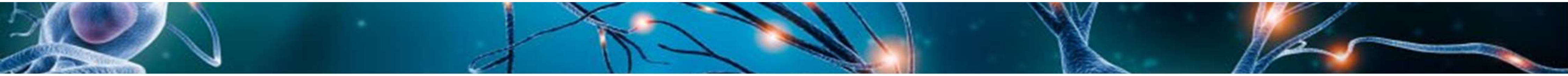

Foundations of Biopsychology

Course Code: 33296
Academic Year: 2024–2025
Lecturers:

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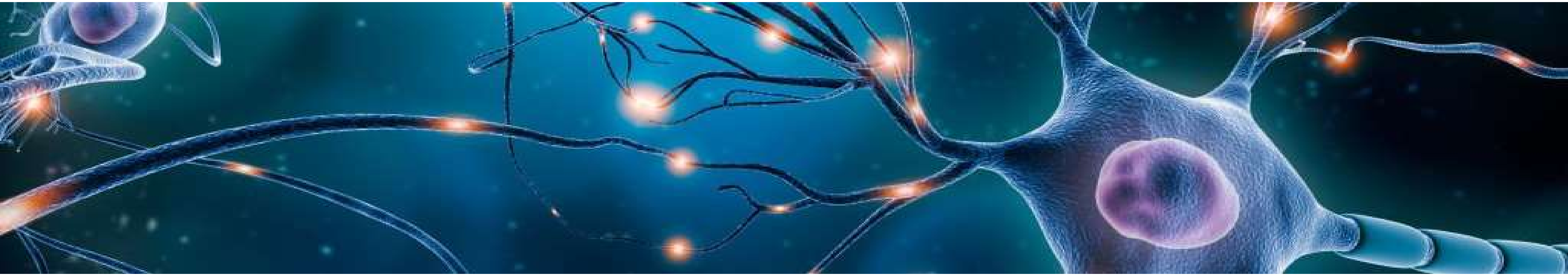
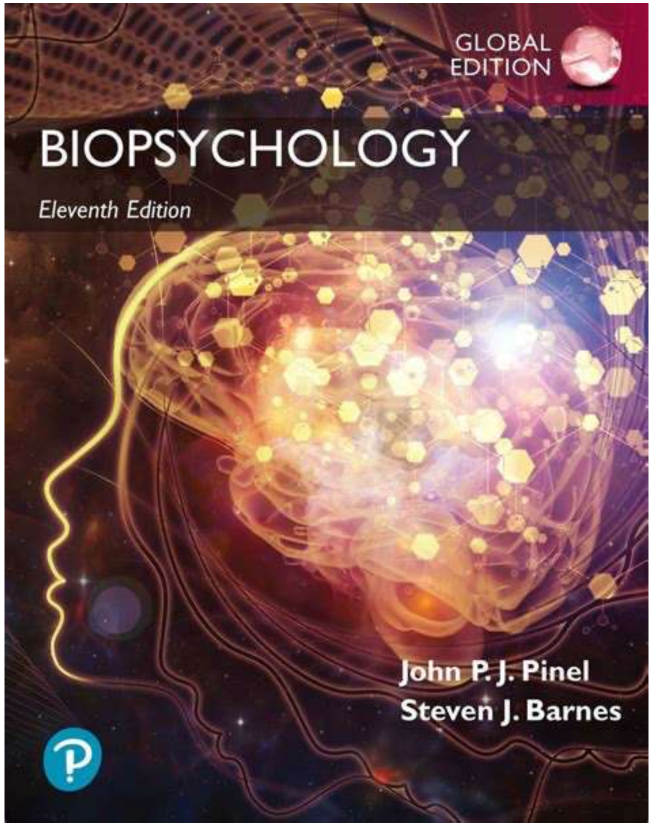
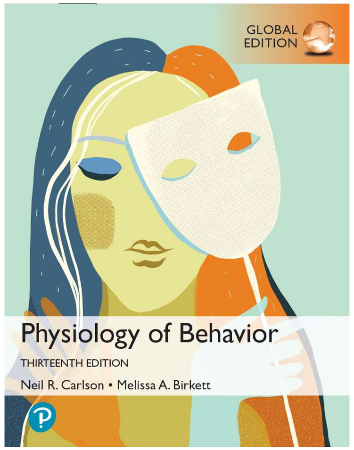


Reference Manuals



Pinel, J. P. J., & Barnes, S. J. (2021). **Biopsychology.** Pearson Higher Ed.



Carlson, N. R., & Birkett, M. A. (2021). **Physiology of Behavior**. Pearson Higher Ed.

Chapter 2: Genetics of Behavior

Genetics is the study of biological inheritance and gene function. It function. It explores how genes influence traits and behaviors. This field This field examines heredity, variation and the interplay between nature between nature and nurture.

Basis of the Teaching Guide for this chapter

Cellular and molecular bases of Genetics. Types of genetic transmission. Mendelian genetics. Polygenic inheritance. Gene-environment interaction.

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Chapter 2: Genetics of Behavior

2.1 Introduction.

2.2 Chromosomal theory of inheritance.

2.3 Types of gene transmission.

2.4 Epigenetics.

Core Concepts in Genetics

1. **Biological inheritance.**

   Characteristics are passed from parents to offspring. Traits are influenced by multiple genes.

2. **Heredity and variation.**

   Similarities between parents and offspring. Differences among family members.

3. **Nature vs. nurture.**

   The interplay between genetic predisposition and environmental environmental factors plays a significant role in shaping individual individual traits.

   a. Nature → Genetics.

   b. Nurture → Learning.

Genetic Influence on Behavior

1. **DNA inheritance.**

   Genes coding for proteins are passed down from parents to offspring.

2. **Neural circuit formation.**

   Proteins guide the development of neural circuits in the brain.

3. **Behavior expression.**

   Neural circuits interact with environmental factors to produce observable behaviors.

Polygenic Inheritance and Behavior

Multiple genes.

Most behaviors result from the combined effects of many genes.

