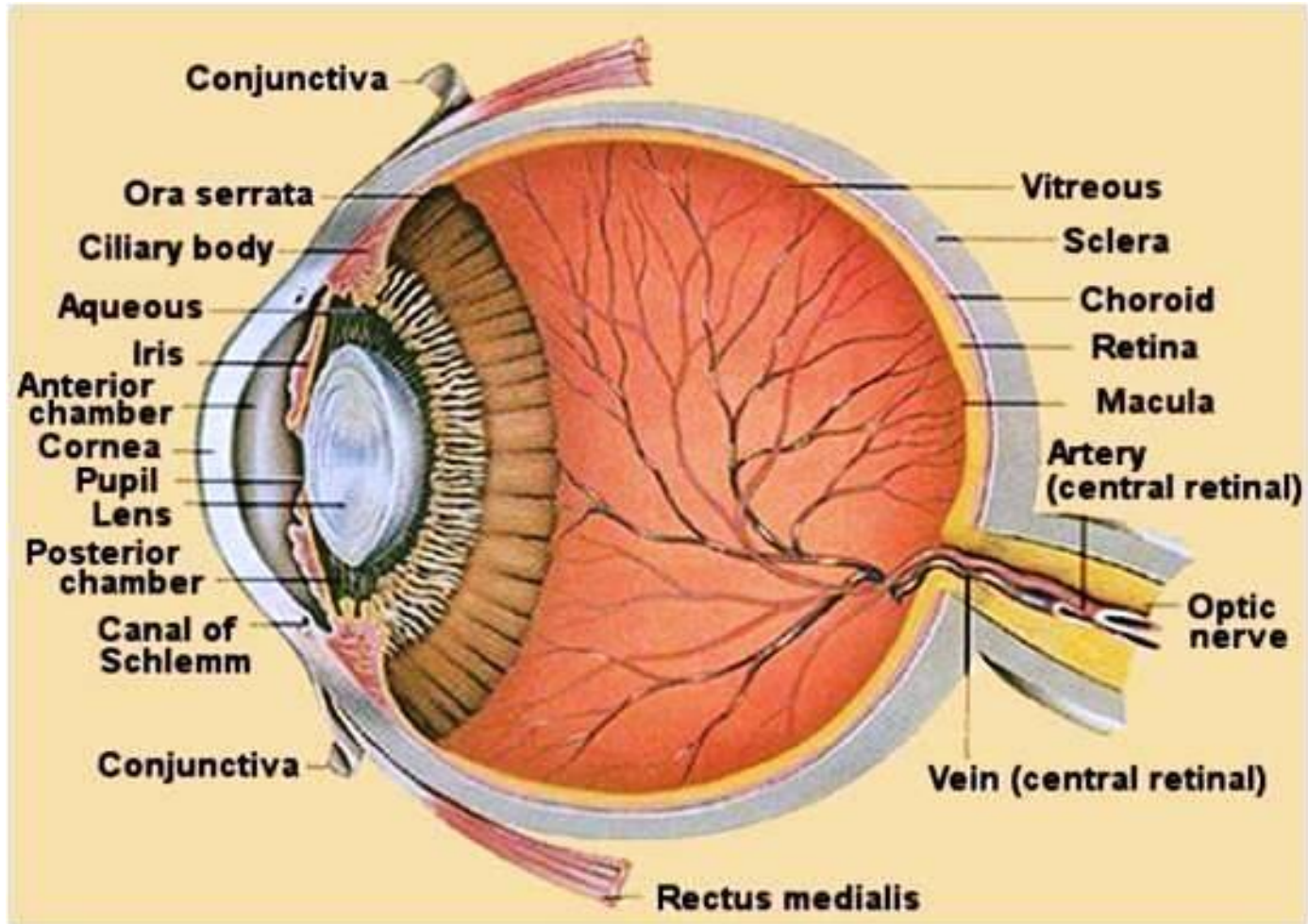
- 
-
- **Special senses**
 - Smell- chemoreceptors (**chemicals**)
 - Taste- chemoreceptors
 - Sight- photoreceptors (**light**)
 - Hearing- mechanoreceptors
 - Equilibrium- (**balance**) mechanoreceptors
 - **General senses**
 - touch (**tactile**)
 - Temperature- thermoreceptors (**heat**)
 - Pressure- mechanoreceptors (**movement**)
 - Pain- mechanoreceptors



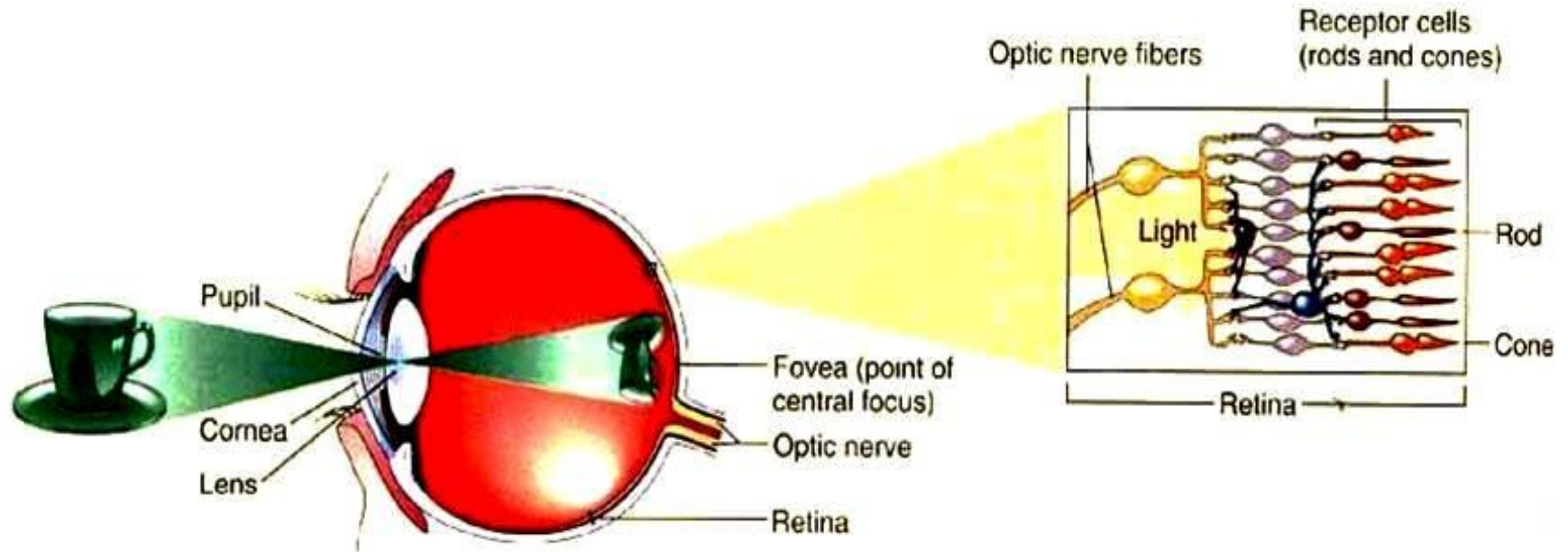
Major Sense Organs

- **Vision** – Eye
- **Hearing** – Ear
- **Taste** – Taste receptors (new)
- **Smell** – Olfactory system
- **Skin** – Hot, cold, pressure, pain

