

## AP Biology Summer Assignment

Directions: Read the PowerPoints for Chapters 43, 45, & 51 that have been printed out for you. In addition to them, use the Bozeman Biology Video Links, as well as the Internet to assist you in answering the accompanying short answer packets.

The Bozeman Biology Video Links are an extremely useful resource that we will continue to use throughout the school year. **On a separate sheet of paper take notes on each video as you watch them.**

This completed assignment is due on **Friday, September 15, 2023**. They will be used to assess how much of the material was understood, as well as count as a grade for Quarter 1.

If you have any questions along the way, feel free to contact Mrs. Grimner or Mrs. Cleere at the email addresses listed below or via REMIND.

[dgrimner@levittownschoools.com](mailto:dgrimner@levittownschoools.com)

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We will check our email accounts once a week during the summer, so remember to give us time to respond.

See you in September! 😊

## Bozeman Biology Videos

<http://www.bozemanscience.com>

**\*\*\*On a separate sheet of paper take notes on each video as you watch them.\*\*\***

### AP Biology Introduction:

- The New AP Biology Exam - A User's Guide
  - <http://www.bozemanscience.com/new-ap-biology-exam-users-guide>

### Systems:

- Organ Systems:
  - <http://www.bozemanscience.com/045-organ-systems>

### Nervous System:

- The Nervous System
  - <http://www.bozemanscience.com/nervous-system>
- Flight or Flight Responses
  - <http://www.bozemanscience.com/fight-or-flight-response>
- The Brain
  - <http://www.bozemanscience.com/the-brain>

### Endocrine System:

- The Endocrine System
  - <http://www.bozemanscience.com/endocrine-system>
- Positive and Negative Feedback loops
  - <http://www.bozemanscience.com/positive-and-negative-feedback-loops>
- Response to External Environments:
  - <http://www.bozemanscience.com/019-response-to-external-environments>

### Immune System:

- The Immune System
  - <http://www.bozemanscience.com/immune-system>
- Cell Communication
  - <http://www.bozemanscience.com/037-cell-communication>
- Plant and Animal Defenses
  - <http://www.bozemanscience.com/023-plant-and-animal-defense>

# AP Biology

## Ch. 43: Nervous System

**Central nervous system (CNS)**  
Brain  
Spinal cord

**Peripheral nervous system (PNS)**  
Cranial nerves  
Ganglia outside CNS  
Spinal nerves

## Why do animals need a nervous system?

- To respond to environmental & internal stimuli
- Nervous system characteristics:
  - Fast**
  - Accurate**
  - Reset quickly**

## Nervous System

- Central Nervous System (CNS)**
  - Brain & Spinal Cord
- Peripheral Nervous System (PNS)**
  - Nerves from **senses**
  - Nerves to **muscles**
  - Divided into **Somatic (Voluntary)** & **Autonomic (Involuntary)**
- Autonomic**
  - Divided into **Sympathetic & Parasympathetic**

**CNS**  
• Brain & Spinal Cord  
• Interneurons

**PNS**  
• Nerves branching off CNS  
• Sensory & motor neurons

**Somatic**  
• Voluntary  
• Controls skeletal muscles

**Autonomic**  
• Involuntary  
• Controls cardiac & smooth muscles

**Sympathetic**  
• Fight or Flight Response  
• Increases heart rate  
• Dilates pupils  
• Stimulates glucose release  
• Inhibits digestion

**Parasympathetic**  
• Rest & Digest Response  
• Decreases heart rate  
• Constricts pupils  
• Stimulates digestion

**ANTAGONISTS**

## Human Brain

**Cerebrum**  
• Voluntary Actions  
• Memory  
• Thinking  
• Learning

**Cerebellum**  
• Coordination & Balance

**Medulla Oblongata**  
• Involuntary Actions  
• Heart Beat  
• Breathing

**Spinal Cord**  
• Reflex Center

## Nervous System Cells

- Neurons = nerve cells
- Structure fits function
  - Many entry points for signal
  - One path out
  - Transmits signal: dendrite → cell body → axon

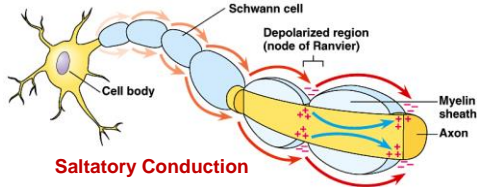
# AP Biology

## Myelin Sheath

**Multiple Sclerosis**

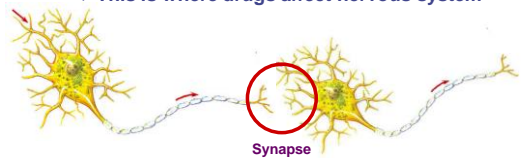
- Immune system (T cells) attacks myelin sheath
- Loss of signal

- Axon coated with insulation made of myelin cells
  - Speeds signal
    - Signal hops from node to node
  - 330 mph vs. 11 mph



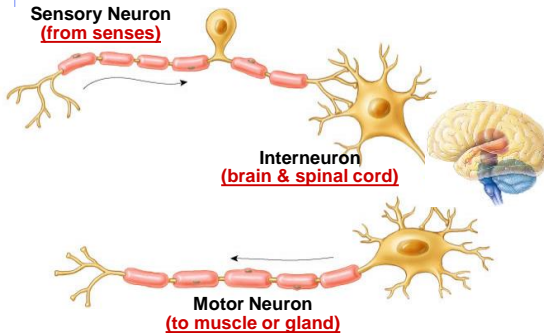
## Synapse

- Junction** (space) between nerve cells
  - Neurotransmitters** get released & diffuse across gap
  - They bind to **receptors** on the dendrites of the next neuron □ starts impulse on next neuron
  - Impulse is **chemical** in nature at this point
  - This is where drugs affect nervous system



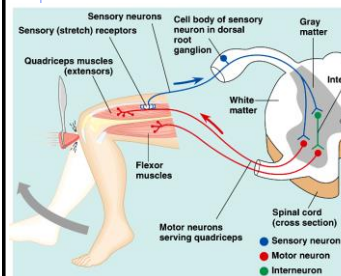
## Types of Neurons

**Sensory Neuron**  
(from senses)



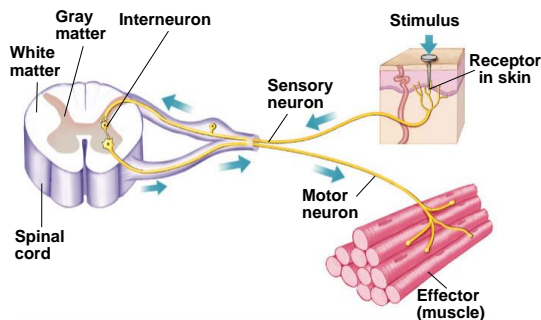
## Simplest Nerve Circuit (RSIME)

- Reflex** or automatic response

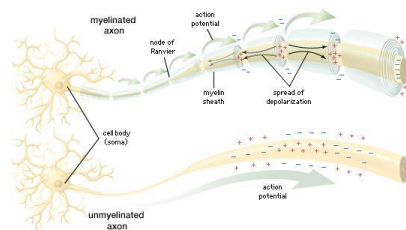


- Rapid response**
  - Automated
  - Signal only goes to spinal cord**
  - No higher level processing
- Advantage
  - Essential actions
  - Don't need to think or make decisions about
    - Blinking
    - Balance
    - Pupil dilation
    - Startle

## Eye Blink or Pain Withdrawal Reflex Arc (RSIME)



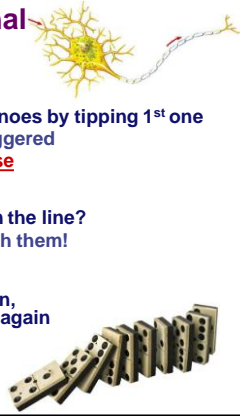
## Neurons & the Nature of Neural Signals



# AP Biology

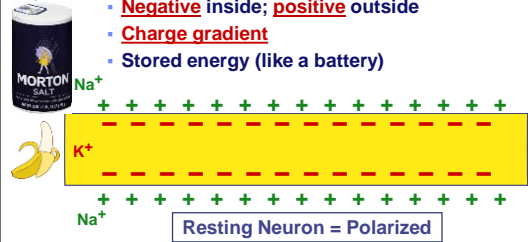
## Transmission of a Signal

- Think Dominoes!
  - Start the signal**
    - Knock down line of dominoes by tipping 1<sup>st</sup> one
      - **Threshold** must be triggered
      - **All-or-nothing response**
  - Propagate the signal**
    - Do dominoes move down the line?
      - No, just a **wave** through them!
  - Re-set the system**
    - Before you can do it again, have to set up dominoes again
      - Reset the axon