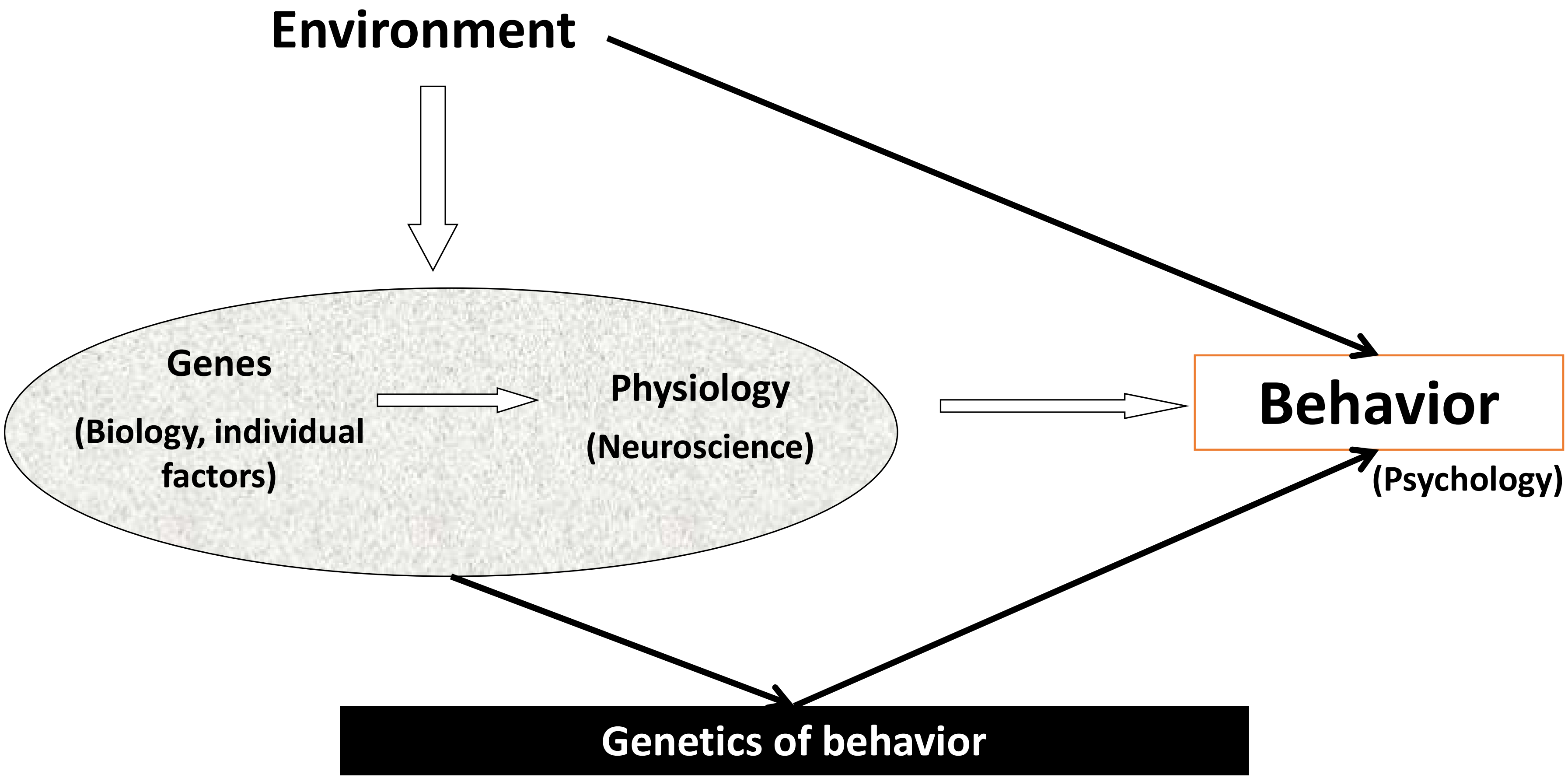
Environmental factors.

The environment plays a crucial role in behavioral development.

Individual variability.

Genes contribute to vulnerability and variability in behavioral traits.

Environment and the Genetics of Behavior



Genetic Counseling for Diseases

Purpose

To provide information on genetic disorders to help alleviate suffering and inform inform decision-making.

Example

Amniocentesis is a prenatal procedure in which a small amount of amniotic fluid is extracted from the uterus for testing. It is typically performed between weeks 15 and 20 of pregnancy to detect genetic or chromosomal abnormalities in the fetus.

Misconceptions

Genetic disorders are not always inevitable or untreatable. Genetic counseling is associated with eugenics, **BUT IT IS NOT eugenics**.

Chapter 2: Genetics of Behavior

2.1 Introduction.

2.2 Chromosomal theory of inheritance.

2.3 Types of gene transmission.

2.4 Epigenetics.

Genotype vs. Phenotype

Genotype

Genetic constitution inherited from parents.

Complete set of genes in 46 chromosomes.

Cannot change over time.

Phenotype

Observable external traits.

Results from gene-environment interactions.

Can change over time.

Types of Phenotypic Variation

1

Discontinuous /Qualitative variation.

Clearly distinguishable categories.

Example: ABO blood system.

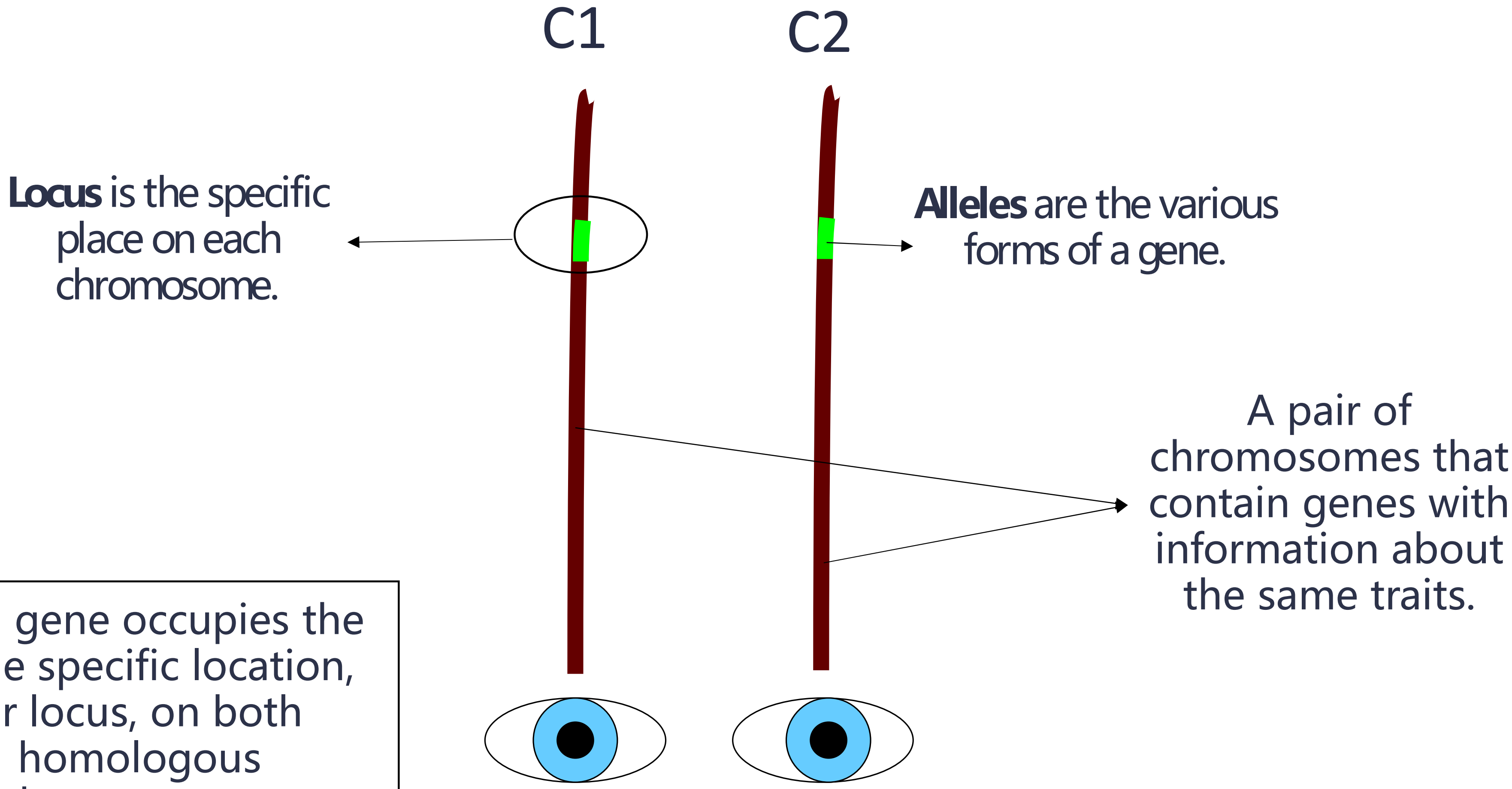
2

Continuous /Quantitative variation.