Eye



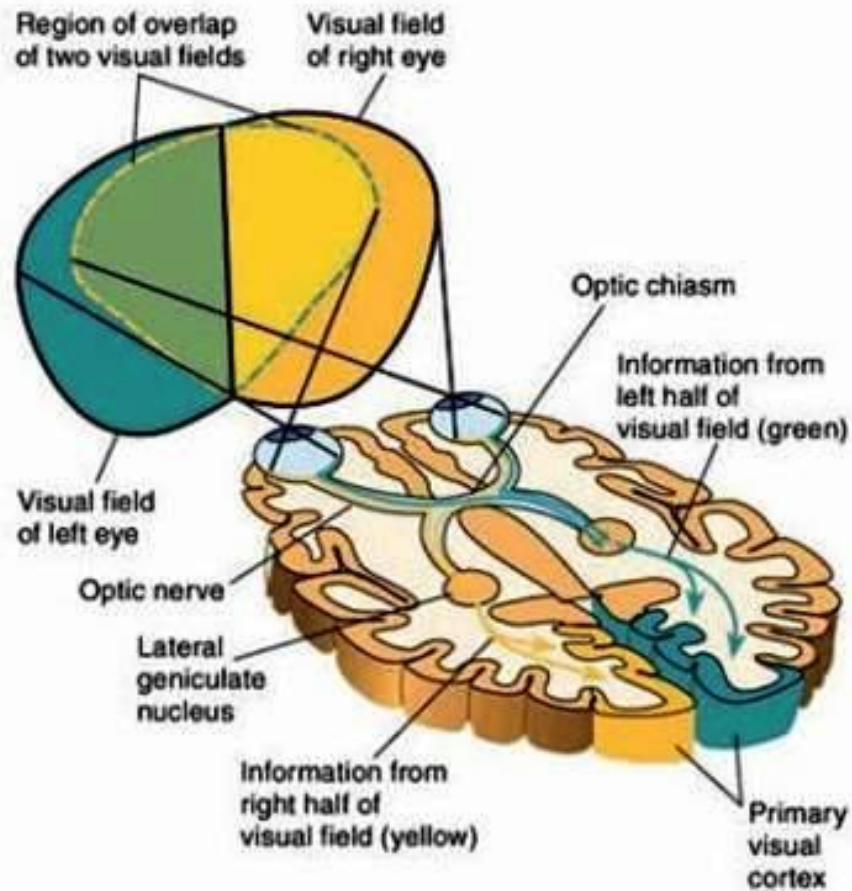
Images



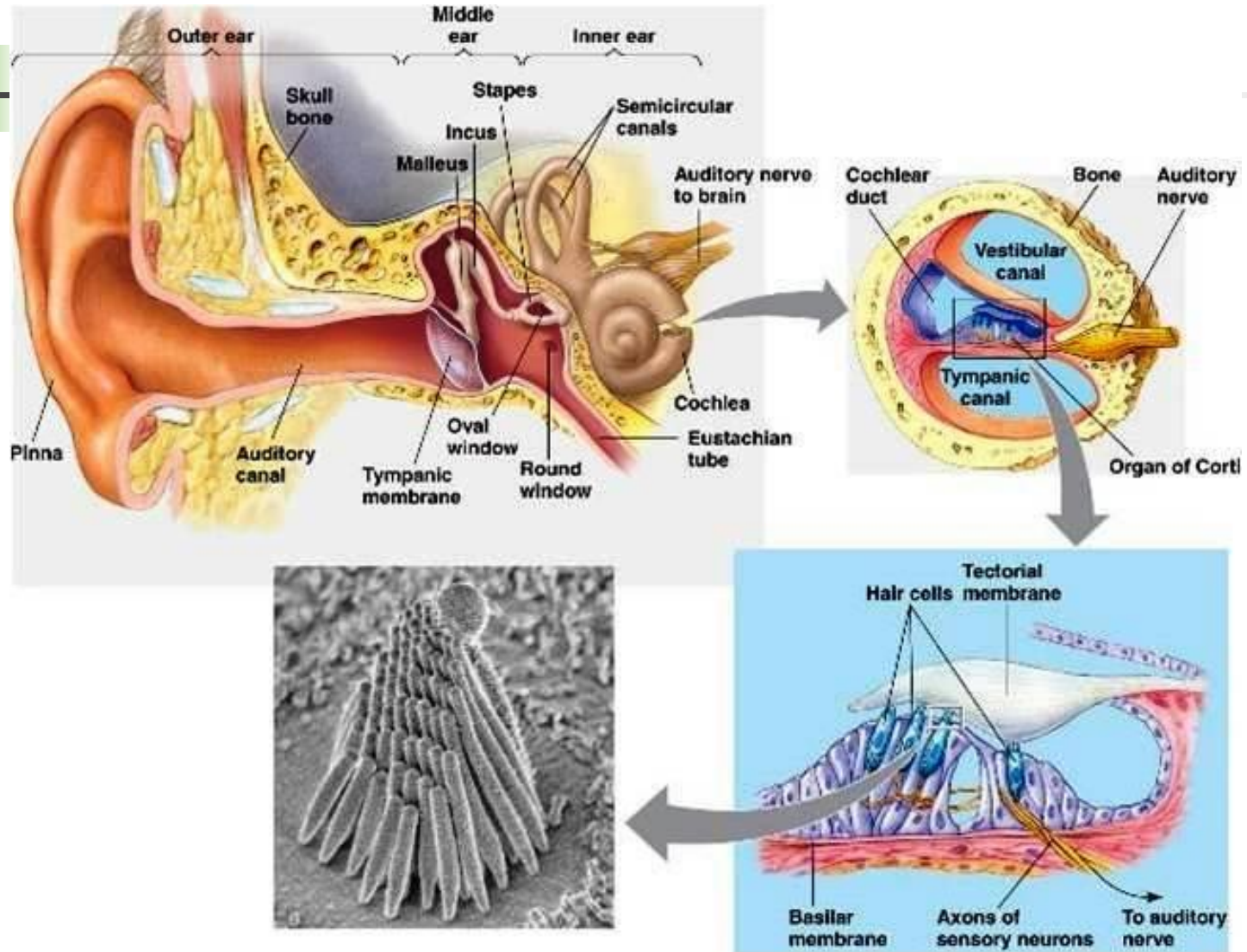
Cornea and the lens help to produce the image
Images are upside down and backwards when
they reach the retina

Visual Pathway

► The Primary Visual Pathway



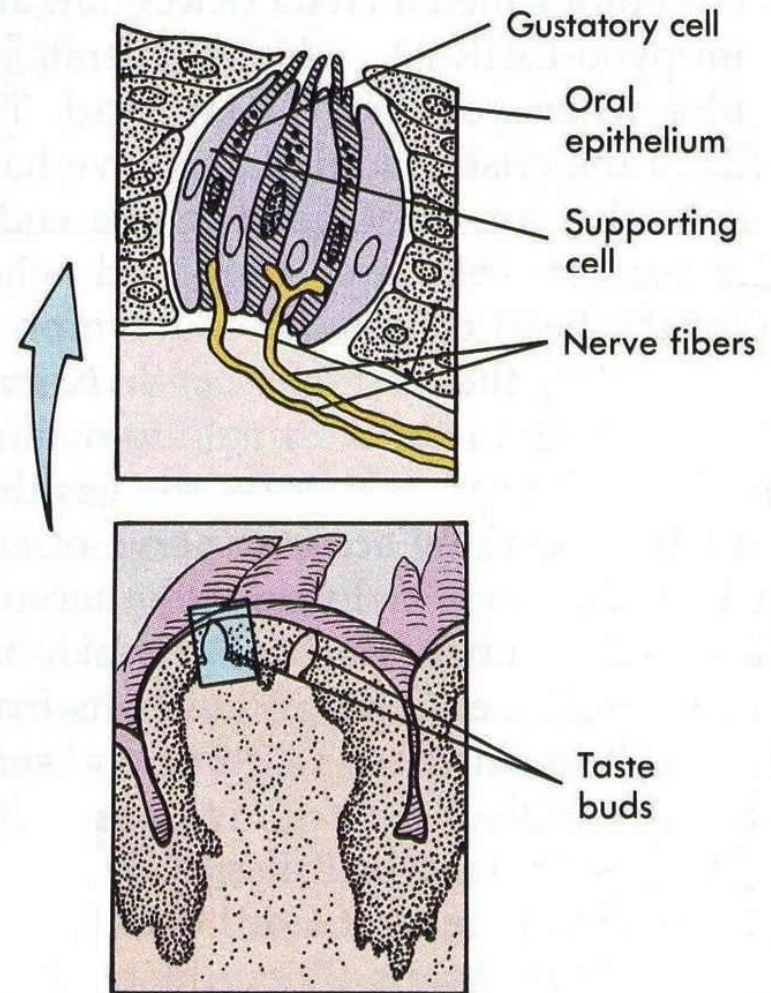
Ear



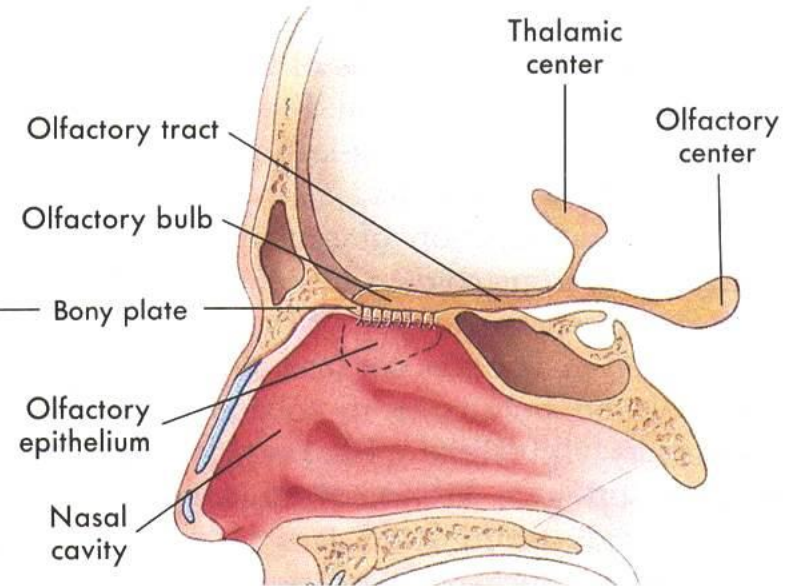
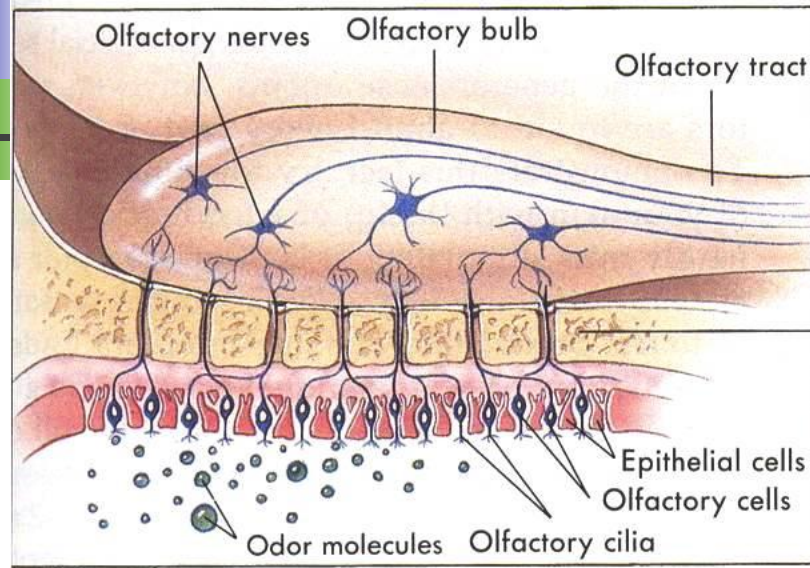
Taste Buds

- **Chemical Receptors**

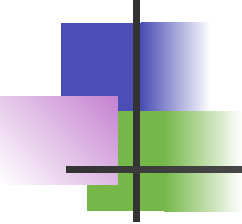
- **Sweet**
- **Sour**
- **Bitter**
- **Salty**
- **MSG**



Olfactory Receptors



- **Chemical Receptors**
- **Top of nasal cavity**
- **Extremely sensitive**
- **Easily fatigued**
- **Much of "taste" involves smell**