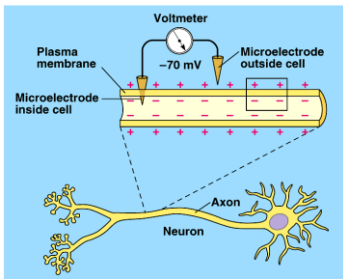


## Cells Have Voltage

- Opposite charges on opposite sides of cell membrane
  - Membrane is **polarized**
    - Negative** inside; **positive** outside
    - Charge gradient**
    - Stored energy (like a battery)



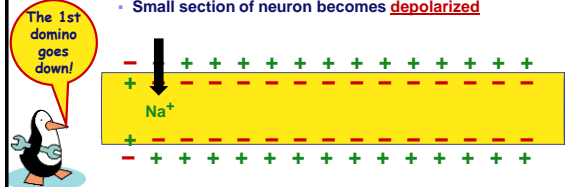
## Measuring Cell Voltage



Unstimulated Neuron = **Resting Potential** of **-70mV**

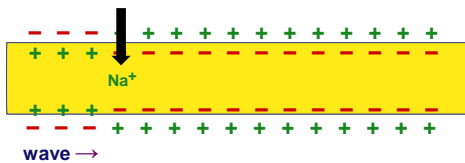
## How does a nerve impulse travel?

- Stimulus:** nerve is stimulated
  - Reaches **threshold potential** (-55mV)
    - Open Na<sup>+</sup> channels in cell membrane**
    - Na<sup>+</sup> ions diffuse **into** cell
  - Charges reverse at that point on neuron
    - Positive** inside; **negative** outside
    - Small section of neuron becomes **depolarized**

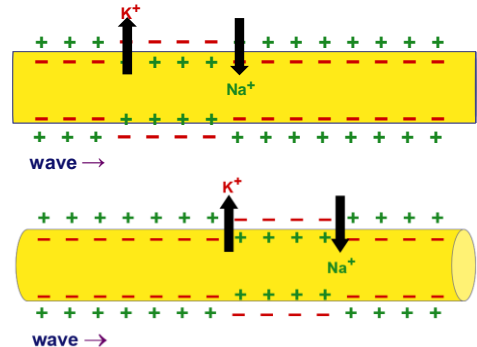


## Area of Nerve Impulse

- Travels like a **wave** down neuron = **Action Potential**
- Impulse is **electric** in nature at this point
- Signal moves in **one** direction → → → →



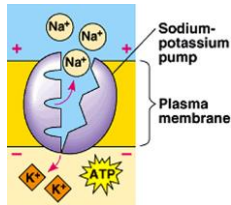
## Propagation of the Impulse



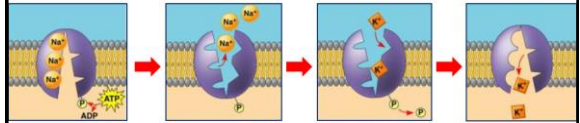
# AP Biology

## How does the neuron re-set itself?

- After firing a neuron must **re-set** itself
  - 3 Na<sup>+</sup> move back out
  - 2 K<sup>+</sup> move back in
  - Both are moving **against** concentration gradients
    - Need the **Sodium-Potassium Pump**
- This is the **refractory period** & the neuron cannot be stimulated



## The Sodium-Potassium Pump



- 3 Na<sup>+</sup> bind to pump
- ATP phosphorylates pump
- 3 Na<sup>+</sup> are released out
- 2 K<sup>+</sup> bind and are transported back in

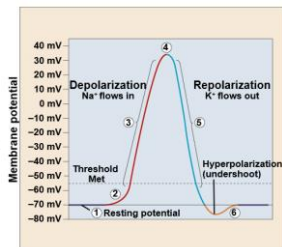


Now the ions are back where they should be!!!



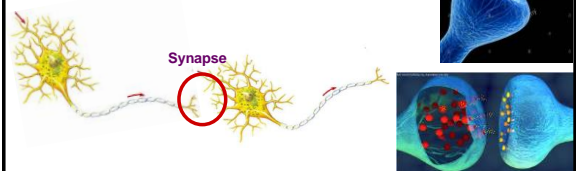
## Action Potential Graph

- Resting Potential**
- Stimulus reaches **Threshold Potential**
- Depolarization**  
Na<sup>+</sup> channels open
- K<sup>+</sup> channels open
- Repolarization**  
reset charge gradient
- Undershoot**  
Refractory Period

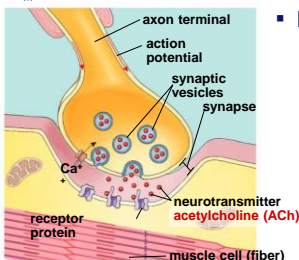


## What happens at the end of the axon?

- Impulse has to jump the **synapse**
  - Jumps quickly from one cell to next
  - Neurotransmitters** get released & bind to **receptors** on next neuron
    - starts impulse over again
  - Impulse is **chemical** in nature at this point



## Chemical Synapse



- Events at synapse**
  - Action potential depolarizes membrane
  - Opens **Ca<sup>++</sup> channels**
  - Neurotransmitter vesicles** fuse with membrane
  - Release **neurotransmitter** to synapse → **diffusion**
  - Neurotransmitter **binds** with protein **receptor**
    - ion-gated channels** open
  - Neurotransmitter degraded or reabsorbed



We switched from an electrical signal to a chemical signal

## Neurotransmitters

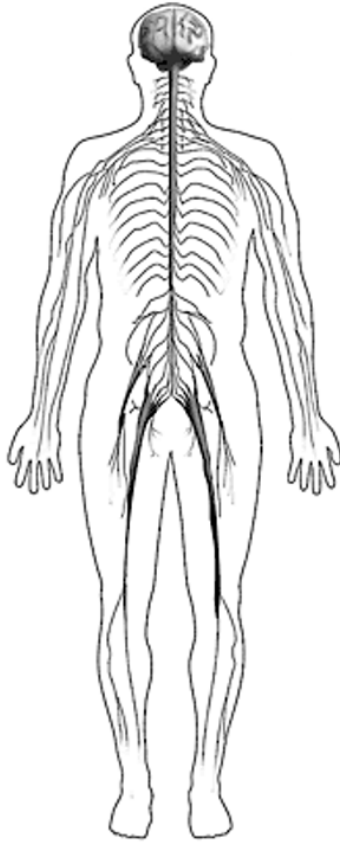
- Acetylcholine**
  - Transmit signal to skeletal muscle
- Epinephrine (Adrenaline) & Norepinephrine**
  - Fight-or-flight response
- Dopamine**
  - Widespread in brain
  - Affects sleep, mood, attention & learning
  - Lack of dopamine in brain associated with Parkinson's disease
  - Excessive dopamine linked to schizophrenia
- Serotonin**
  - Widespread in brain
  - Affects sleep, mood, attention & learning