Traits vary continuously within limits.

limits. Example: height.

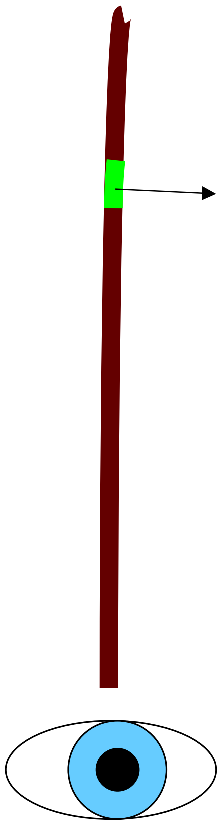
Homozygosis and Heterozygosis



Each gene occupies the same specific location, or locus, on both homologous chromosomes.

Homozygosis and Heterozygosis

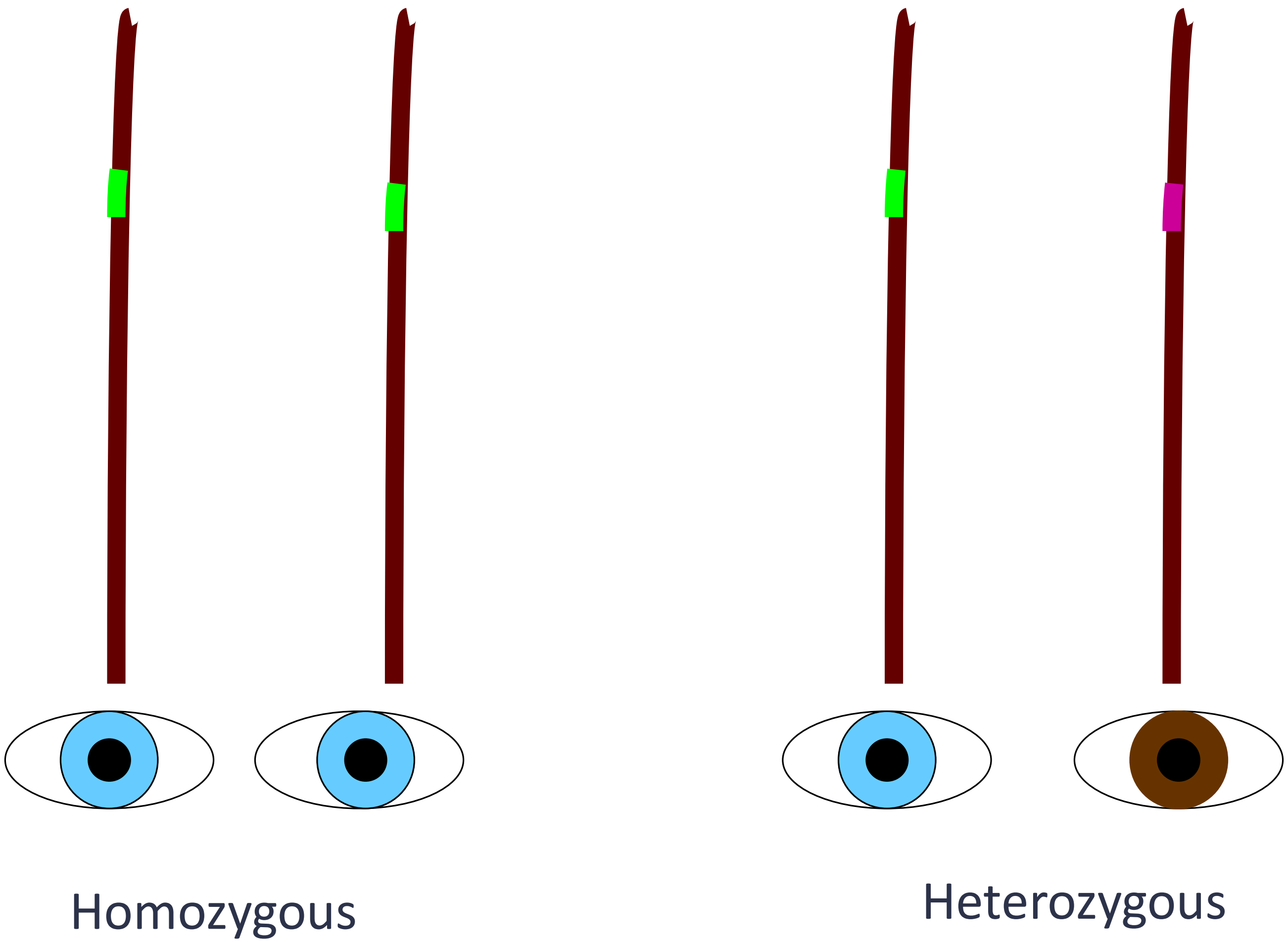
C2



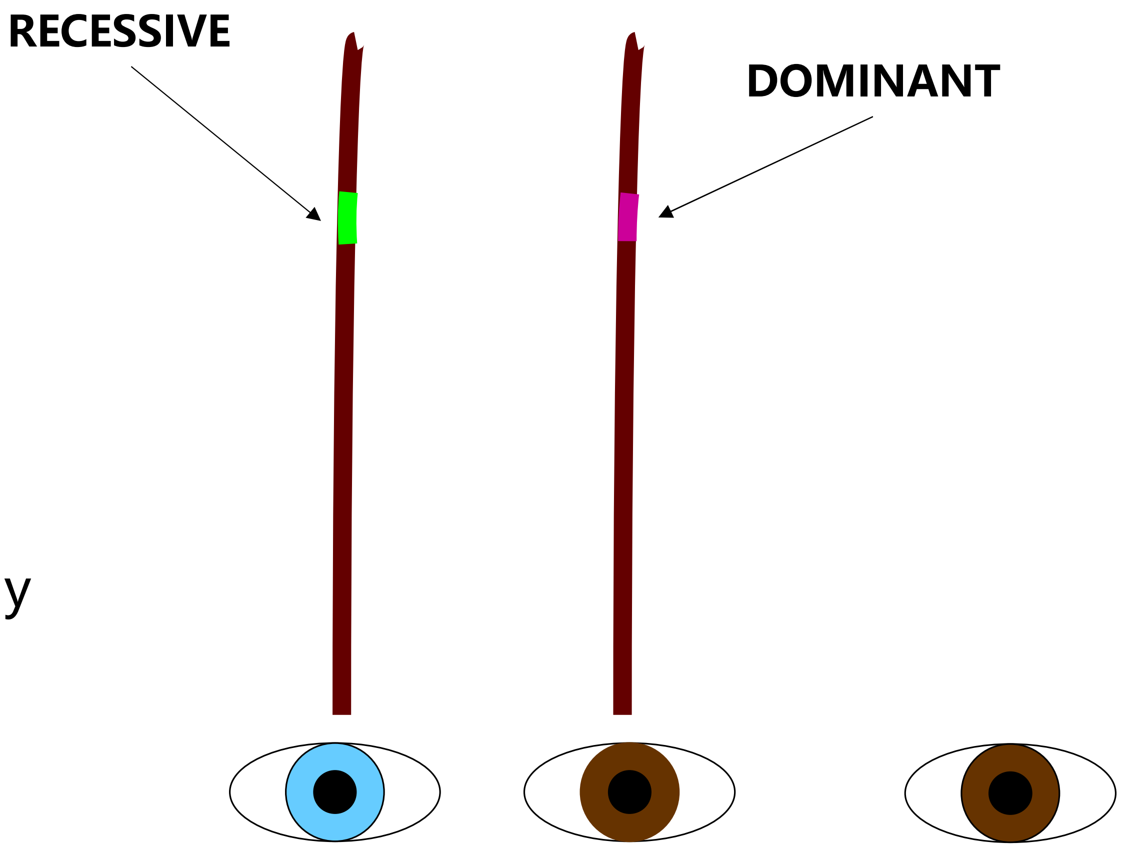
ALLELES

For any given trait, multiple forms of a gene, known as alleles, may exist. For instance, in the case of blood type (phenotype), there are three distinct alleles: O, A, and B. Although a gene can have multiple alleles, an individual can carry only two of them, with one allele located on each homologous chromosome.

Homozygosis and Heterozygosis



Homozygosis and Heterozygosis



<u>Types of Alleles:</u>

DOMINANT: phenotypically expressed.

RECESSIVE: NOT phenotypically expressed.

Dominant and Recessive Alleles

Dominant Alleles

These are expressed in the phenotype when present and and are represented by capital capital letters (e.g., A).