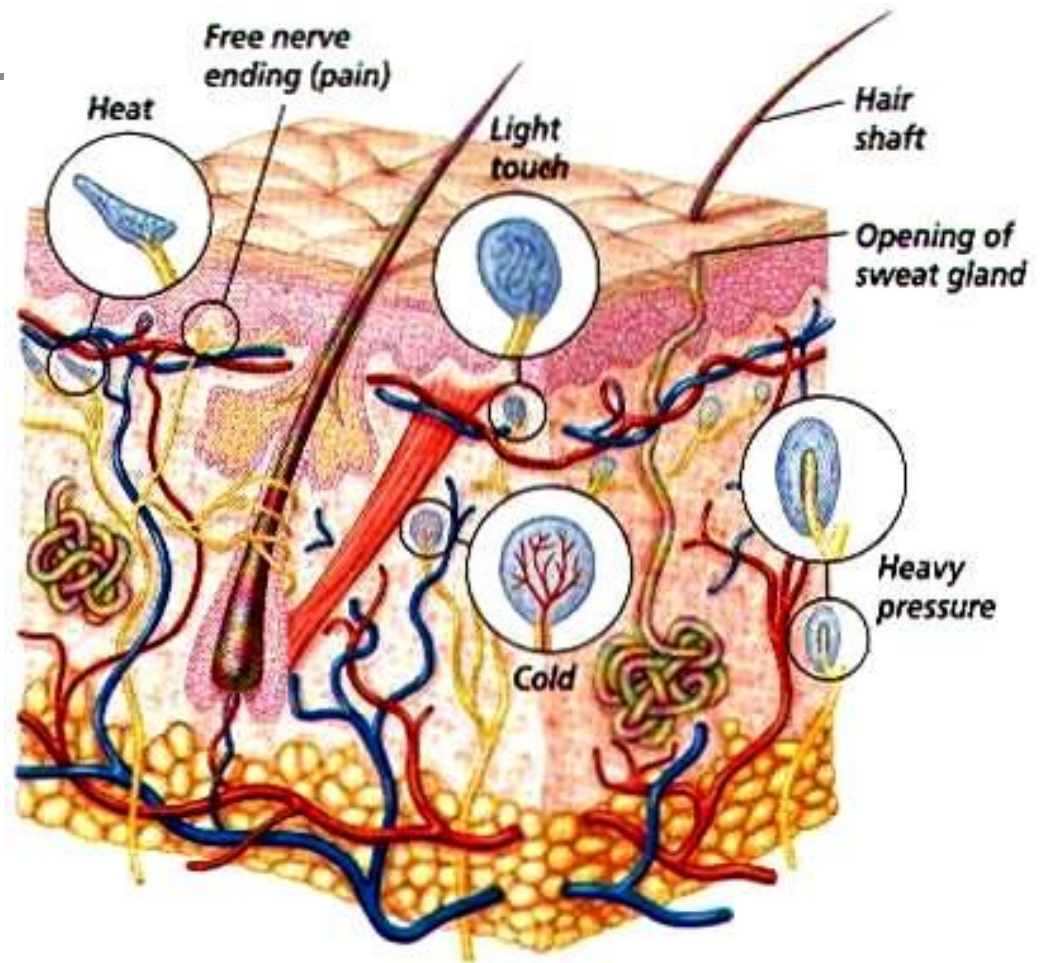


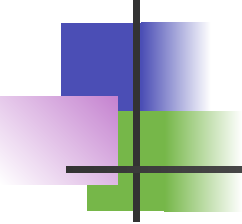
General Senses

- **Skin receptors** – touch, pressure, heat, cold, pain
- **Proprioceptors** – Stretch receptors in joints, ligaments, and tendons
- **Pain receptors** – skin, skeletal muscle and visceral

Senses in Skin

- Heat
- Cold
- Light pressure
- Heavy Pressure
- Pain



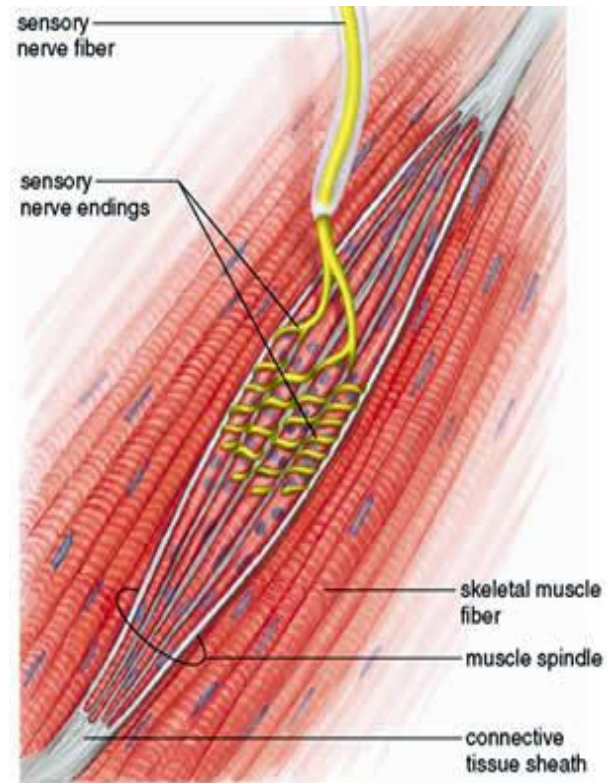


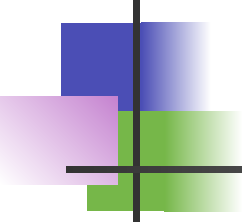
General Senses

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Proprioceptors

- Maintain some degree of continuous contraction (partial sustained contraction) or **muscle tone**
- **Muscle spindles** – modified muscle fibers with sensory nerve endings wrapped around the middle (and also found at the ends)
- Detect stretch and stimulate a reflex contraction





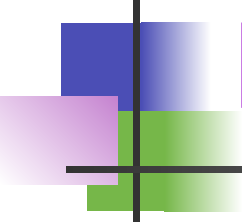
Pain Receptors

- **Somatic nociceptors** - from skin and skeletal muscle
- **Visceral nociceptors** - receptors that help maintain internal homeostasis
 - Respond to stretch, lack of O_2 , chemicals released from damaged cells and inflammatory cells.
 - ***Referred pain*** – visceral pain afferents travel along the same pathways as somatic pain afferents, so sometimes the brain interprets the visceral pain as the more common somatic pain. Example – Often pain from the heart felt during a heart attack is perceived as a pain that originates in the left arm.

Disorders of the Nervous System



- **Epilepsy,**
- **Seizures,**
- **Alzheimer's Disease**
- **Multiple Sclerosis**
- **Parkinson's Disease,**
- **Shingles (herpes zoster),**
- **Cerebral palsy,**
- **Glaucoma,**
- **Pink eye (conjunctivitis)**
- **Symptoms of disorders**
- **Treatments and prevention**



Effects of Drugs

Effects of drugs on the nervous system

- Alcohol
- Caffeine
- Nicotine
- Marijuana



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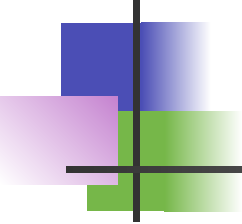
ENDOCRINE SYSTEM

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National Bio Rules

Committee Chairman

Nervous System vs. Endocrine System



	Nervous System	Endocrine System
Chemical Messenger	neurotransmitters	hormones
Location of message	synapses	target cells
Effects	rapid & short-lasting	slower & longer lasting
Controls	muscles & glands	activities of cells

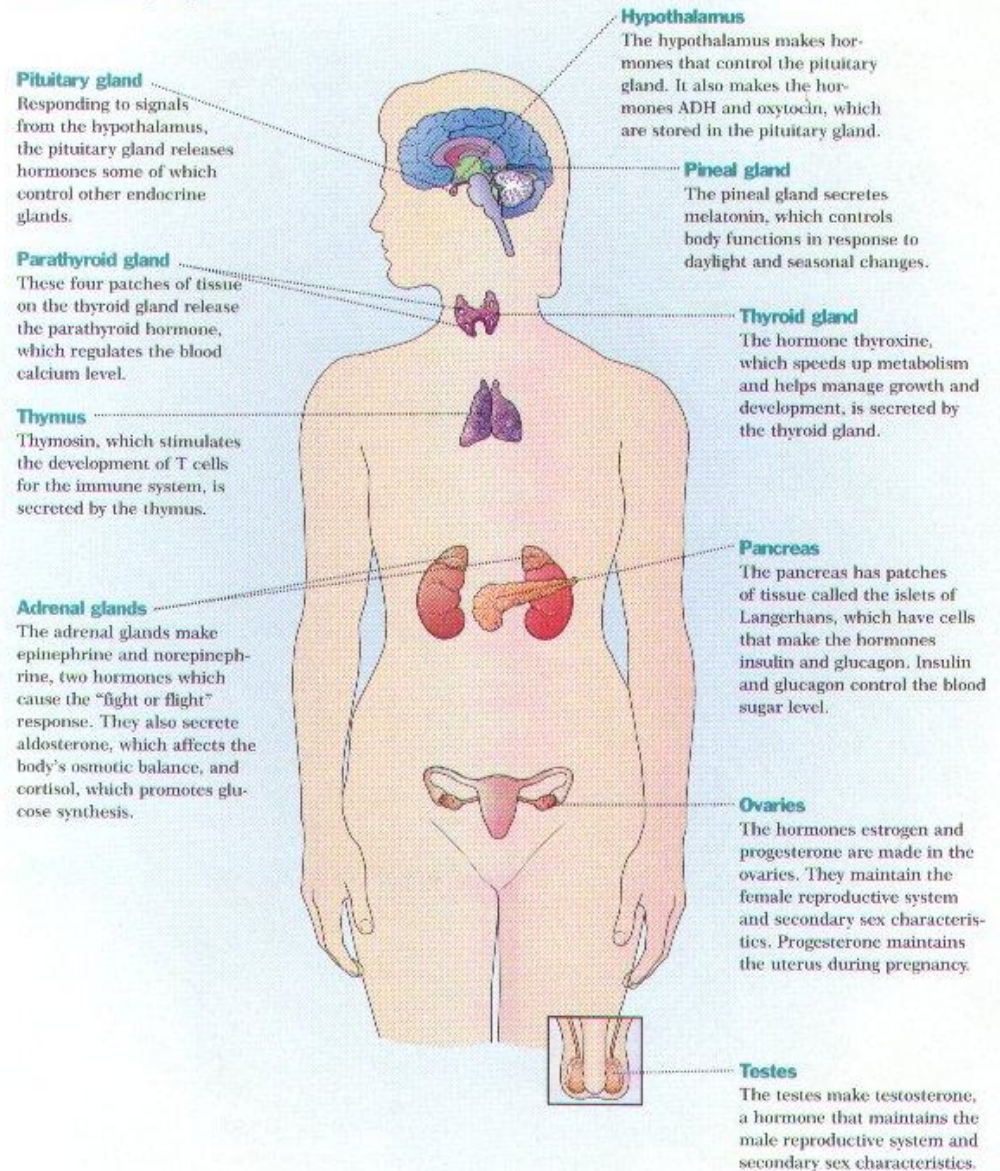
Endocrine System

Major Endocrine Organs

- Hypothalamus
- Pituitary gland
- Pineal gland
- Thyroid gland
- Parathyroid gland
- Thymus
- Adrenal gland
- Pancreas
- Ovaries
- Testes

Human Endocrine System

Endocrine glands produce hormones that control many body functions.



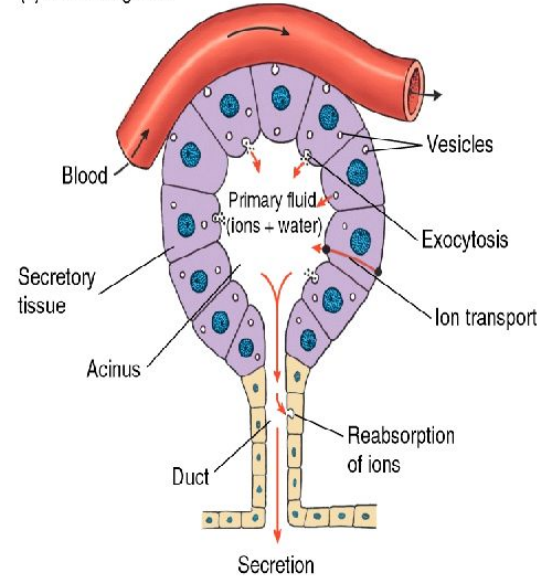
GLAND TYPES

A.