Name: \_\_\_\_\_

Date: \_\_\_\_\_

**AP Biology**  
**Ch. 43: Nervous System**  
**Short Answer Questions**

1. Label the CNS and PNS on the diagram below.



2. Briefly describe the parts/functions of the human nervous system.

a. CNS: \_\_\_\_\_

b. PNS: \_\_\_\_\_

c. Somatic: \_\_\_\_\_

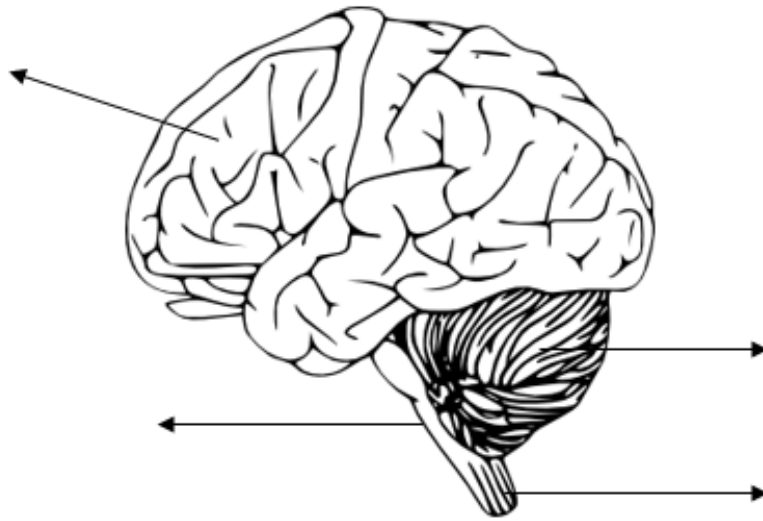
d. Autonomic: \_\_\_\_\_

e. Sympathetic: \_\_\_\_\_

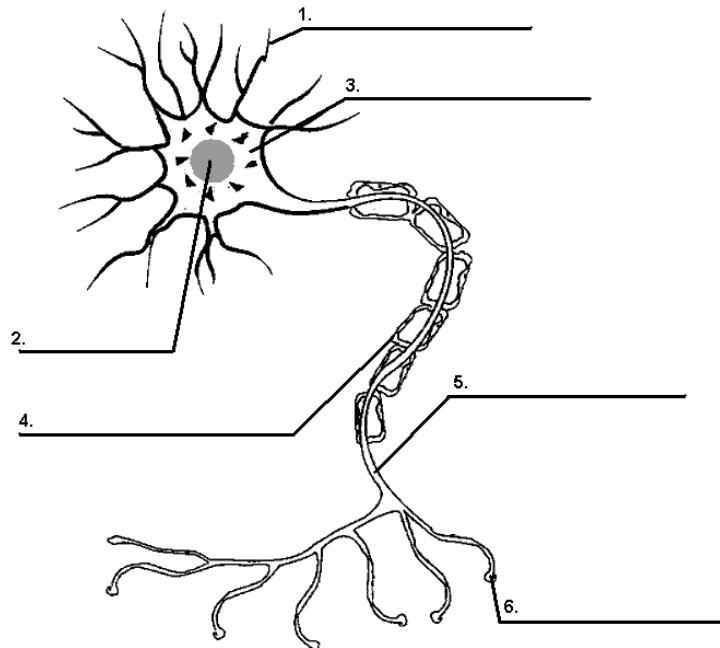
f. Parasympathetic: \_\_\_\_\_



3. Label the major components of the human brain on the diagram that follows. List one function for each part.

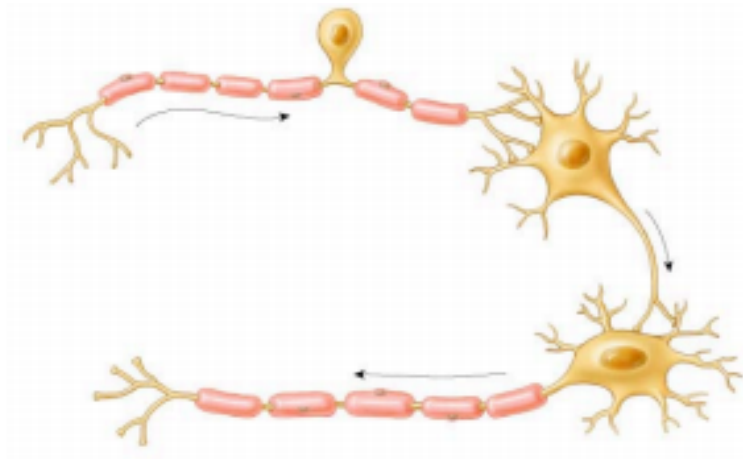


4. Label the diagram of a typical neuron.





5. Label the different types of neurons and describe their function.

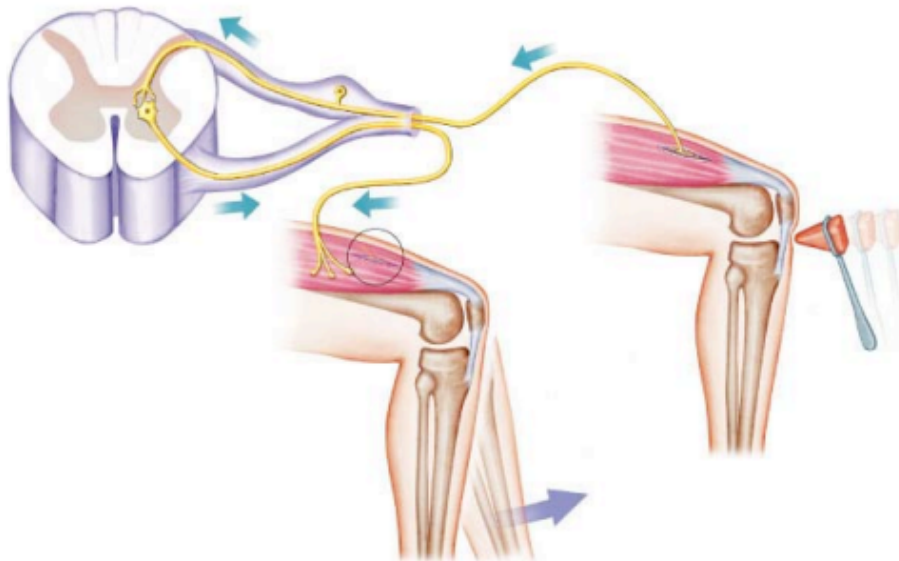


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5. Trace the reflex pathway by naming the structures.



6. In which direction does an impulse propagate down the neuron?

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7. Describe what happens when an impulse reaches the axon terminal (synaptic knobs).

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8. Describe what happens at the synapse.

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9. How are "messages" carried...

a. Along neurons: \_\_\_\_\_

b. Between neurons: \_\_\_\_\_

10. What is myelin and what purpose does it serve?

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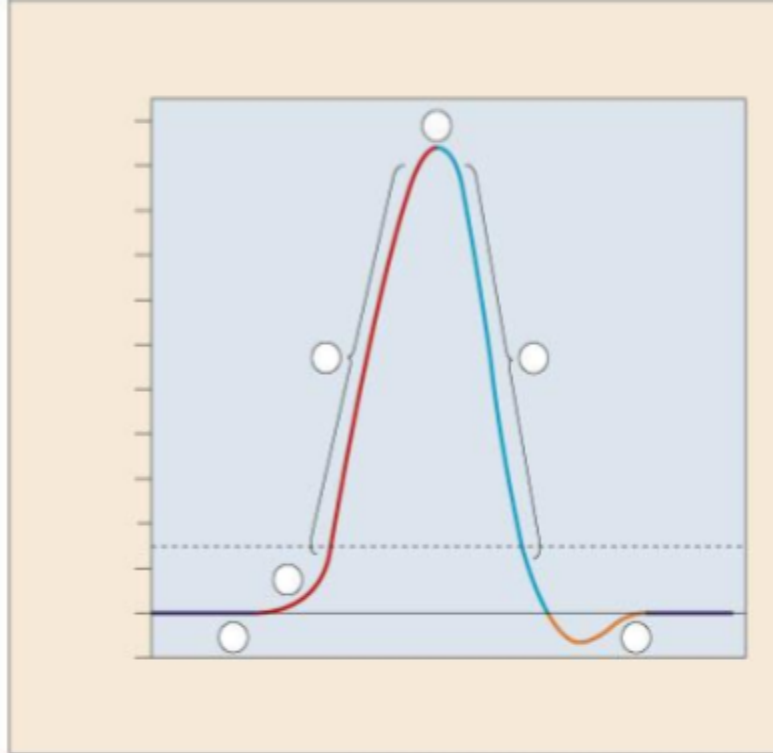
11. Draw in the charges and appropriate ions associated with the axon of a neuron at resting potential.



12. Depict how the polarity changes in the area of the axon that the impulse hits.



13. The graph below shows the changes in neuron membrane voltage as an action potential or impulse passes along it. Indicate what is happening at each stage.



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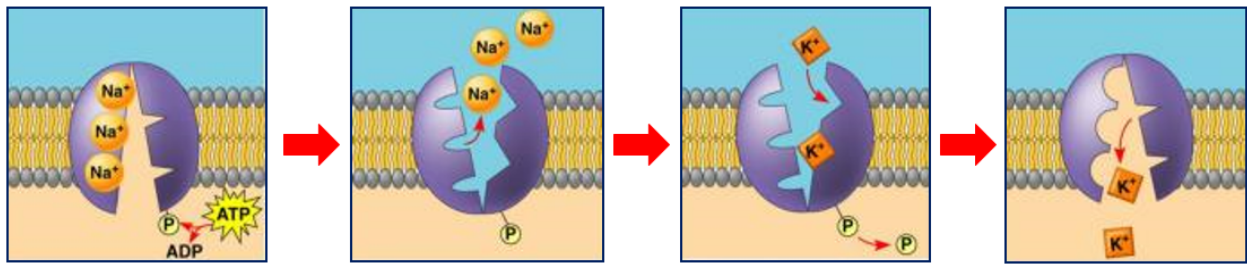
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12. What is the voltage for a neuron at resting potential? \_\_\_\_\_

13. What is the minimum voltage for threshold potential to be reached and the impulse to fire?

14. The diagram below shows the function of the sodium-potassium pump. Describe what is happening in each picture.




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15. Why is the  $\text{Na}^+/\text{K}^+$  pump necessary for proper neuron functioning?