Recessive Alleles

These are expressed only when two copies are present. They are represented by lowercase letters (e.g., a).

Phenotypic Expression

In heterozygous individuals, dominant alleles mask the effects of recessive alleles.



Dominant and Recessive Alleles

Concept	Definition
Homozygous dominant	Two identical dominant alleles (AA).
Homozygous recessive	Two identical recessive recessive alleles (aa).
Heterozygous	One dominant and one recessive allele (Aa).

Chapter 2: Genetics of Behavior

2.1 Introduction.

2.2 Chromosomal theory of

inheritance.

2.3 Types of gene transmission.

2.4 Epigenetics.

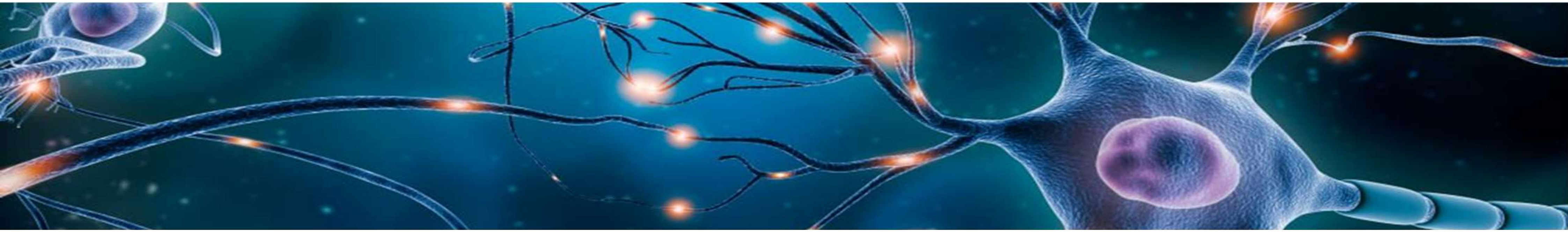
Types of Genetic Transmission

Monogenic Inheritance

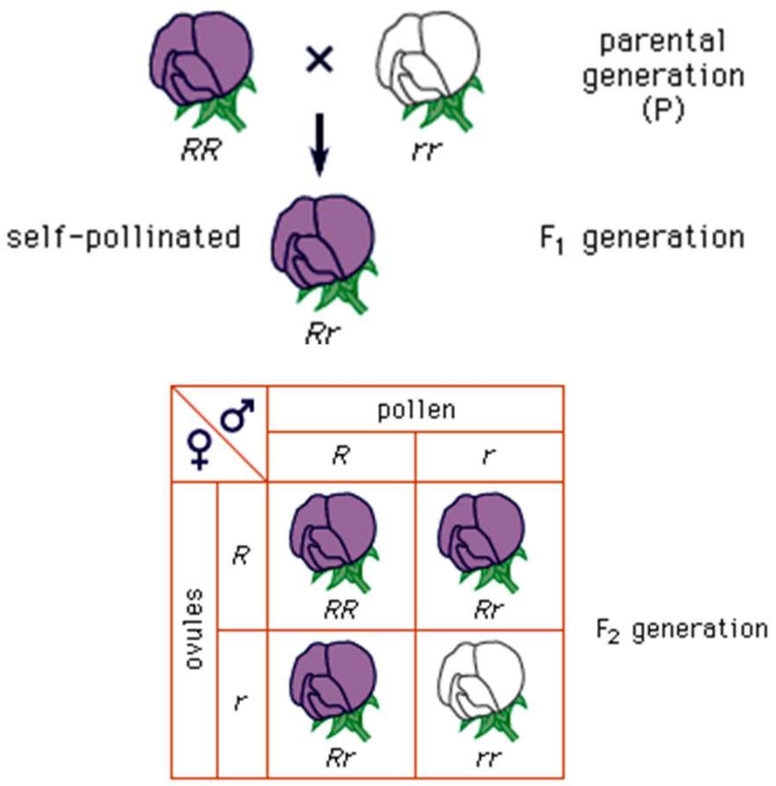
Traits are controlled by two alleles of a single gene.

Polygenic Inheritance

Traits are influenced by multiple genes. Examples: height and intelligence in humans.