Exocrine gland

- Ducts
- Lumen and surfaces

(a) Exocrine glands

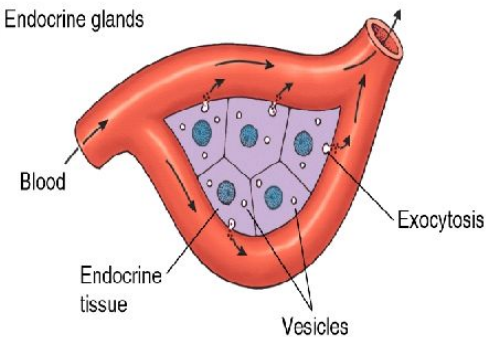


B.

Endocrine gland

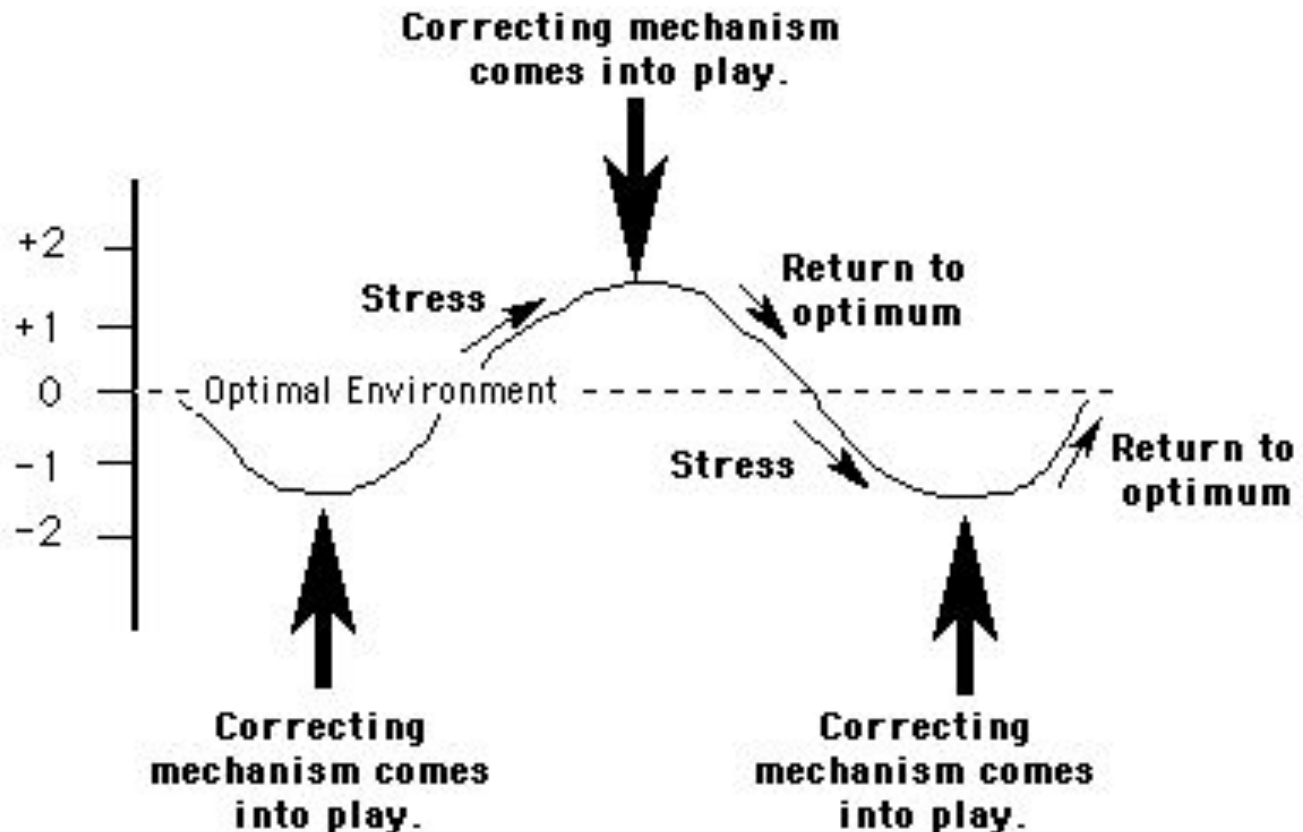
- Chemical messengers
- Blood stream

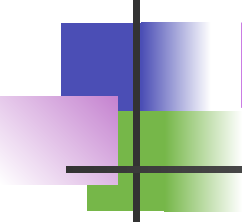
(b) Endocrine glands



ENDOCRINE SYSTEM AND HOMEOSTASIS

■ Homeostasis





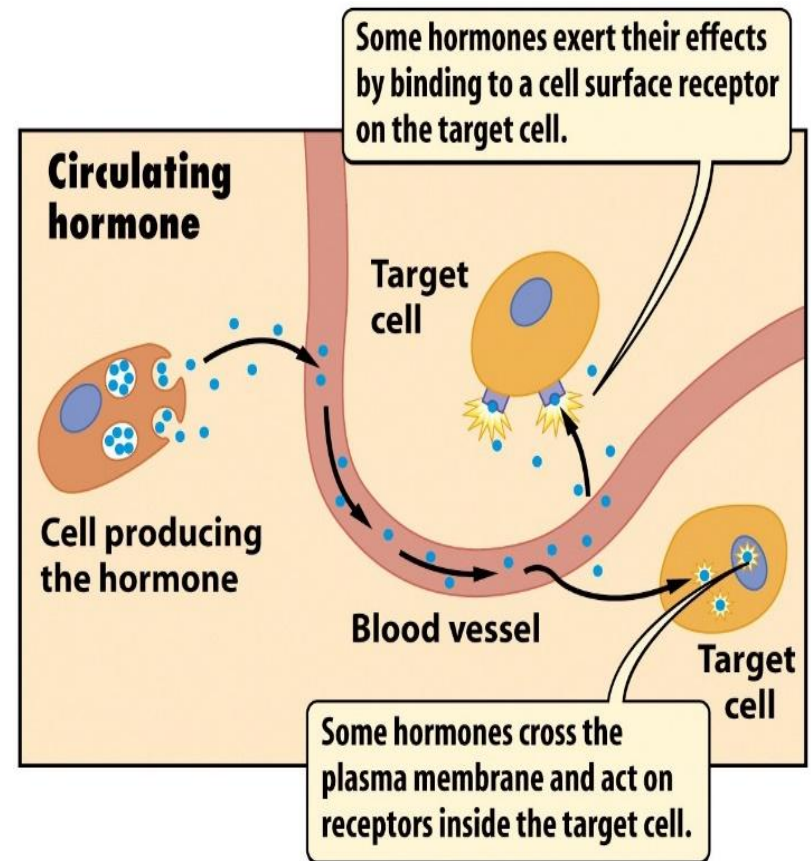
Feedback Mechanisms

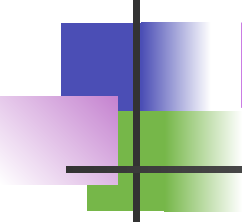
- Stimulus
 - change in homeostatic environment
 - signal sent to CNS
- Response
 - signal sent from CNS
 - produce effect
 - body returns to homeostasis

Hormones

■ Chemical messenger

- Secreted by endocrine gland
- Specific to target
- Activate cellular change
- Of 4 different chemical types





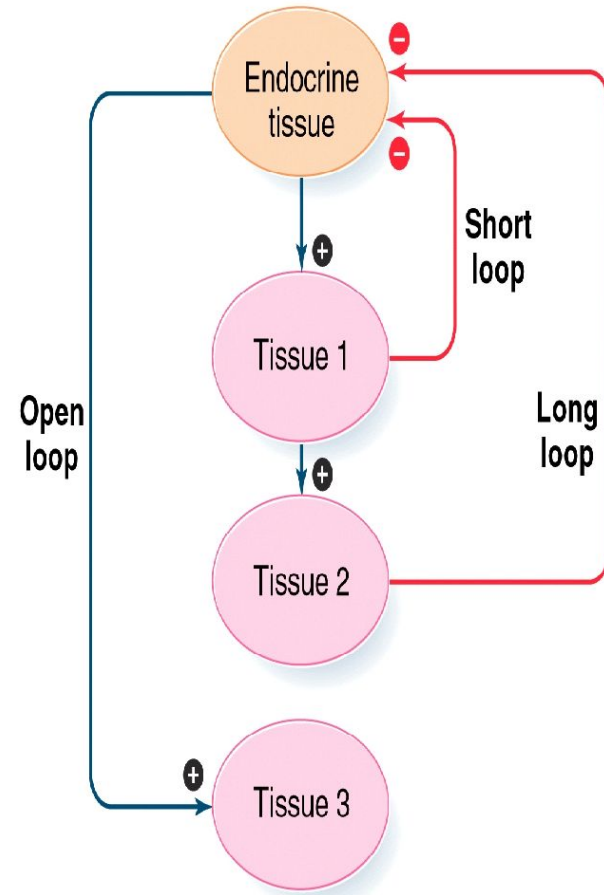
Hormones

- **specific chemical compound**
- **produced by a specific tissue of the body**
- **released in the body fluids**
- **carried to a distant target tissue**
- **affects a pre-existing mechanism**
- **effective is small amounts.**

Control of Endocrine Function

- A. **Positive**
- B. **or Negative Feedback mechanisms**

- **Self-regulating system**



STIMULUS

Hypothalamus

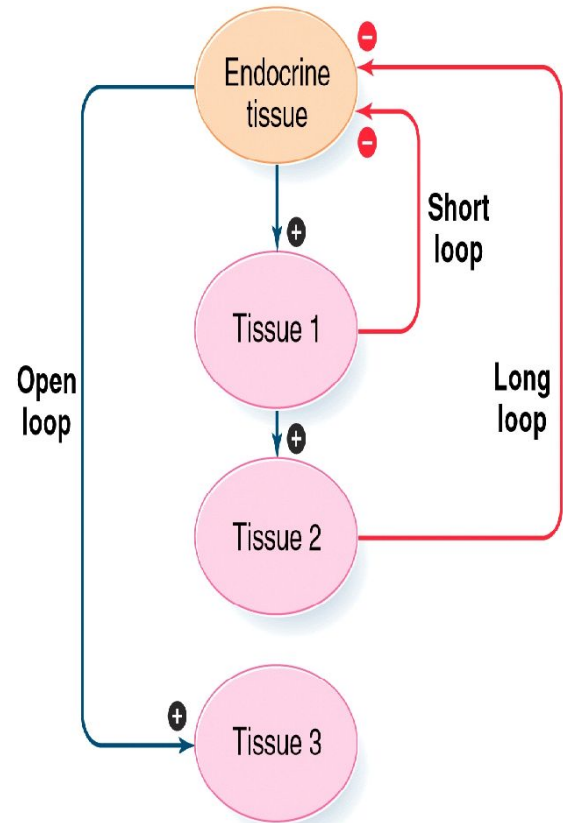
Releasing Hormone
(Release-Inhibiting
Hormone)