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16. Briefly describe the different neurotransmitters below.

a. Acetylcholine: \_\_\_\_\_

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b. Epinephrine (Adrenaline) & Norepinephrine: \_\_\_\_\_

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c. Dopamine: \_\_\_\_\_

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d. Serotonin: \_\_\_\_\_

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Name: \_\_\_\_\_

Date: \_\_\_\_\_

AP Biology  
Ch. 45: Endocrine System & Hormones

**PITUITARY HORMONES**

<b>LOBE</b>	<b>HORMONES</b>	<b>FUNCTION</b>
Anterior	Thyroid Stimulating Hormone (TSH)	
Anterior	Adrenocorticotropic Hormone (ACTH)	
Anterior	Growth Hormone (GH)	
Anterior	Follicle Stimulating Hormone (FSH)	
Anterior	Luteinizing Hormone (LH)	
Anterior	Prolactin	
Posterior	Oxytocin	
Posterior	Anti-diuretic Hormone (ADH) {Vasopressin}	

## OTHER HORMONES

GLAND	HORMONES	FUNCTION
Pineal	Melatonin	
Thyroid	1. Thyroxin	1.
	2. Calcitonin	2.
Parathyroids (4)	Parathormone	
Thymus	Thymosin	
Adrenal Glands (2)	1. Adrenaline/ Noradrenaline (Epinephrine/ Norepinephrine)	1.
	2. Cortisol	2.
Pancreas - Islets of Langerhans	1. Insulin	1.

	2. Glucagon	2.
Ovaries (2)	1. Estrogen	1.
	2. Progesterone	2.
Testes (2)	Testosterone	
Stomach	Gastrin	
Small Intestine	Secretin	

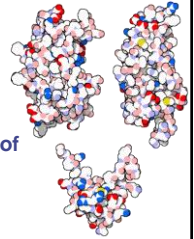


# AP Biology

## Ch. 45: Endocrine System Hormones

## Regulation

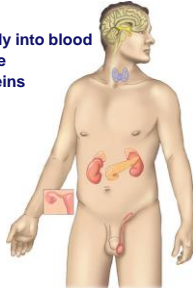
- Why are hormones needed?
  - Chemical messages from one body part to another
  - Communication needed to coordinate whole body
  - Daily homeostasis & regulation of large scale changes
    - Solute levels in blood**
      - Glucose, Ca<sup>++</sup>, salts, etc.
    - Metabolism**
    - Growth**
    - Development**
    - Maturation**
    - Reproduction**



growth hormones

## Regulation & Communication

- Animals rely on 2 systems for regulation
  - Endocrine System**
    - System of ductless glands
      - Secrete chemical signals directly into blood
      - Chemical travels to target tissue
      - Target cells have receptor proteins
      - Slow, long-lasting response
    - Nervous System**
      - System of neurons
        - Transmits "electrical" signal & release neurotransmitters to target tissue
        - Fast, short-lasting response

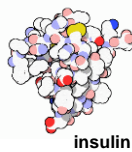


## Regulation By Chemical Messengers

- Neurotransmitters** released by neurons
- Hormones** release by endocrine glands

## Classes of Hormones

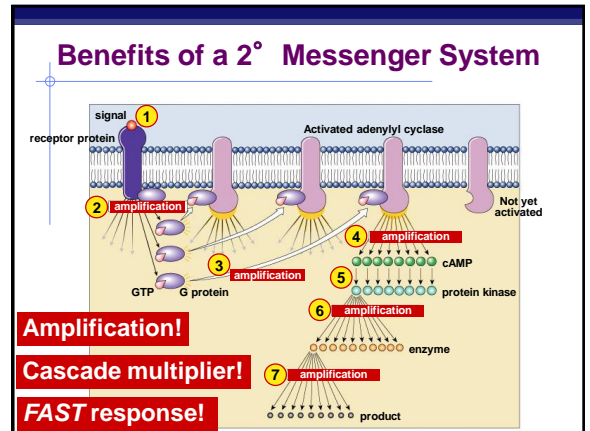
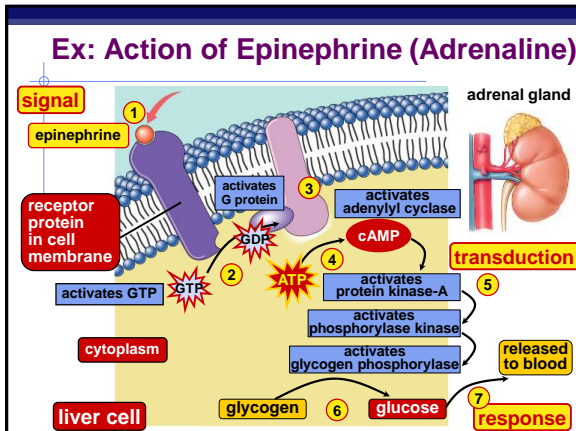
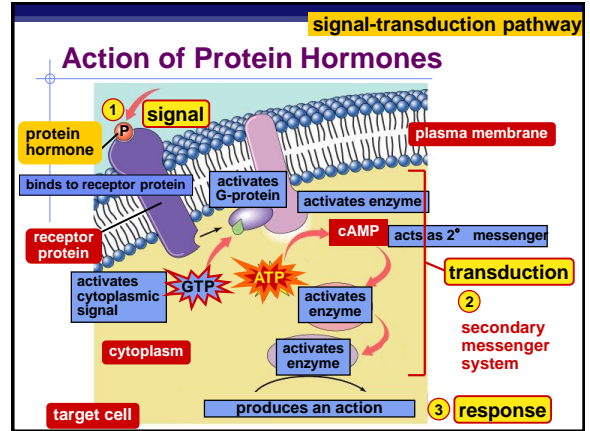
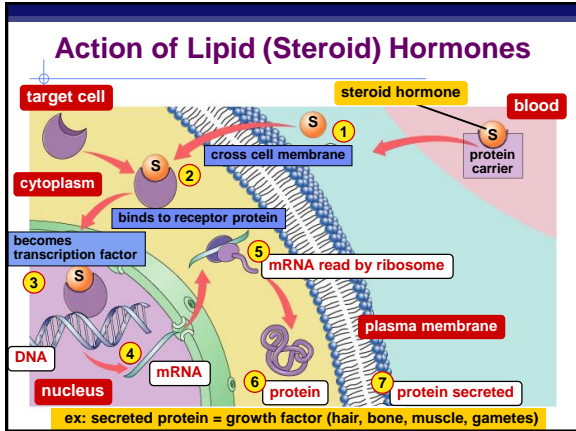
- Protein-based Hormones**
  - Polypeptides
    - Small proteins: **insulin, ADH**
  - Glycoproteins
    - Large proteins + carbohydrate: **FSH, LH**
  - Amines
    - Modified amino acids: **epinephrine, melatonin**
- Lipid-based Hormones**
  - Steroids
    - Modified cholesterol: **sex hormones, aldosterone**



## How do hormones act on target cells?

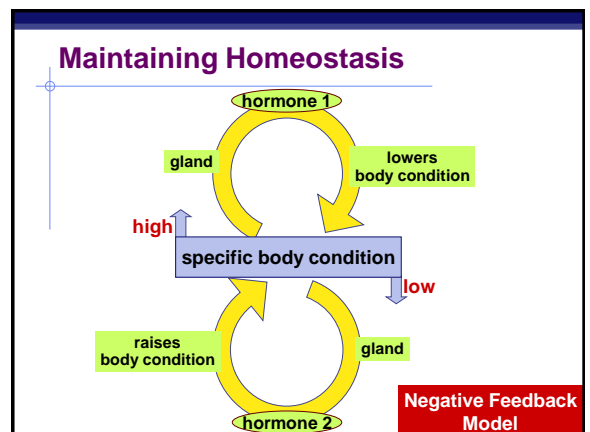
- Lipid-based Hormones**
  - Hydrophobic & lipid-soluble**
    - Diffuse across cell membrane & enter cells
    - Bind to **receptor proteins in cytoplasm & nucleus**
    - Bind to DNA as **transcription factors**
      - Turn on genes
- Protein-based Hormones**
  - Hydrophilic & not lipid soluble**
    - Can't diffuse across cell membrane
    - Bind to **receptor proteins in cell membrane**
    - Trigger **secondary messenger pathway**
    - Activate internal cellular response
      - Enzyme action, uptake or secretion of molecules...