Mendel's first law



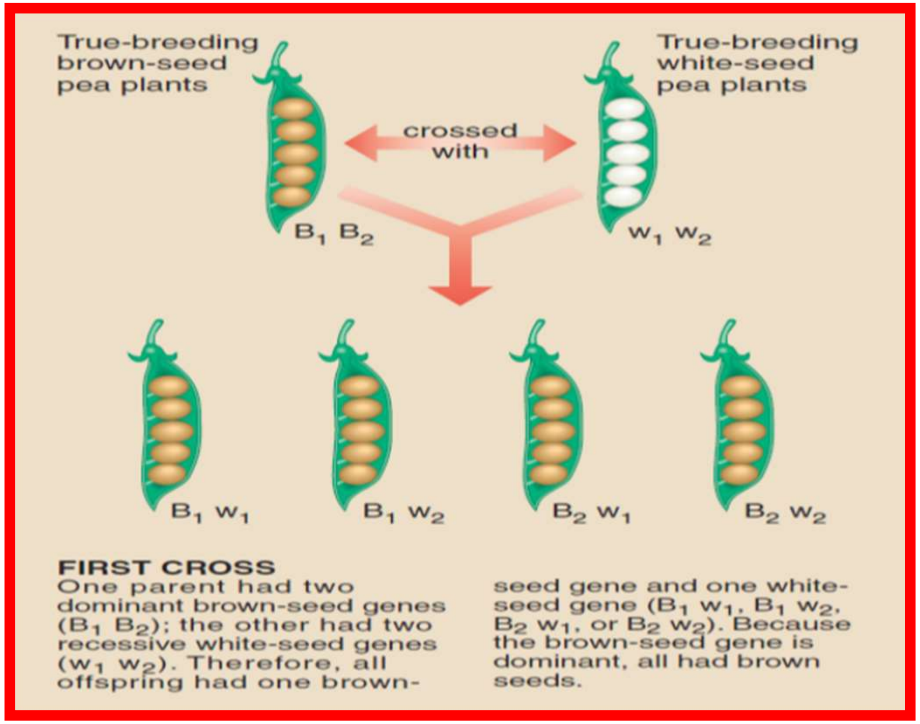
<u>Uniformity of Hybrids of the First Generation (F1). (F1).</u>

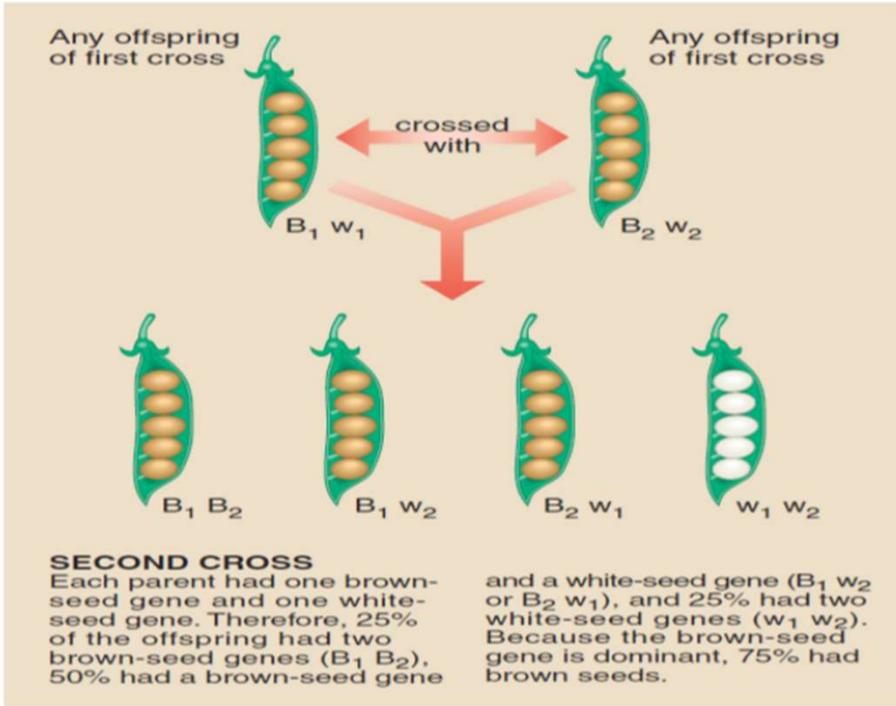
- When two purebred (both homozygous) individuals are crossed for a specific trait, the resulting hybrids in the first generation exhibit uniform characteristics.

- All first-generation hybrids (F1) display the same phenotype for the trait in question.

https://www.britannica.com/science/Mendelian-inheritance#/media/1/374776/95557

Mendel's First Law

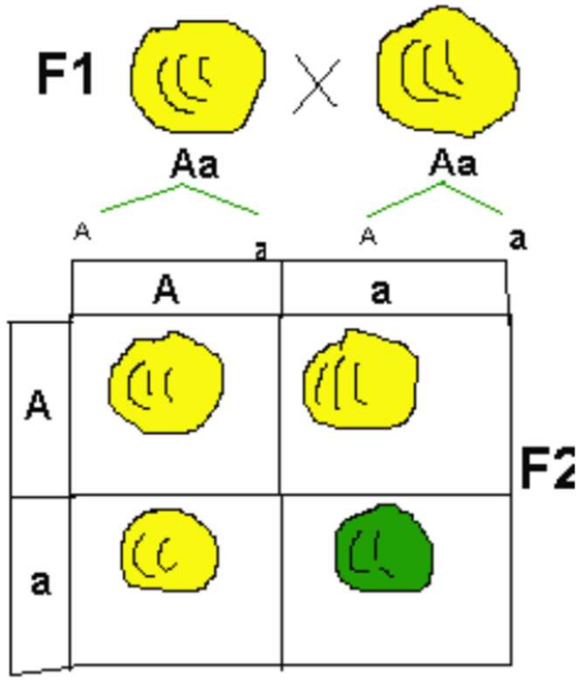




Mendel's Second Law

Segregation of Alleles

- Recessive traits that are masked in the first generation (F1) reappear in the second generation (F2).
- The second generation (F2) is produced through the self-fertilization of the F1 hybrids, which reveals the previously hidden recessive traits (proportion = 3:1).