Pituitary

Stimulating
Hormone

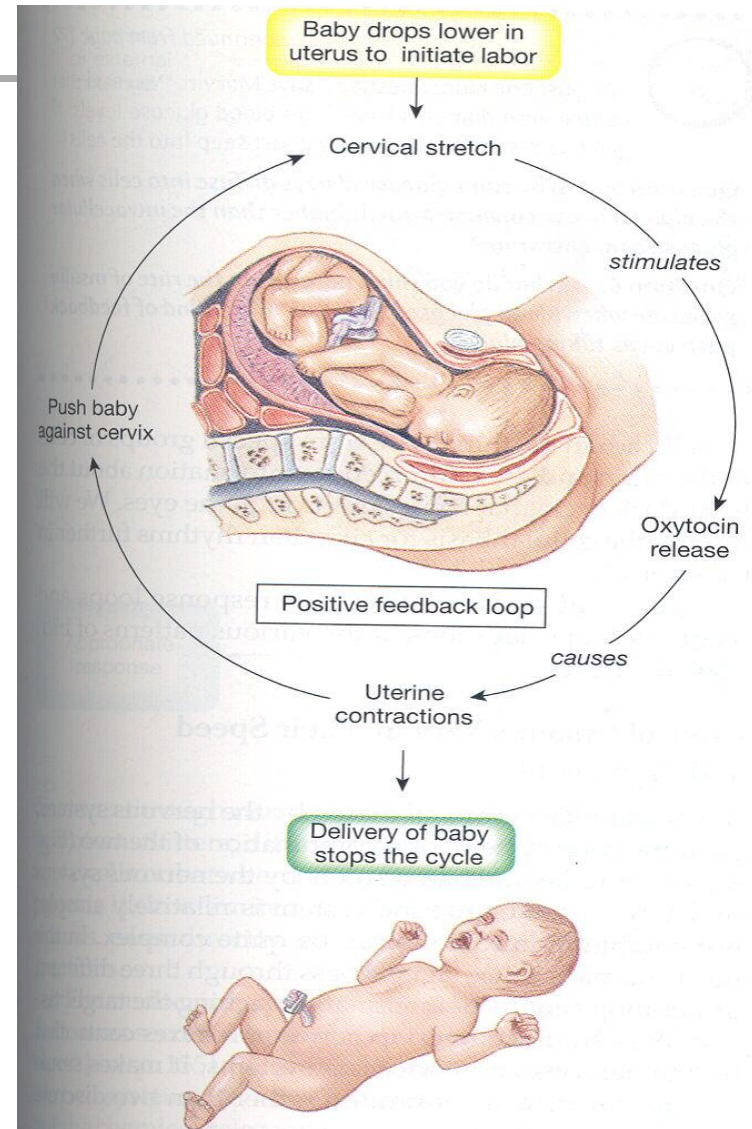
Gland
Hormone
e

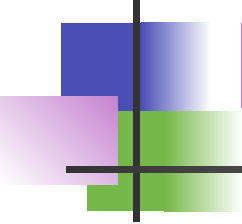
Target
t



Positive Feedback

- Not common
- Classic example:
Action of
OXYTOCIN on
uterine muscle
during birth.



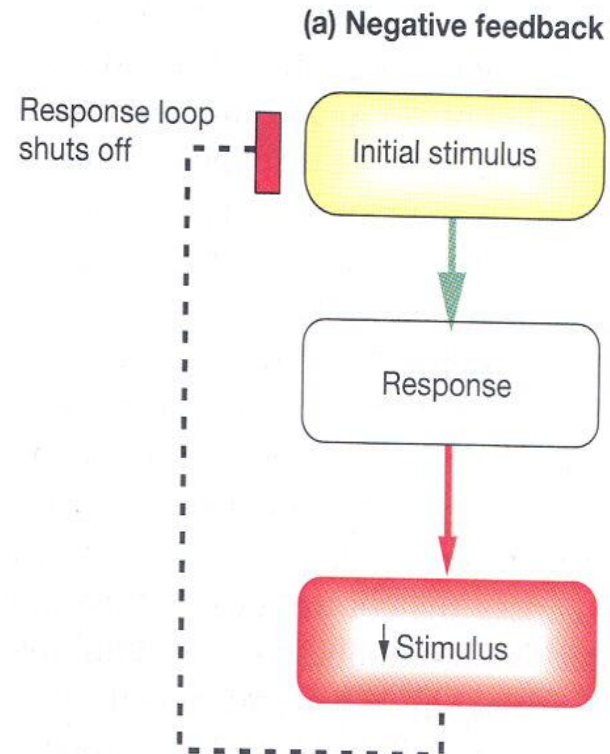


Positive Feedback

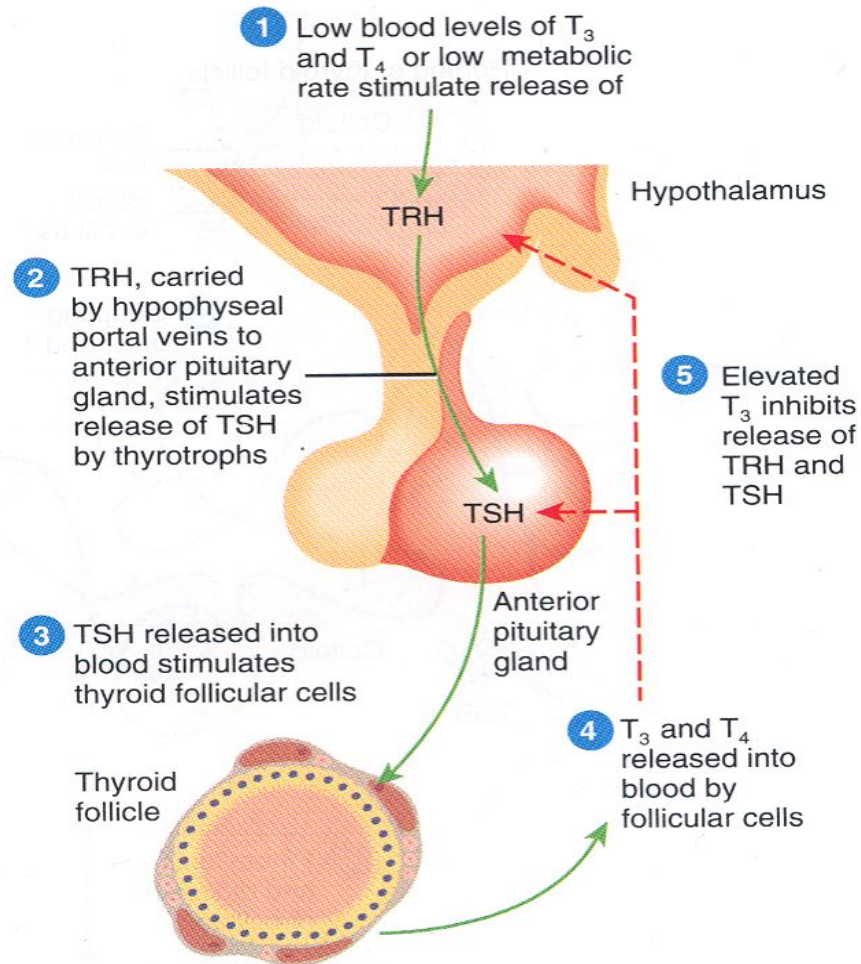
- **Baby pushes on cervix**
- **Nervous signal to Hypothalamus**
- **Hypothal. manufactures OXY**
- **OXY transported to POSTERIOR PITUITARY & released**
- **OXY stimulates uterine contraction**
- **Loop stops when baby leaves birth canal**

Negative Feedback

- **Most common control mechanism**
- **Level of hormone in blood or body's return to homeostasis shuts off loop at hypothalamus and pituitary**



Negative Feedback: Thyroid



Key:

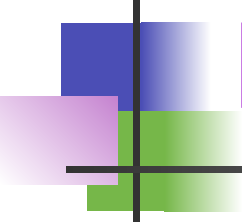
TRH = Thyrotropin releasing hormone

TSH = Thyroid-stimulating hormone

T_3 = Triiodothyronine

T_4 = Thyroxine (Tetraiodothyronine)

Basic Structure of Feedback Loop



- **Environmental Stimulus**
- **Stimulates Control Center (Brain-hypothalamus)**
- **Hypothalamic hormones stimulate Pituitary**
- **Pituitary hormone stimulate Target area**
- **Target area produces change**
- **Change acts negatively or positively on the cycle.**