# AP Biology

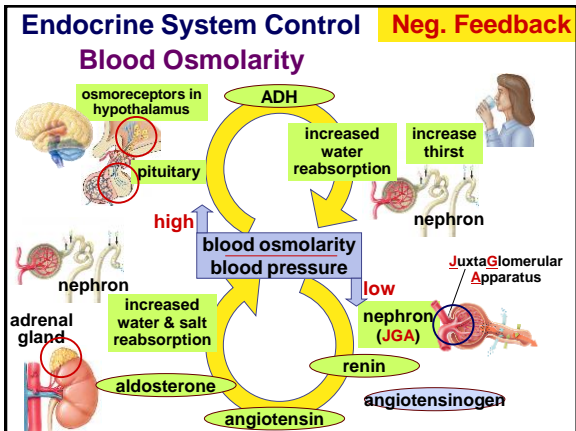
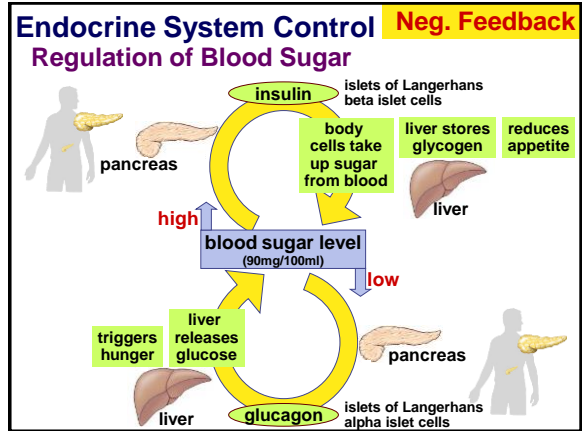
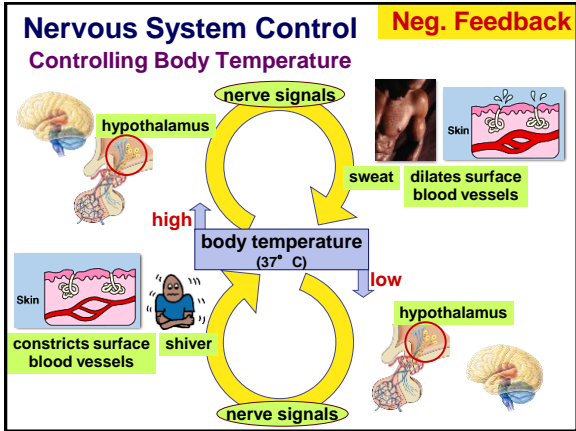


## Negative Feedback

- An **increase** in a substance or activity **inhibits** the process leading to the increase
- Also known as **feedback inhibition**
- Very common control mechanism** in the body and nature
- Works just like a thermostat

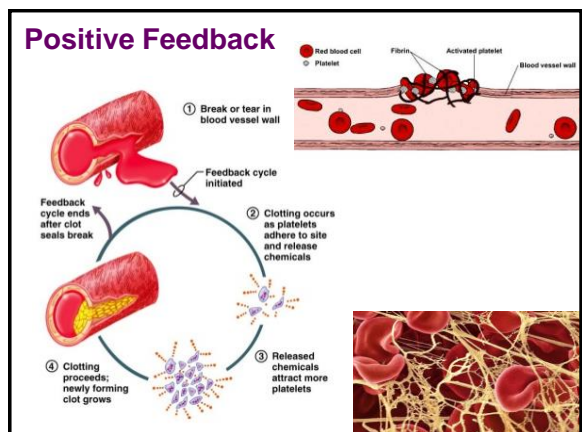
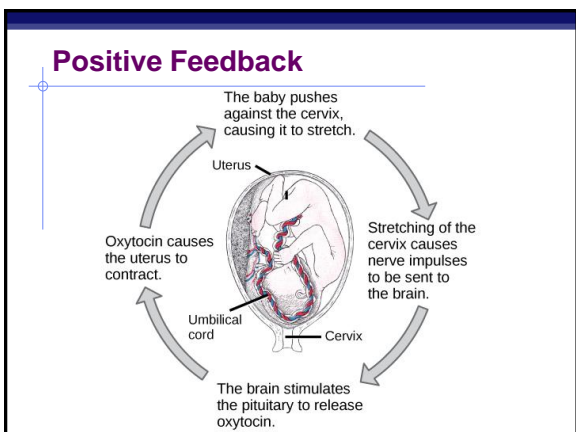


# AP Biology



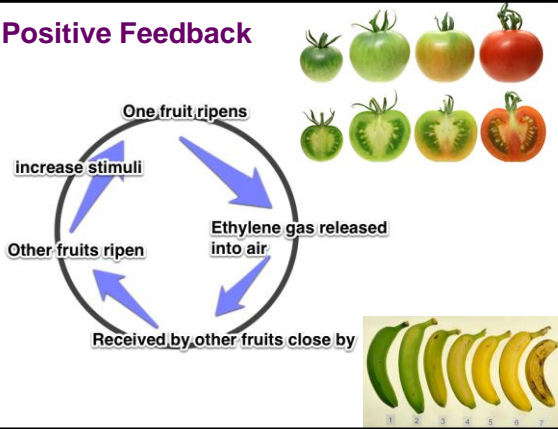
### Positive Feedback

- A **change from the normal** range of function elicits a response that **amplifies or enhances** that change
- **Not as common** in the body or nature as negative feedback
- Childbirth, blood clotting, fruit ripening



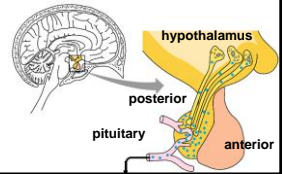
# AP Biology

## Positive Feedback

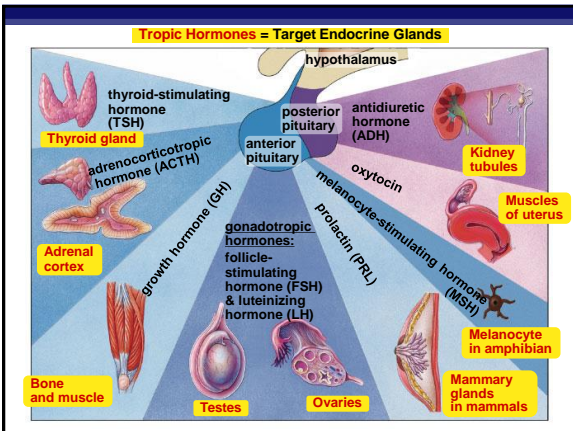


## Nervous & Endocrine Systems Linked

- **Hypothalamus** = “master nerve control center”
  - ♦ **Nervous system**
  - ♦ Receives information from nerves around body about internal conditions
  - ♦ **Releasing hormones**: regulates release of hormones from pituitary
- **Pituitary Gland** = “master gland”
  - ♦ **Endocrine system**
  - ♦ Secretes broad range of “tropic” hormones regulating other glands in body



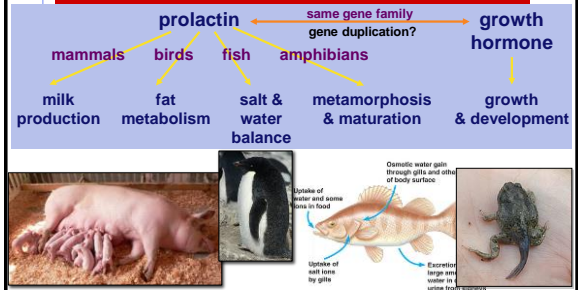
## Tropic Hormones = Target Endocrine Glands



## Homology In Hormones

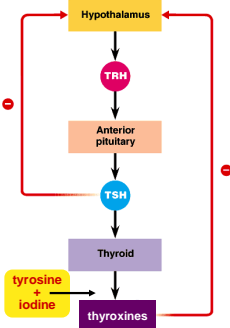
What does this tell you about these hormones?

How could these hormones have different effects?