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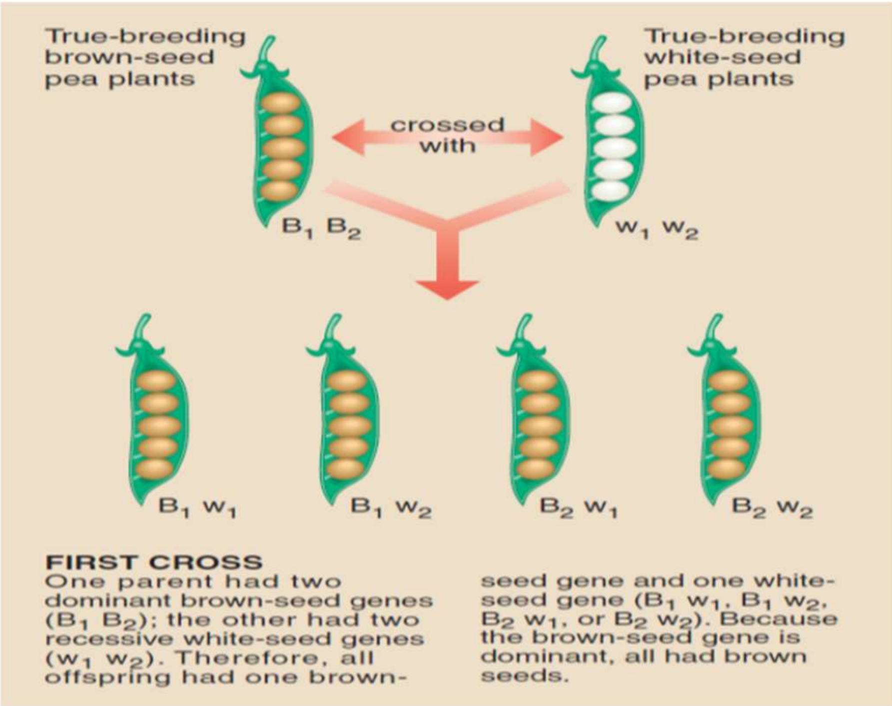
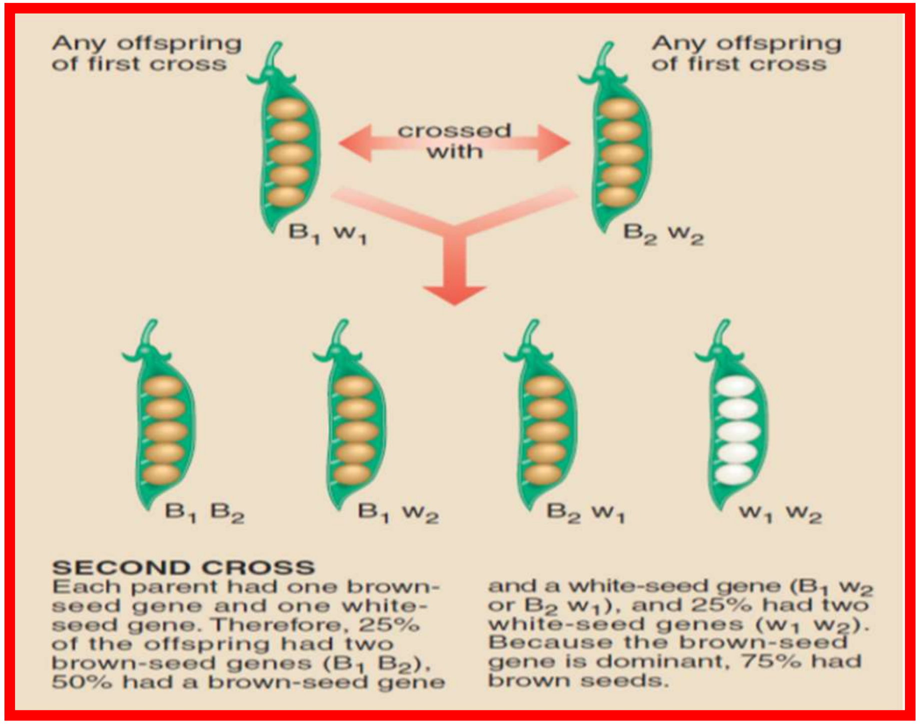
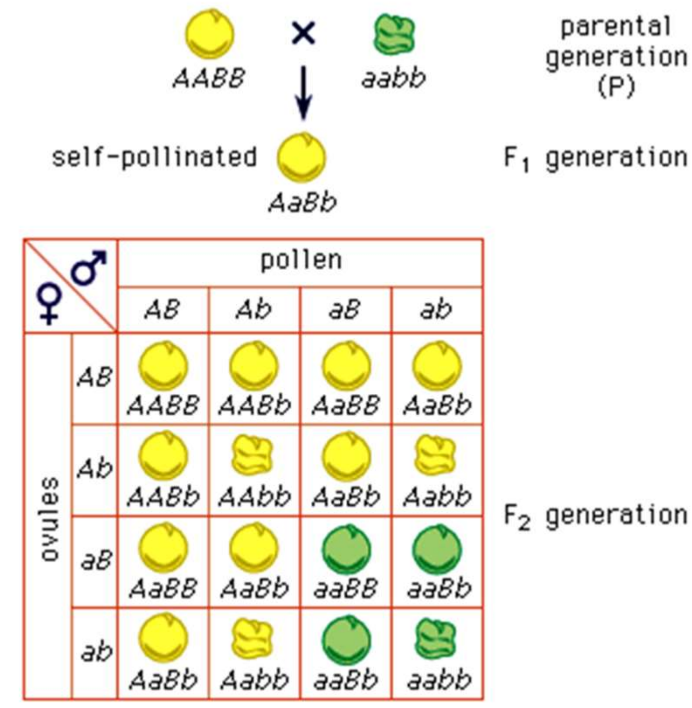
Mendel's Second Law





Mendel’s Third Law



<u>Independent Combination.</u>

- When considering two distinct traits, each trait is trait is inherited according to Mendel’s laws laws independently of the presence of the other. other.

- The transmission of one trait does not influence influence the inheritance pattern of the other. other.

https://www.britannica.com/science/Mendelian-inheritance#/media/1/374776/95557

Monogenic or Mendelian Inheritance

AUTOSOMES

- Dominant gene → AUTOSOMAL DOMINANT.
- Recessive gene → AUTOSOMAL RECESSIVE.

GONOSOMES

- Dominant → X-Linked DOMINANT.
- Recessive → X-Linked RECESSIVE.

Autosomal Dominant Inheritance

1. **Gene presence.**
   Trait expression requires the dominant gene (A) in at least one parent.
2. **Phenotype visibility.**
   The trait is visible in both homozygous (AA) and heterozygous (Aa) individuals.
3. **Generational patterns.**
   No generational skips occur. The trait affects sons and daughters equally.
4. **Examples.**
   Achondroplasia and Huntington's chorea are notable autosomal dominant disorders with significant impacts.

Autosomal Recessive Inheritance

1

Gene presence

The expression of a recessive trait requires the presence of the recessive allele (a) in both alleles of the genotype, which requires that each parent contributes a copy of this allele.

2

Phenotype visibility

The trait is **ONLY** expressed in homozygous (aa) individuals who inherit both recessive ‘a’ alleles, one from each parent.