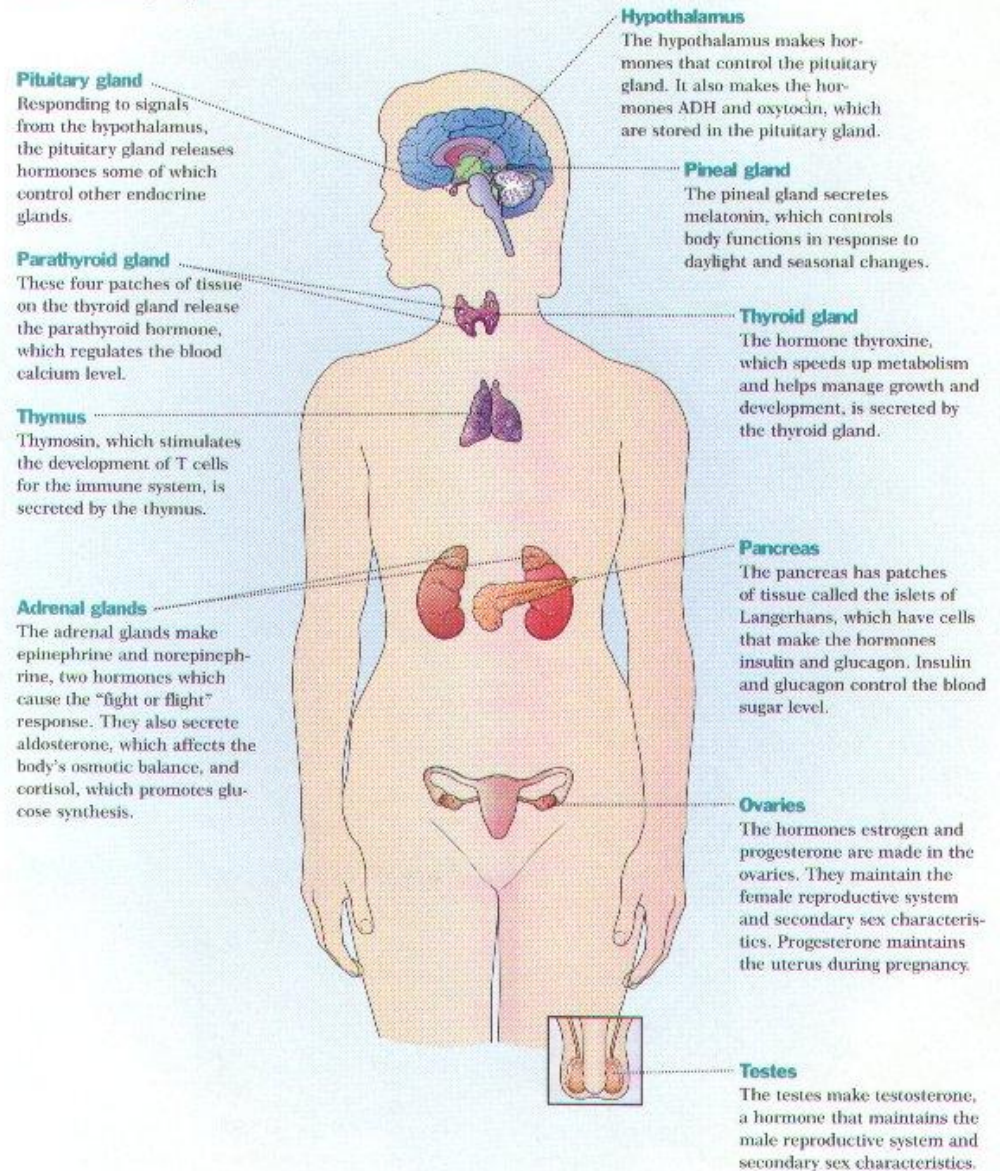
Endocrine System

Major Endocrine Organs

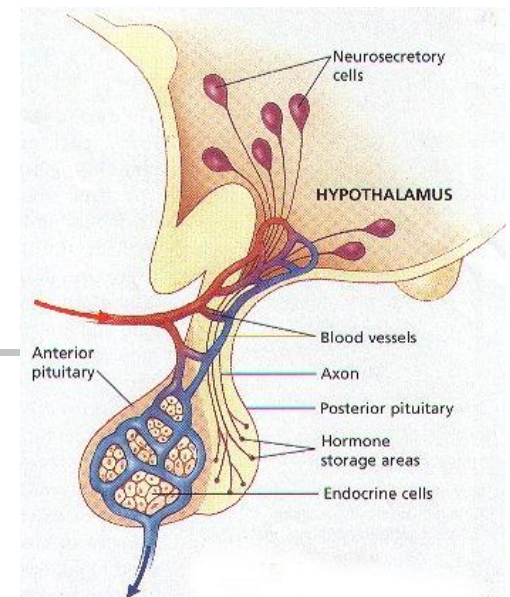
- Pituitary gland
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- Testes

Human Endocrine System

Endocrine glands produce hormones that control many body functions.



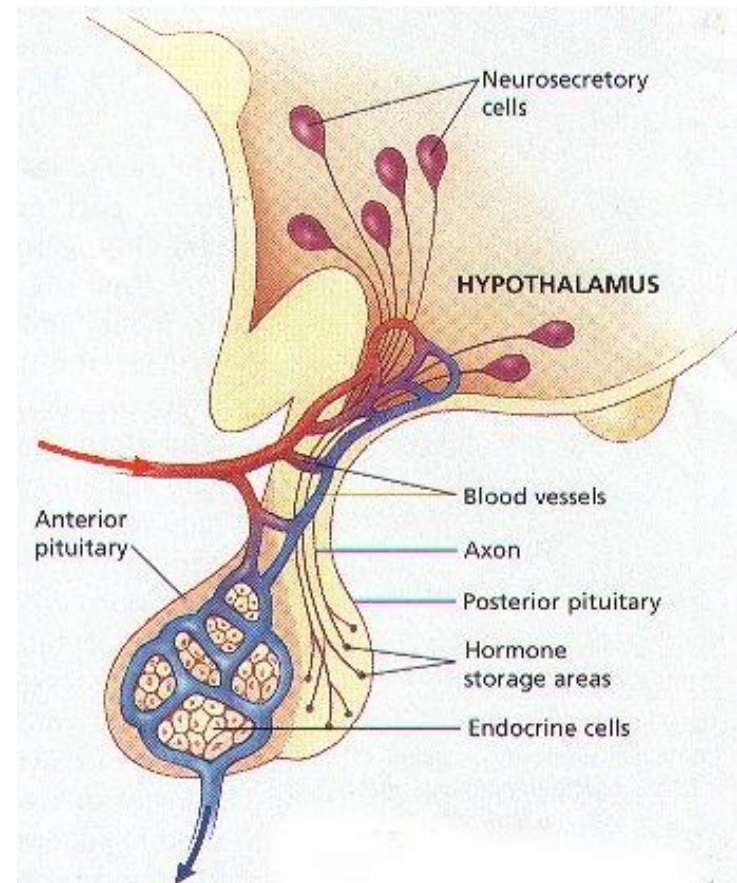
Hypothalamus

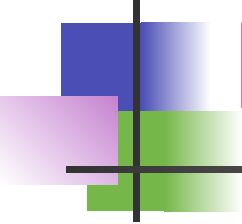


- **Connection to pituitary**
- **Also part of the brain, attached to the posterior pituitary gland**
- **Its function is to synchronize the information from the brain and the secretions of hormones**
- **Neurosecretory cells** – specialized neurons that synthesize & secrete hormones
- **The hypothalamus controls the secretions of the pituitary gland through nervous stimulation (posterior pituitary) and releasing hormones secreted to the anterior pituitary**
- **Neuronal to POSTERIOR PITUITARY**
- **Endocrine to ANTERIOR PITUITARY**
 - **RH = Pituitary releasing hormones**
 - **RIH = Pituitary release inhibiting hormones**

Neurosecretory Cells

1. **Specialized neurons**
 - Synthesize and secrete hormones
2. **Extend from HYPOTHALAMUS to POSTERIOR PITUITARY**

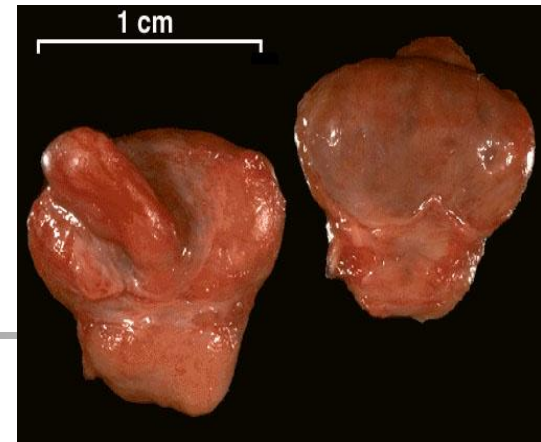




Hypothalamic Hormones

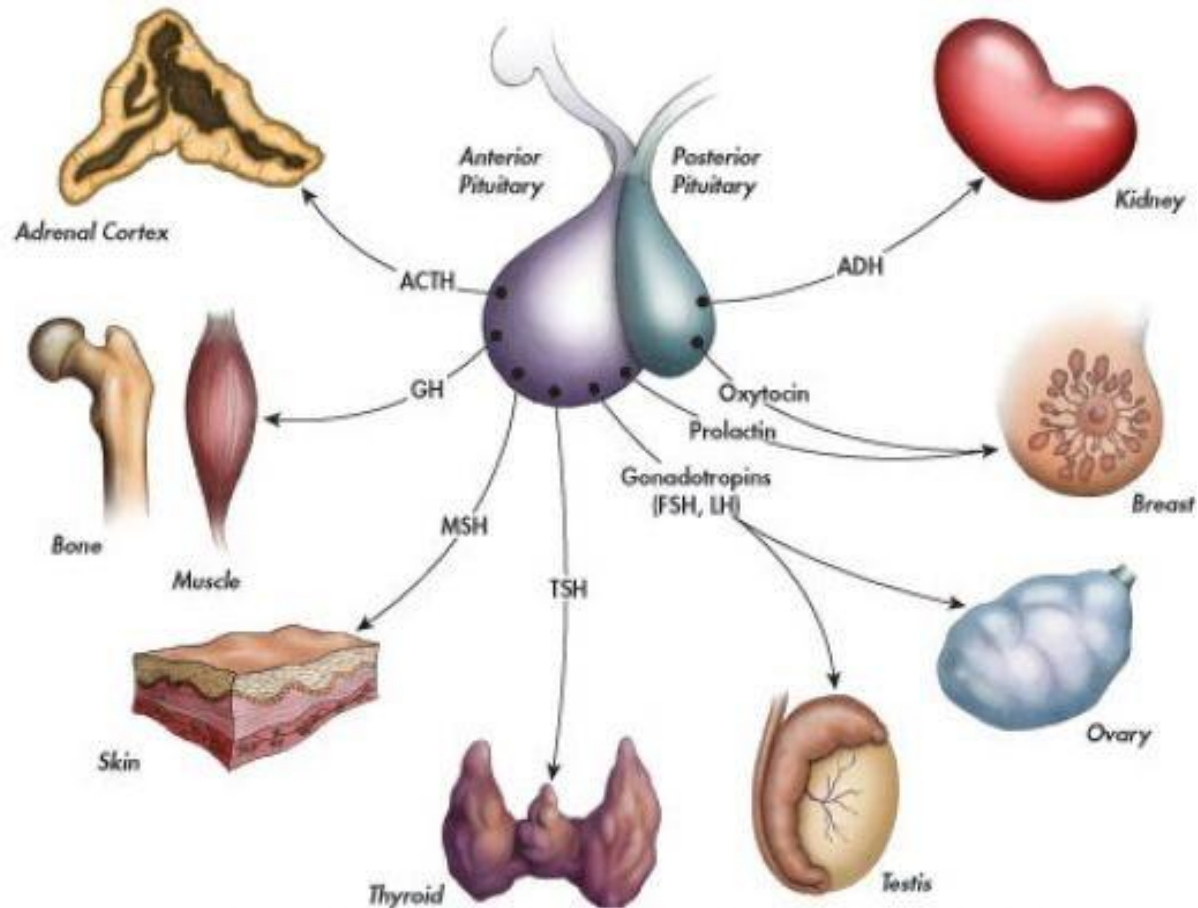
- **Release Inhibiting Hormones**
 - **Somatostatin**
 - **Prolactin release inhibiting hormone-PIH**
- **Releasing Hormones**
 - **Thyrotropin releasing hormone-TRH**
 - **Growth hormone releasing hormone-GHRH**

Pituitary gland



- Located at the base of the brain and is no larger than the size of a pea.
- Considered the most important part of the endocrine system and is often called the "*master gland*".
- Controls many other endocrine system glands. The pituitary gland helps control body and tissue growth.
- Also secretes endorphins, chemicals that reduce sensitivity to pain.
- Divided into anterior and posterior sections