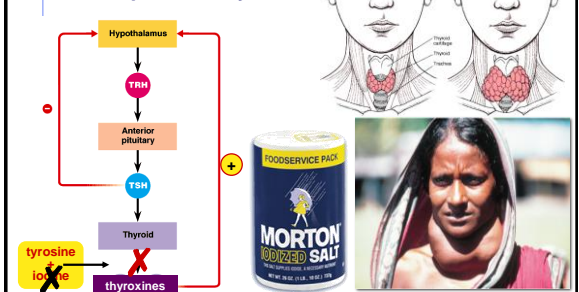
## Regulating Metabolism

- **Hypothalamus**
  - ♦ **TRH** = TSH-releasing hormone
- **Anterior Pituitary**
  - ♦ **TSH** = Thyroid stimulating hormone
- **Thyroid**
  - ♦ Produces **thyroxine hormones**
  - ♦ Metabolism & development
    - Bone growth
    - Mental development
    - Metabolic use of energy
    - Blood pressure & heart rate
    - Muscle tone
    - Digestion
    - Reproduction



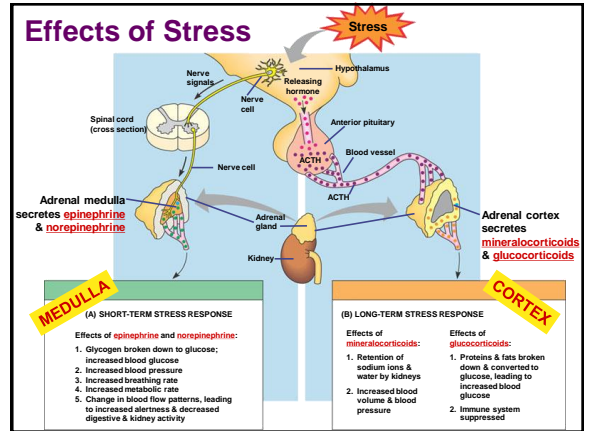
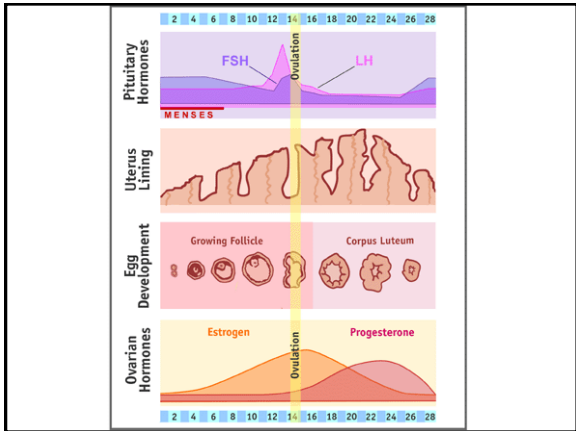
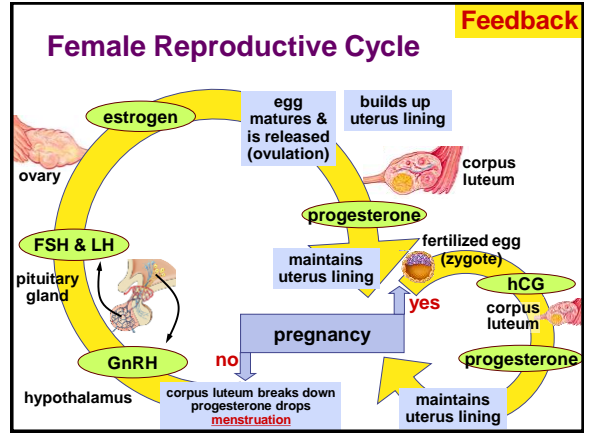
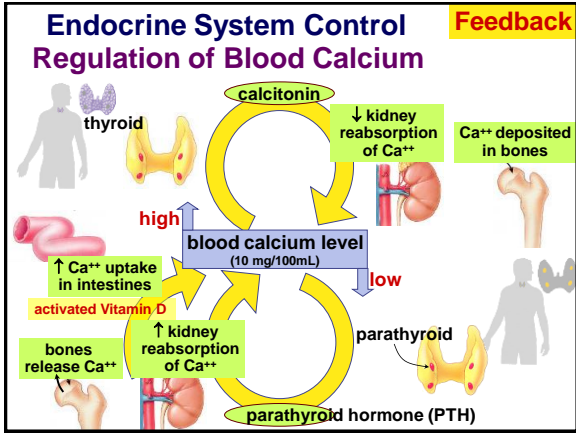
## Goiter

Iodine deficiency causes thyroid to enlarge as it tries to produce thyroxine





# AP Biology



Name: \_\_\_\_\_

Date: \_\_\_\_\_

**AP Biology**  
**Ch. 45: Endocrine System & Hormones**  
**Short Answer Questions**

1. List a few similarities and differences comparing:

a. Endocrine System: \_\_\_\_\_

\_\_\_\_\_

b. Nervous System: \_\_\_\_\_

\_\_\_\_\_

2. What is a hormone?

\_\_\_\_\_

\_\_\_\_\_

3. Explain the similarities and differences between neurotransmitters and hormones.

a. Similarities: \_\_\_\_\_

\_\_\_\_\_

b. Differences: \_\_\_\_\_

\_\_\_\_\_

4. Hormones are carried throughout the body to every cell via the circulatory system. Explain how only specific target cells respond to the hormone when many others do not.

\_\_\_\_\_

\_\_\_\_\_

5. How do duct and ductless glands differ? Give examples of each.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

6. Explain negative feedback. Give an example.

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7. Sketch a diagram illustrating the negative feedback example you gave.

8. Explain positive feedback. Give an example.

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9. Sketch a diagram illustrating the positive feedback example you gave.



10. Describe the mechanism by which steroid hormones regulate their target cells.  
(steroid model for hormone action)

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11. Describe the general mechanism by which protein or hydrophilic hormones regulate their target cells. (protein model for hormone action)

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12. Identify molecules that serve as "second messengers" in a cell?

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13. What does the "second messenger" do in the cell?

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14. Elaborate on the role of the hypothalamus.

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# AP Biology

**Fighting the Enemy Within!**

**phagocytic leukocyte**

**Ch. 51: Immune & Lymphatic Systems**

**lymphocytes attacking cancer cell**

**lymph system**

## Avenues of Attack

- Points of Entry
  - Digestive System
  - Respiratory System
  - Urogenital Tract
  - Break in Skin
- Routes of Attack
  - Circulatory System
  - Lymph System

## Why an Immune System?

- Attack from outside
  - Lots of organisms want you for lunch!
  - Animals are a tasty nutrient- & vitamin-packed meal
    - Cells are packages of macromolecules
  - Animals must defend themselves against invaders (**pathogens**)
    - Viruses**
      - HIV, flu, cold, measles, chicken pox
    - Bacteria**
      - pneumonia, meningitis, tuberculosis
      - Lyme disease
    - Fungi**
      - yeast ("Athlete's foot" ...)
    - Protists**
      - amoeba, malaria
- Attack from inside
  - Cancers = abnormal body cells**

## Lymphatic System

Production & transport of leukocytes  
Traps foreign invaders

**lymph vessels**  
(intertwined amongst blood vessels)

**lymph node**

## Development of Red & White Blood Cells

**Pluripotent stem cells** (in bone marrow)

**Lymphoid stem cells** → B cells, T cells → **Lymphocytes**

**Myeloid stem cells** → Erythrocytes, Platelets, Basophils, Eosinophils, Monocytes (develop into macrophages), Neutrophils (short-lived phagocytes 60-70% WBC) → **Leukocytes**

## Lines of Defense

- 1st Line: Non-specific Barriers**
  - Broad, external defense
    - "Walls & moats"
  - Skin & mucous membranes
- 2nd Line: Non-specific Patrols**
  - Broad, internal defense
    - "Patrolling soldiers"
  - Leukocytes = Phagocytic WBCs**
- 3rd Line: True Immune System**
  - Specific, acquired immunity**
    - "Elite trained units"
  - Lymphocytes & Antibodies**
    - B cells & T cells**

*Bacteria & insects inherit resistance. Vertebrates acquire immunity.*

# AP Biology

## 1st line: Non-specific External Defense

### Barrier

- **Skin**

### Traps

- **Mucous membranes, cilia, hair, earwax**

### Elimination

- **Coughing, sneezing, urination, diarrhea**

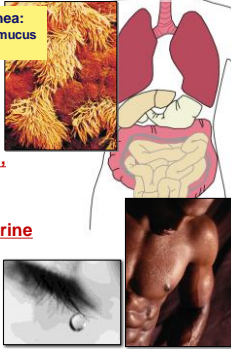
### Unfavorable pH

- **Stomach acid, sweat, saliva, urine**

### Lysozyme enzyme

- **Digests bacterial cell walls**
- **Tears, sweat**

Lining of trachea: ciliated cells & mucus secreting cells



## 2nd Line: Non-specific Patrolling Cells

### Patrolling cells & proteins

- ♦ Attack pathogens, but don't "remember" for next time

#### Leukocytes

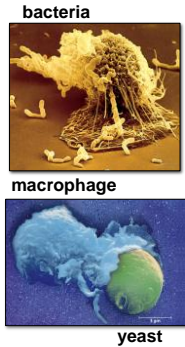
- ♦ **Phagocytic** white blood cells
- ♦ Macrophages, neutrophils, natural killer cells