3

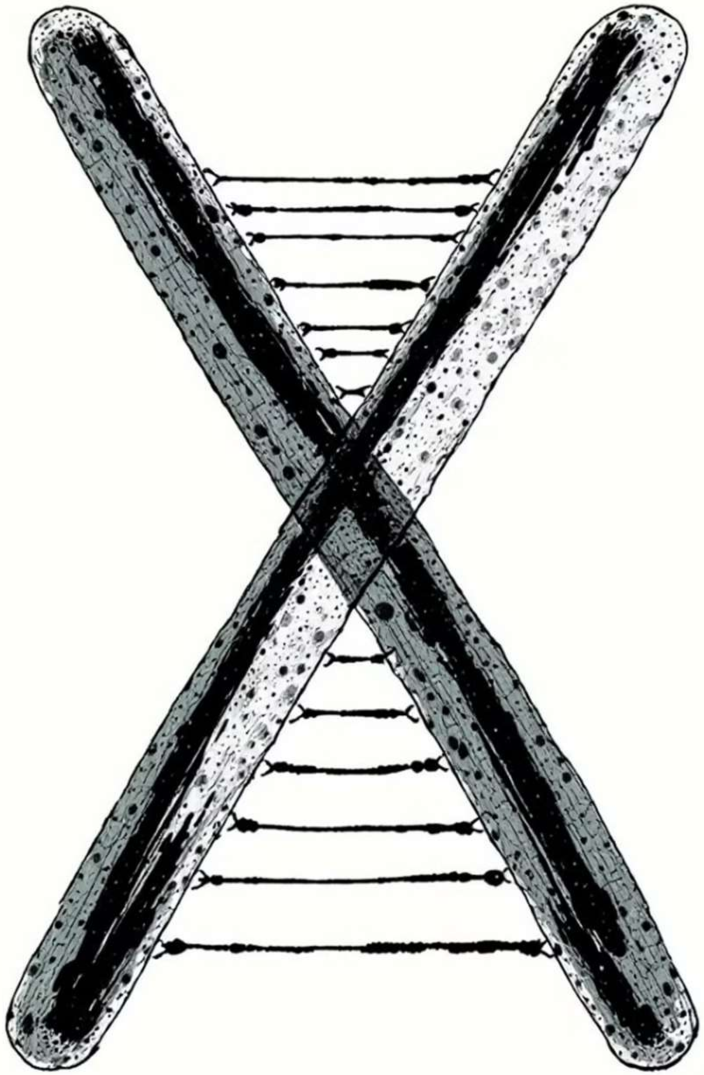
Generational patterns

Generational skips may occur.

4

Examples

Albinism and phenylketonuria are significant autosomal recessive disorders affecting metabolism and appearance.



Sex-Linked Inheritance: Introduction

Definition.

Sex-linked inheritance involves traits determined by genes on sex sex chromosomes, primarily the X chromosome.

Transmission.

Gene transmission depends on the sex of both parents and the offspring.

X Chromosome inheritance.

Daughters inherit X chromosomes from both parents. Sons inherit them inherit them only from their mother.

Hemizygosity.

Males are hemizygous for X-linked genes, having only one X chromosome.

KPC0

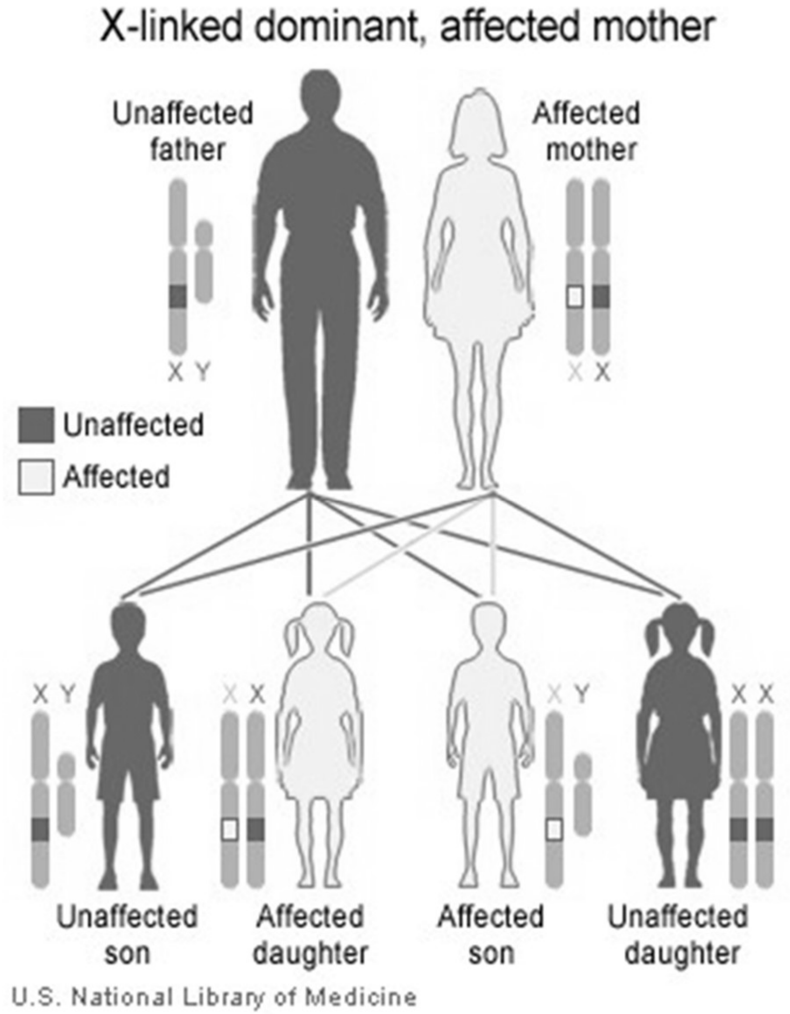
Slide 29

KPC0 This is a dangling participle (the subject of the verb "have" is not made specific, so the intended meaning of the clause is hidden.

Do you mean "Males are hemizygous for X-linked genes since they have only one X chromosome"?

Kevin Costello, 2024-11-20T14:11:12.921

X-Linked Dominant Inheritance



1

Expression.

Both females (homozygous/heterozygous) and males (hemizygous) exhibit this trait.

2

Transmission pattern.

Fathers transmit to all daughters. Mothers transmit to half of half of their children.

3

Gender prevalence.

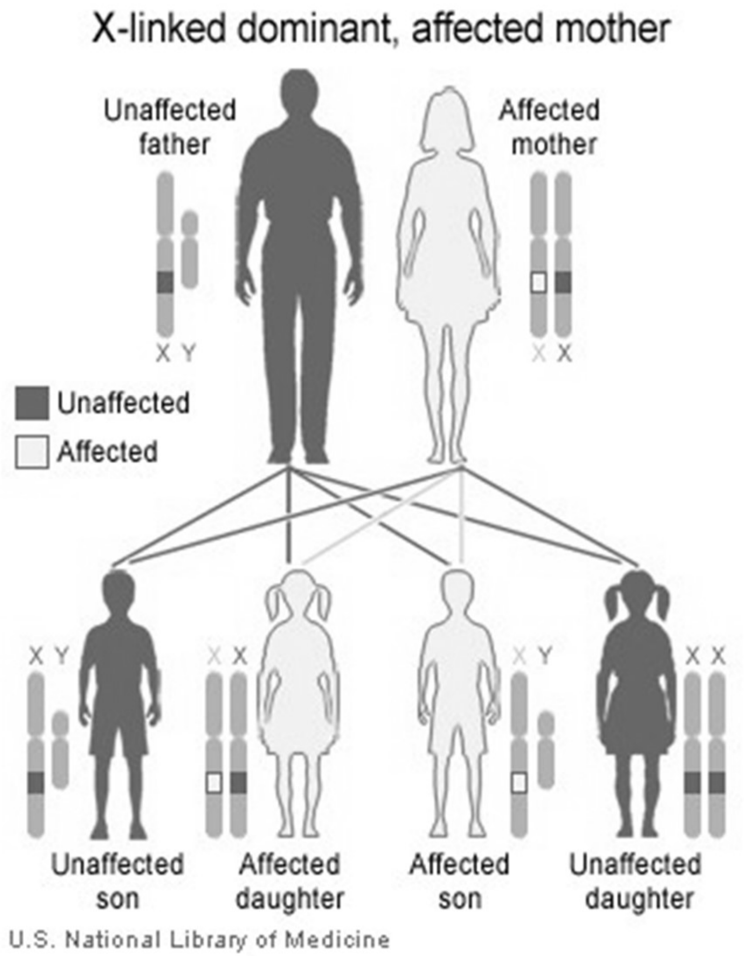
Traits are twice as likely to manifest in females as in males.