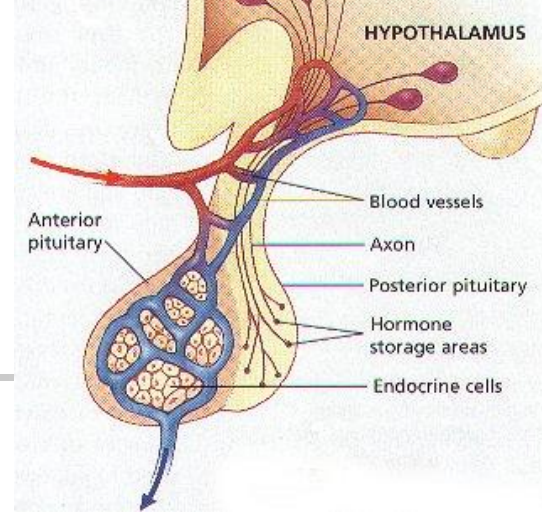
Anterior & Posterior Pituitary



Anterior Pituitary Hormones

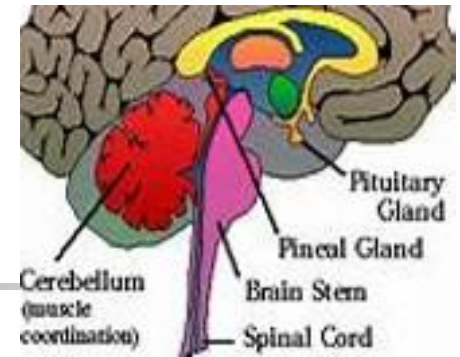
HORMONE	TARGET	FUNCTION
Thyroid (TSH) Stimulating	Thyroid gland	TH synthesis & release
Growth (GH)	Many tissues	growth
Adrenocortico- Tropin (ACTH)	Adrenal cortex	Cortisol release (androgens)
Prolactin (Prl)	Breast	Milk production
Follicle (FSH)	Gonads	Egg/sperm prod.
Luteinizing (LH)	Gonads	Sex hormones

Posterior Pituitary Hormones

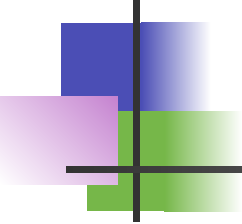


- **Manufactured in Hypothalamus, & released from Posterior Pituitary**
- **Oxytocin**
 - **Target = smooth ms. Uterus and Breast (&brain)**
 - **Function = labor and delivery, milk ejection,(pair bonding)**
- **ADH (Vasopressin AVP)**
 - **Target = kidneys**
 - **Function = water reabsorption**

Pineal Gland



- The pineal gland is located in the brain
- It secretes **melatonin**, which regulates our internal clocks and any rhythmic activities
- It plays a large role in our sleep and wake cycles



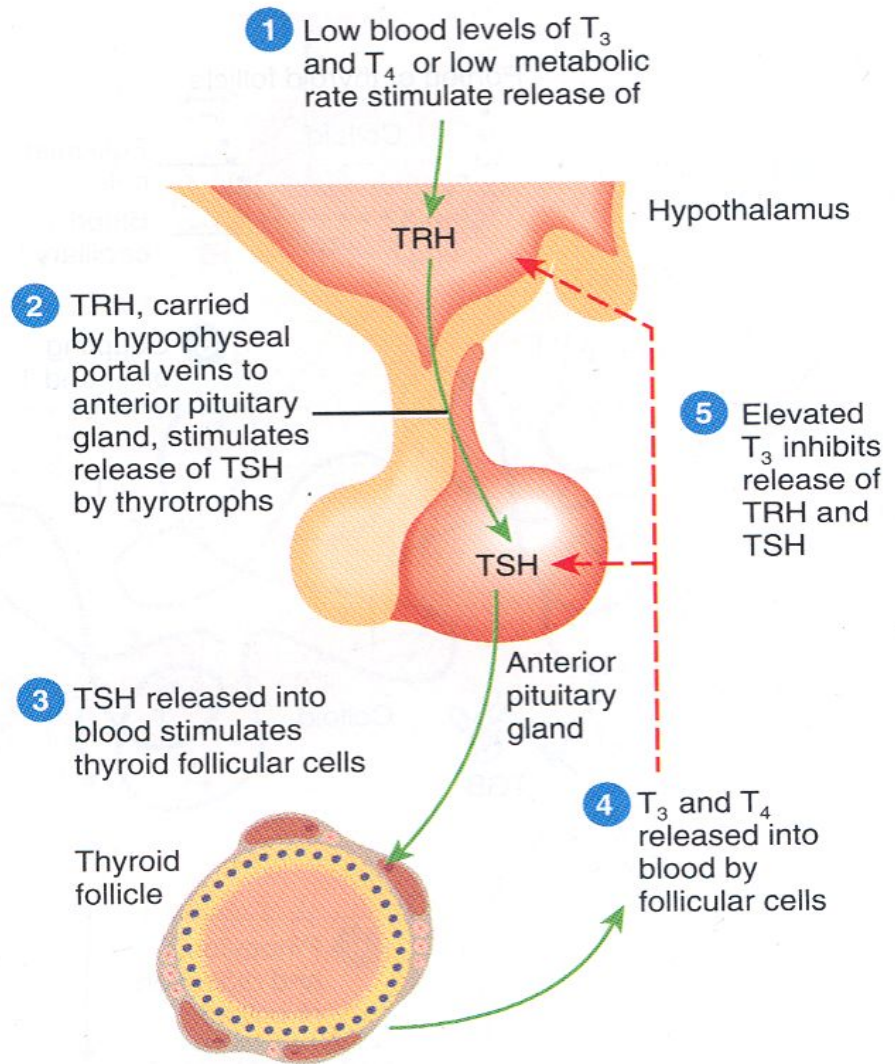
Thyroid



- It wraps around the trachea at the base of the neck
- Secretes a hormone called **thyroxine**
- Thyroxine regulates the metabolic rates of almost all the cells in the body
- As the thyroxine levels in the blood increase so does the rate of cellular respiration
- The thyroid gland needs iodine to create thyroxine, that is why salt is iodized now

Thyroid Hormone

- ↓ T₃ & T₄ stim. Or environmental stim. Hypothalamus
- TRH stim. Anterior Pituitary
- TSH stim. Thyroid
- ↑ T₃ & T₄ shuts off TRH and TSH production



Key:

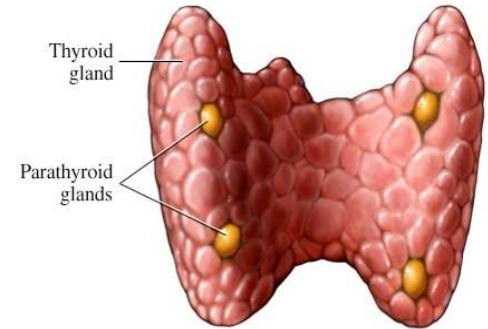
TRH = Thyrotropin releasing hormone

TSH = Thyroid-stimulating hormone

T₃ = Triiodothyronine

T₄ = Thyroxine (Tetraiodothyronine)

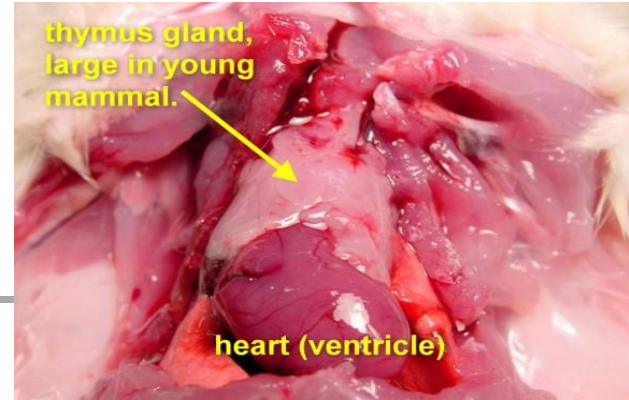
Parathyroid



These four little glands are embedded in the thyroid gland

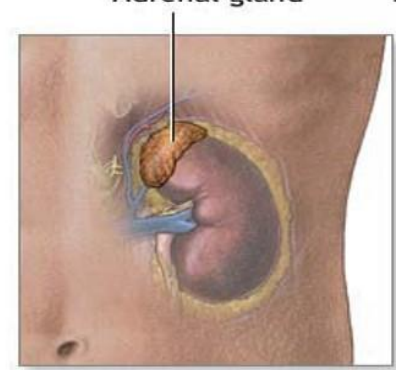
They secrete **parathyroid hormone** which regulates the amount of calcium in the blood and its absorption by bones

Thymus



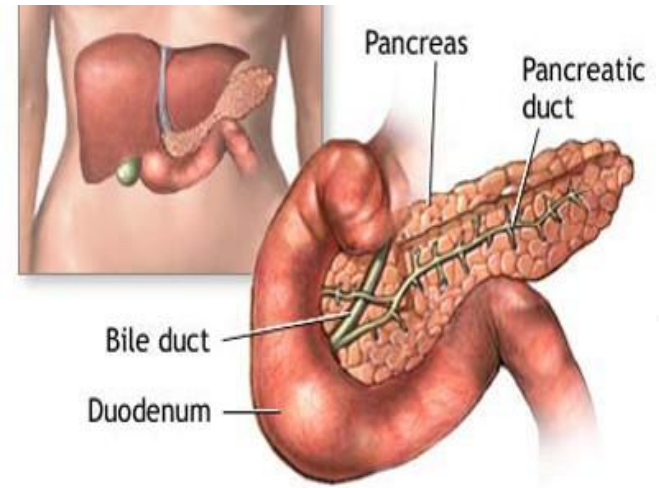
- Located below the thyroid between the right and left lung
- Secretes **thymosin** which stimulates T-cell (that is a type of white blood cell) production in children.
- This gland shrinks with age as we are exposed to more germs and build up our stores of antibodies

Adrenal



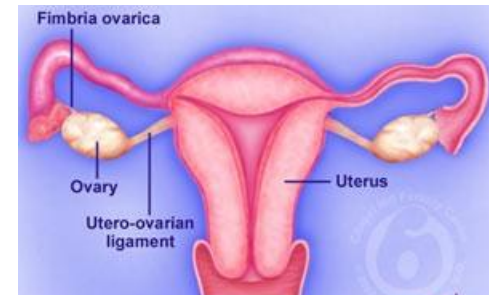
- There are two located on top of the kidneys
- Medulla secretes **epinephrine (adrenaline)** and **norepinephrine** which regulate our fight or flight response at times of extreme stress
- Cortex secretes **aldosterone** which regulates reabsorption of nutrients from the kidney
- It also secretes **cortisol** which controls the rate of metabolism of carbohydrates, fats, and proteins

Pancreas



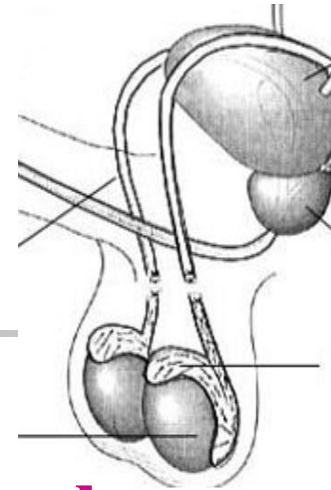
- Located behind the right side of the stomach
- Secretes **insulin** which tells the liver and muscles to remove sugar from the blood and store it as fat
- Also secretes **glucagon** which tells the liver to break down fat stores and release sugar back into the blood

Ovaries (females)



- **Secrete estrogen and progesterone which regulate the female menstrual cycle**
- **Endometrium in the uterus also secretes a female hormone when a fertilized egg binds to it to stop the menstrual cycle from progressing to menstruation**

Testicles (Males)



Secretes male steroid hormones such as testosterone.