#### Complement System

- ♦ Proteins that destroy cells

#### Inflammatory Response

- ♦ Increase in body temp.
- ♦ Increase capillary permeability
- ♦ Attract macrophages



## Leukocytes: Phagocytic WBCs

- ♦ Attracted by chemical signals released by damaged cells

- ♦ Ingest pathogens
- ♦ Digest in lysosomes

#### Neutrophils

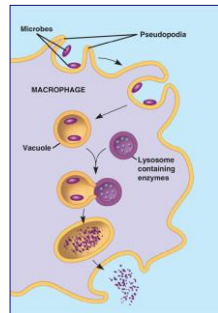
- ♦ Most abundant WBC (~70%)
- ♦ ~ 3 day lifespan

#### Macrophages

- ♦ "Big Eater", long-lived

#### Natural Killer Cells

- ♦ Destroy virus-infected cells & cancer cells

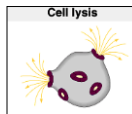


## Destroying Cells Gone Bad!

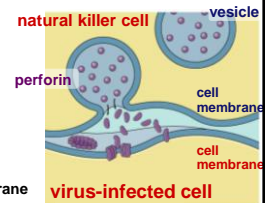
### Natural Killer Cells perforate cells

- ♦ Release **perforin** protein
- ♦ Insert into membrane of target cell
- ♦ Forms pore allowing fluid to flow in & out of cell
- ♦ Cell ruptures (lysis)

#### Apoptosis



Perforin punctures cell membrane



## Anti-microbial Proteins

### Complement System

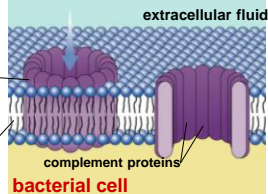
- ♦ ~20 proteins circulating in blood plasma
- ♦ Attack bacterial & fungal cells
- Form a **membrane attack complex**
- Perforate target cell

#### Apoptosis

- ♦ Cell lysis

complement proteins form cellular lesion

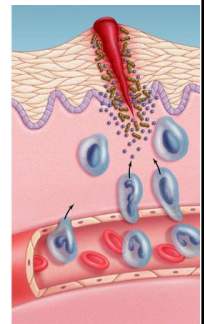
plasma membrane of invading microbe



## Inflammatory Response

### Damage to tissue triggers local non-specific inflammatory response

- ♦ Release chemical signals
  - **Histamines & prostaglandins**
- ♦ Capillaries dilate, become more permeable (leaky)
  - Delivers macrophages, RBCs, platelets, clotting factors
  - Fight pathogens
  - Clot formation
- ♦ Increases temperature
  - Decrease bacterial growth
  - Stimulates phagocytosis
  - Speeds up repair of tissues



# AP Biology

## Fever

- When a local response is not enough
  - System-wide response to infection
  - Activated macrophages release **interleukin-1**
    - Triggers **hypothalamus in brain** to readjust body thermostat to raise body temperature
  - Higher temperature helps defense
    - Inhibits bacterial growth
    - Stimulates phagocytosis
    - Speeds up repair of tissues
    - Causes liver & spleen to store iron, reducing blood iron levels
      - Bacteria need large amounts of iron to grow



## 3rd line: Acquired (Active) Immunity

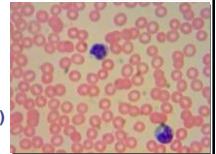
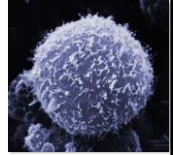
### Specific defense with memory

- Lymphocytes**
  - B cells
  - T cells
- Antibodies**
  - Immunoglobulins

### Responds to...

- Antigens**
  - Cellular name tags
    - Specific pathogens
    - Specific toxins
    - Abnormal body cells (cancer)

B cell



## How are invaders recognized?

### Antigens

- Cellular name tag proteins
  - "Self" Antigens**
    - No response from WBCs
  - "Foreign" Antigens**
    - Response from WBCs
    - Pathogens: Viruses, bacteria, protozoa, parasitic worms, fungi, toxins
    - Non-pathogens: Cancer cells, transplanted tissue, pollen



## Lymphocytes

### B cells

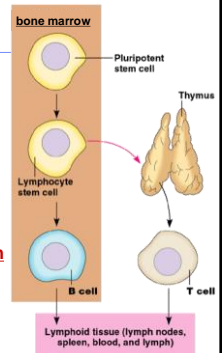
- Mature in **bone marrow**
- Humoral response system**
  - "Humors" = body fluids
  - Attack pathogens still circulating in blood & lymph
- Produce antibodies**

### T cells

- Mature in **thymus**
- Cell-Mediated response system**
  - Attack invaded cells

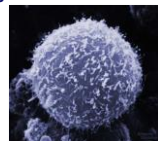
### "Maturation"

- Learn to distinguish "self" from "non-self" antigens
  - If react to "self" antigens, cells are destroyed during maturation



## B cells

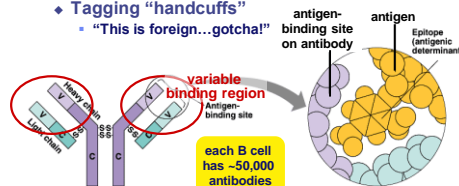
- Attack, learn & remember pathogens circulating in blood & lymph
- Produce specific **antibodies** against specific **antigen**
- Types of B cells
  - Plasma cells**
    - Immediate production of antibodies
    - Rapid response, short term release
  - Memory cells**
    - Continued circulation in body
    - Long term immunity



## Antibodies

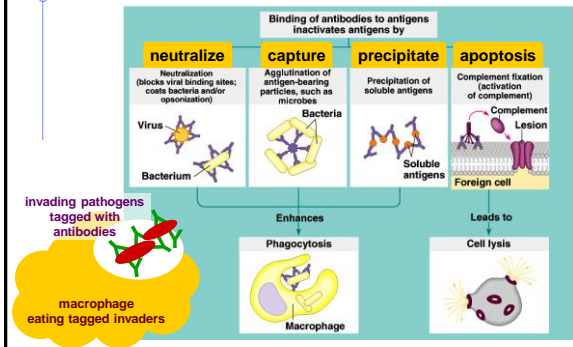
### Proteins that bind to a specific antigen

- Multi-chain proteins
- Binding region matches molecular shape of antigens
- Each antibody is unique & specific
  - Millions of antibodies respond to millions of foreign antigens
- Tagging "handcuffs"
  - "This is foreign...gotcha!"



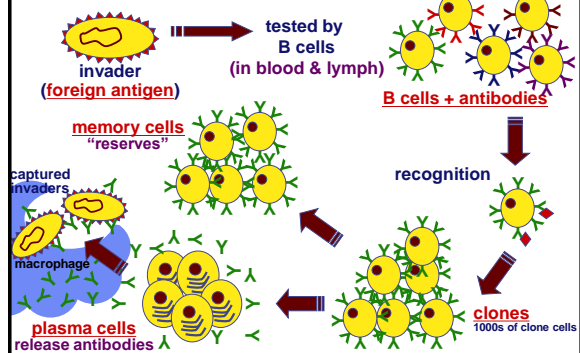
# AP Biology

## What do antibodies do to invaders?



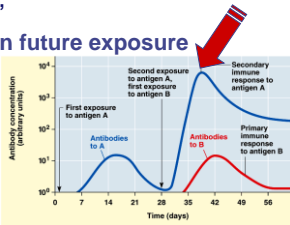
## B cell Immune Response

10 to 17 days for full response



## Vaccinations

- Immune system exposed to harmless version of pathogen
  - Stimulates B cell system to produce antibodies to pathogen
    - "Active Immunity"
  - Rapid response on future exposure
  - Creates immunity without getting disease!
- Most successful against viruses



## Jonas Salk

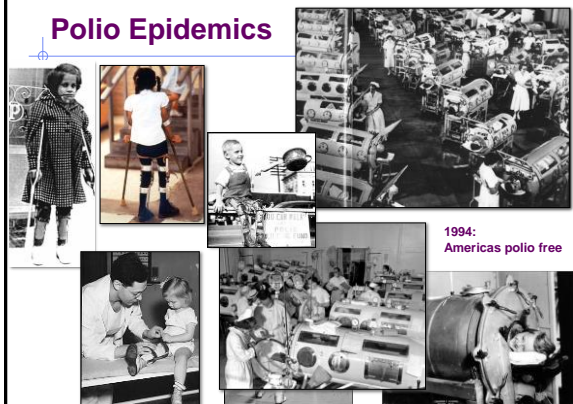
1914 – 1995

April 12, 1955

- Developed first vaccine
  - Against polio
    - Attacks motor neurons



## Polio Epidemics



## Passive Immunity

- Obtaining antibodies from another individual
  - Maternal Immunity**
    - Antibodies pass from mother to baby across placenta or in mother's milk
    - Critical role of breastfeeding in infant health
      - Mother is creating antibodies against pathogens baby is being exposed to
  - Injection**
    - Injection of antibodies
    - Short-term immunity





# AP Biology

**What if the attacker gets past the B cells in the blood & actually infects (hides in) some of your cells?**

You need trained assassins to recognize & kill off these infected cells!