Testosterone controls development of male characteristics such as formation of male sex organs in the womb, sperm development, and secondary sex characteristics at puberty (deep voice, facial hair, chest and armpit hair, etc.)

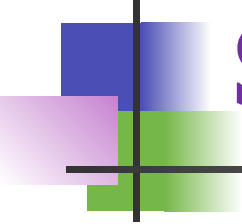


Endocrine Disorders

Hypersecretion disorders are caused by too much hormone – these are much harder to treat

Hyposecretion disorders are caused by too little hormone – they can be treated by addition of the hormone

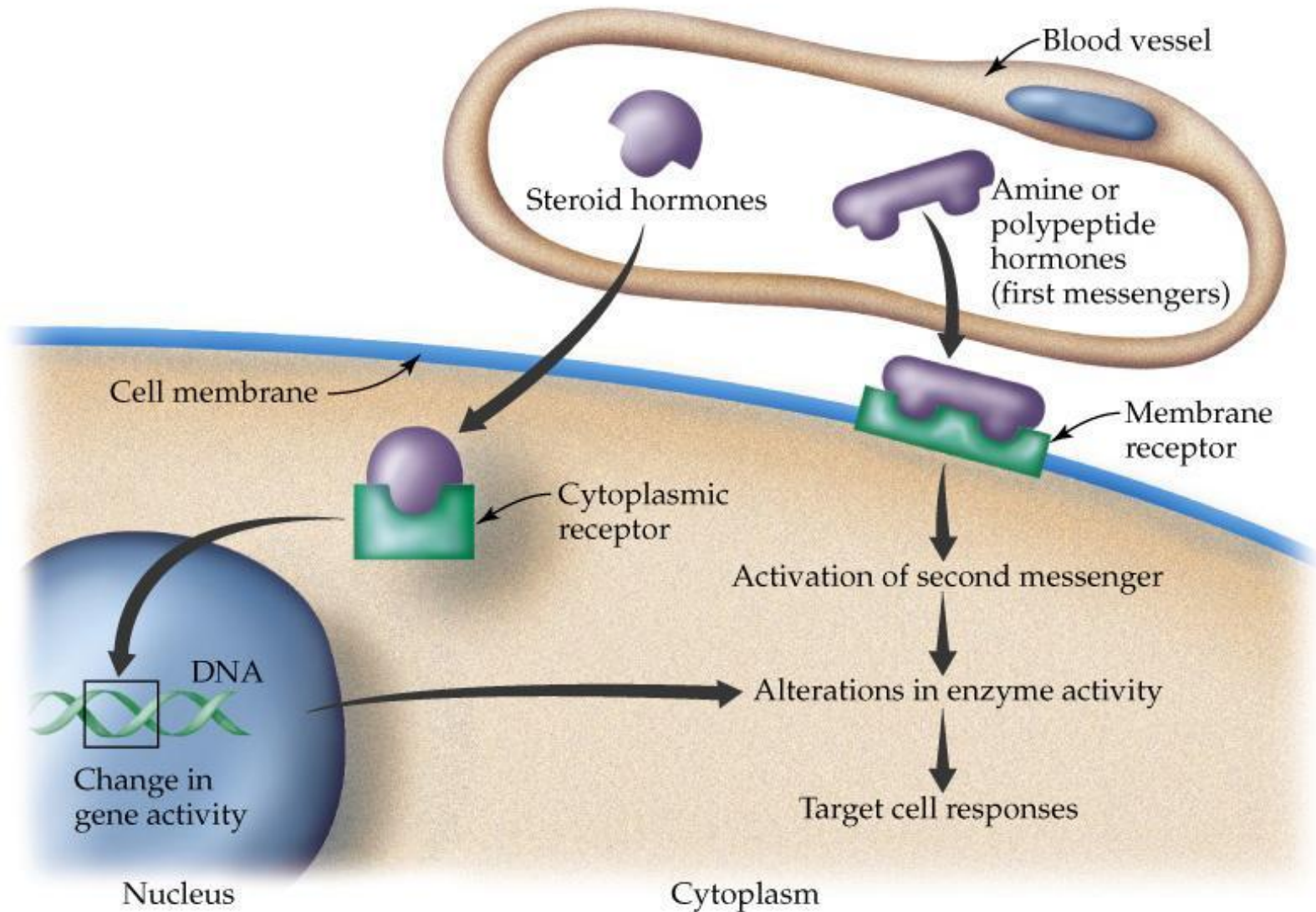
Target cell insensitivity produces symptoms similar to hyposecretion

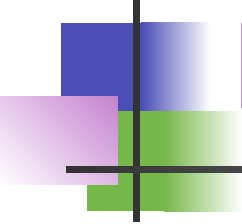


Examples of the Endocrine System Disorders

- **Diabetes** – increased levels of glucose in blood
- **Hypoglycemia** - low blood sugar
- **Graves Disease** – overactive thyroid
- **Goiter** – enlarged thyroid gland

Mechanism of Hormone Action

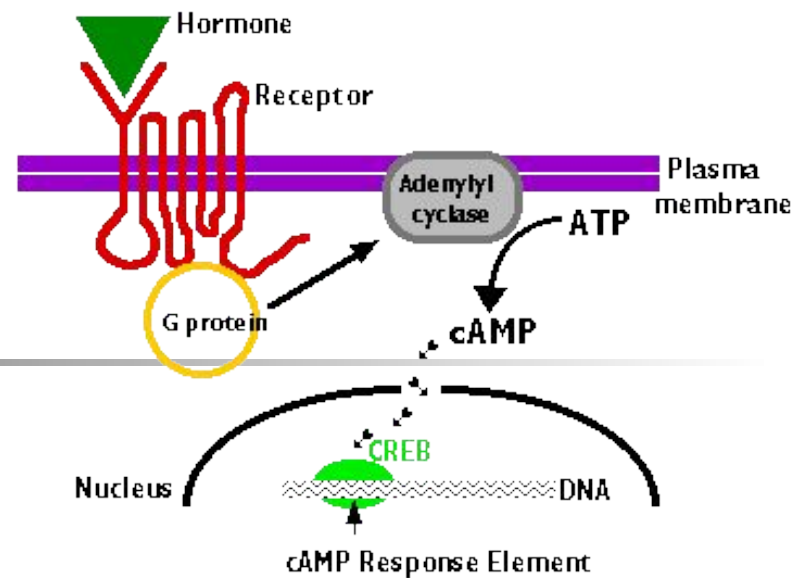




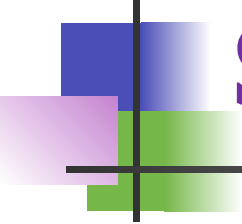
Protein/Peptide Hormones

- **Hydrophilic**
- **Large**
- **Can't fit through membrane**
- **Second messenger mechanism of action**
- **Most hormones**
- **Example: Insulin**

peptide and amines



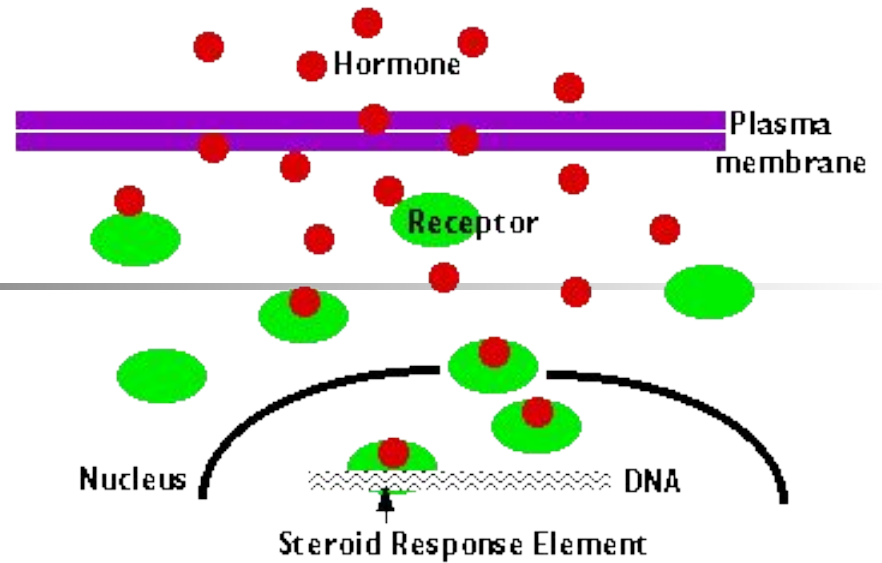
- **Protein hormones (1st messengers)** - bind to receptor on target cell triggering 2nd messenger to affect cell's activity
- **hormone (1st messenger)** *does not enter the cell* but binds to receptor on the plasma membrane receptors
- **hormone-receptor complex** activates G protein
- **generates chemical signal (2nd messenger)** – most common is cAMP and IP3
- **2nd messenger chemical** signal activates other intracellular chemicals to produce response in target cell



Steroid Hormones

- **Small**
- **Hydrophobic/Lipophilic**
- **Travel in blood w/carrier**
- **Cytoplasmic or nuclear receptors**
- **change protein synthesis**
- **Example: estradiol**

Steroid Hormones



- **Steroid hormones** - bind to receptors within target cell and influence cell activity by acting on specific genes
- **hormone** diffuses freely into cell where cytoplasmic and/ or nuclear proteins serve as receptors
- **hormone** binds to receptor (hormone-receptor complex)
- **complex binds** to steroid response element (sections of DNA receptive to the hormone-receptor complex)
- **hormone-receptor complex** acts as transcription factor to turn target genes "on" or "off"