**Attack of the Killer T cells!**

But how do T cells know someone is hiding in there?

**How is any cell tagged with antigens?**

- Major Histocompatibility (MHC) Proteins**
  - Proteins which constantly carry bits of cellular material from the cytosol to the cell surface
  - "Snapshot" of what is going on inside cell
  - Give the surface of cells a unique label or "fingerprint"

Who goes there? self or foreign?

T or B cell

MHC protein

MHC proteins displaying self-antigens

**How do T cells know a cell is infected?**

- Infected cells digest some pathogens**
  - MHC proteins carry pieces to cell surface
    - Foreign antigens now on cell membrane
    - Called **Antigen Presenting Cell (APC)**
      - Macrophages can also serve as APC
    - Tested by Helper T cells

infected cell

MHC proteins displaying foreign antigens

WANTED

T<sub>H</sub> cell

T cell with antigen receptors

**T cells**

- Attack, learn & remember pathogens hiding in infected cells**
  - Recognize **antigen fragments**
  - Also defend against "non-self" body cells
    - Cancer & transplant cells
- Types of T cells**
  - Helper T cells**
    - Alerts rest of immune system
  - Killer (cytotoxic) T cells**
    - Attack infected body cells
  - Memory T cells**
    - Long term immunity

T cell attacking cancer cell

**T Cell Response**

APC: infected cell

recognition

helper T cell

interleukin 1

or

APC: activated macrophage

recognition

helper T cell

interleukin 1

clones

interleukin 2

activate killer T cells

stimulate B cells & antibodies

killer T cell

**Attack of the Killer T cells**

- Destroys infected body cells**
  - Binds to target cell
  - Secretes **perforin** protein
    - Punctures cell membrane of infected cell
      - Apoptosis

Cell lysis

Killer T cell binds to infected cell

infected cell destroyed

vesicle

cell membrane

perforin punctures cell membrane

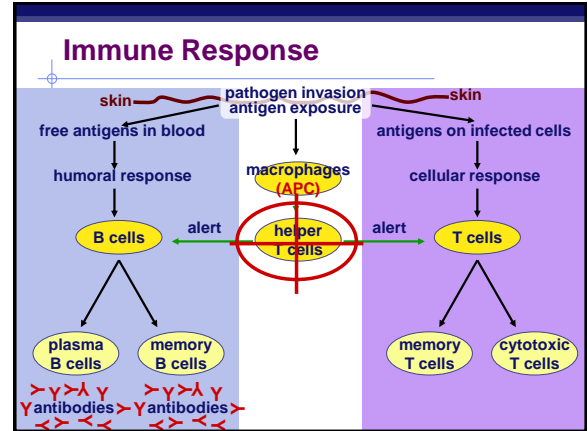
target cell

cell membrane

# AP Biology


Immune System & Blood Type				
Pheno-type	Genotype	Antigen on RBC	Antibodies in Blood	Can Receive
A	$I^A I^A$ or $I^A i$	Type A antigens on surface of RBC	Anti-B antibodies	A, O
B	$I^B I^B$ or $I^B i$	Type B antigens on surface of RBC	Anti-A antibodies	B, O
AB	$I^A I^B$	Both Type A & Type B antigens on surface of RBC	No antibodies	A, B, AB, O
O	$ii$	No antigens on surface of RBC	Anti-A & Anti-B antibodies	Only O

Matching compatible blood groups is critical for blood transfusions  
A person produces antibodies against foreign blood antigens



## HIV & AIDS

- Human Immunodeficiency Virus**
  - Virus infects **helper T cells**
    - Helper T cells don't activate rest of immune system: Killer T cells & B cells
    - Also destroys helper T cells
- AIDS: Acquired ImmunoDeficiency Syndrome**
  - Infections by opportunistic diseases
  - Death usually from "opportunistic" infections
    - Pneumonia, cancers



HIV infected T cell

## Immune System Malfunctions

- Auto-immune Diseases**
  - Immune system attacks own molecules & cells
    - Lupus**
      - Antibodies against many molecules released by normal breakdown of cells
    - Rheumatoid Arthritis**
      - Antibodies causing damage to cartilage & bone
    - Diabetes**
      - Beta-islet cells of pancreas attacked & destroyed
    - Multiple Sclerosis**
      - T cells attack myelin sheath of brain & spinal cord nerves
- Allergies**
  - Over-reaction to environmental antigens
    - Allergens = proteins on pollen, dust mites, in animal saliva
    - Stimulates release of histamine



Name: \_\_\_\_\_

Date: \_\_\_\_\_

**AP Biology**  
**Ch. 51: Immune & Lymphatic Systems**  
**Short Answer Questions**

1. List the two lines of non-specific defense mechanisms with examples of each.

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2. What is meant by specific defense? What line of defense is associated with it?

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3. Give examples of "barrier defenses."

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4. What is the role of phagocytic leukocytes?

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5. What is the role of the lymphatic system?

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6. How does the lymphatic system aid in immunity?

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7. Outline the significant steps that occur during an inflammatory response?

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8. What is an antigen?

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9. Identify several differences between the following lymphocytes.

a. B Lymphocytes: \_\_\_\_\_

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b. T Lymphocytes: \_\_\_\_\_

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10. Which lymphocytes are involved in the humoral immune response? \_\_\_\_\_

11. Which lymphocytes are involved in the cell-mediated immune response? \_\_\_\_\_

12. What are antibodies (immunoglobulins)?

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13. List and briefly describe four ways antibodies aid in immunity.

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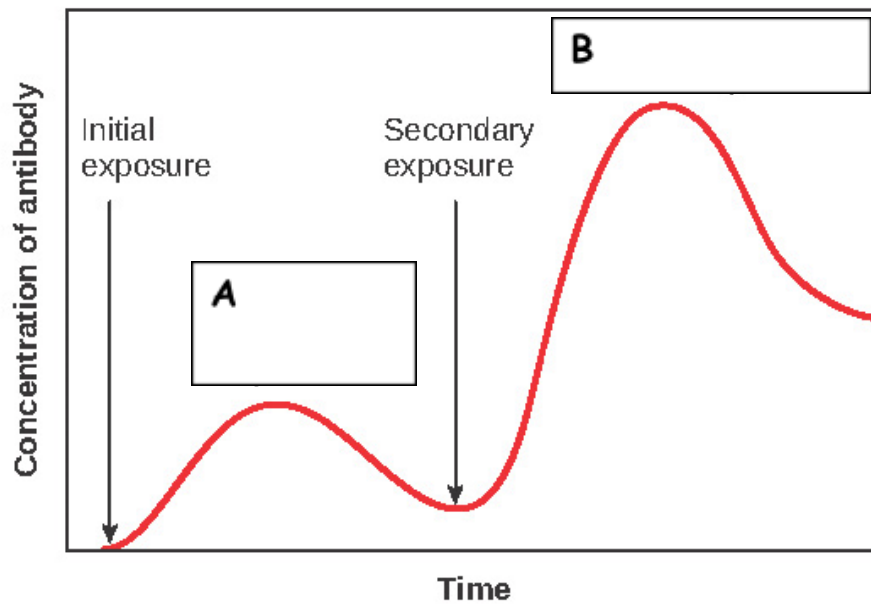
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14. Define active immunity.

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15. Label box A and B on the active immunity graph below. It depicts what happens to the antibody concentration in a patient's bloodstream after an initial exposure to a particular pathogen and then a secondary exposure to that same pathogen.



16. Why is secondary immune response quicker and more robust than primary response?

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17. Explain the basic mechanism behind vaccinations?

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18. Define passive immunity.

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19. What is the role of MHC?

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20. What is the role of cytotoxic T cells (killer T) and describe their mechanism of action?

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21. What are some of the actions of helper T cells?

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22. Explain what happens when a person has an autoimmune disease? Give some examples.

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23. What happens when you have an allergy?

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