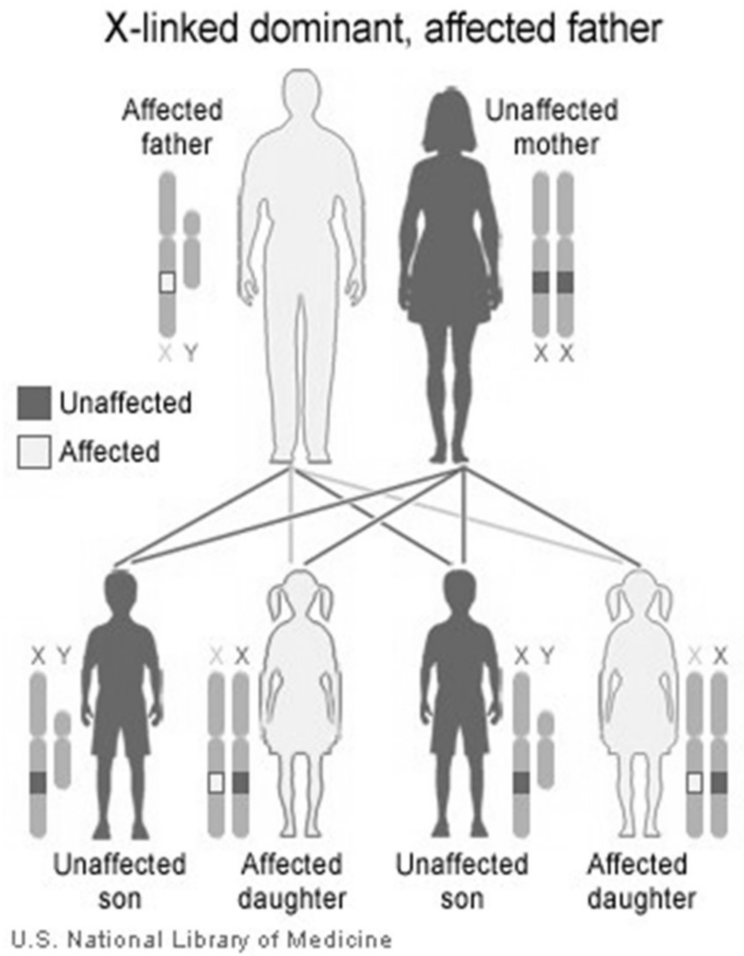
4

Examples.

Defective tooth enamel and *hypophosphatemic rickets* are are notable X-linked dominant disorders.

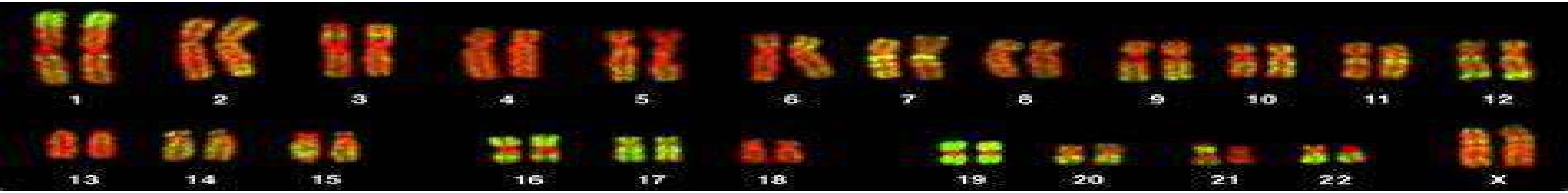
X-Linked Dominant Inheritance



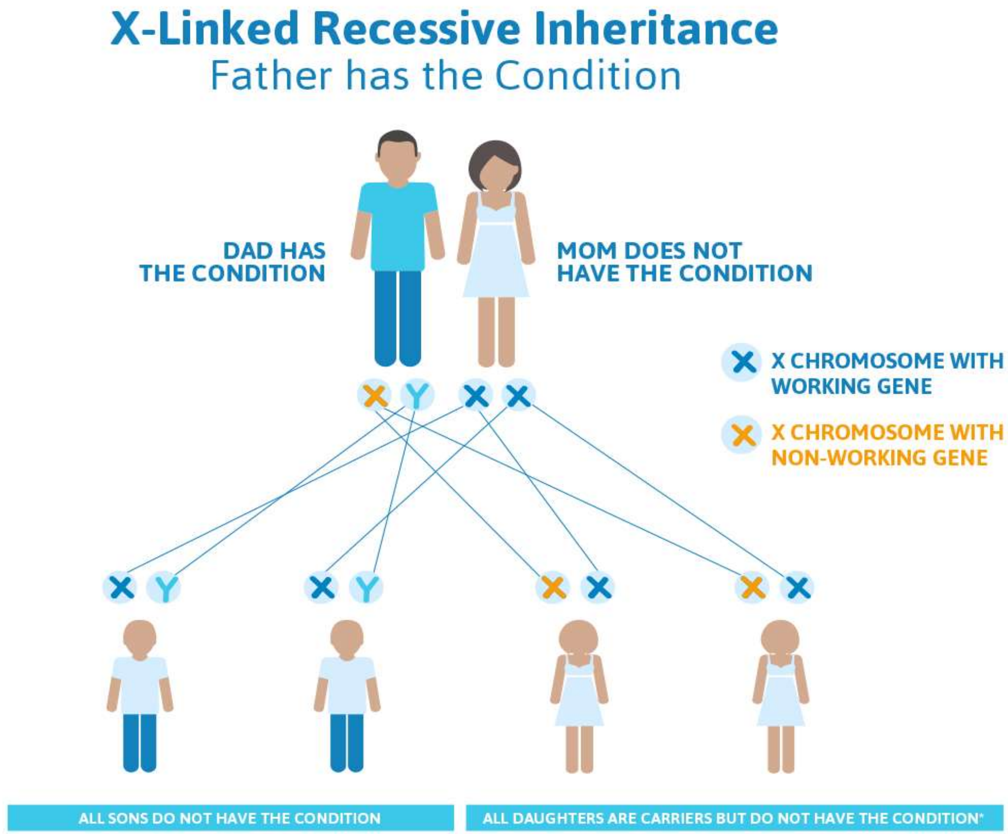


X-Linked Recessive Inheritance

Characteristic	Males	Females
Gene expression	Hemizygous state	Homozygous recessive
Frequency	More frequent	Less frequent
Inheritance pattern	From mother	From both parents



X-Linked Recessive Inheritance



Hemizygosity and Sex-Linked Traits

Non-Homologous Sex Chromosomes

Males have XY chromosomes, while females have XX chromosomes.

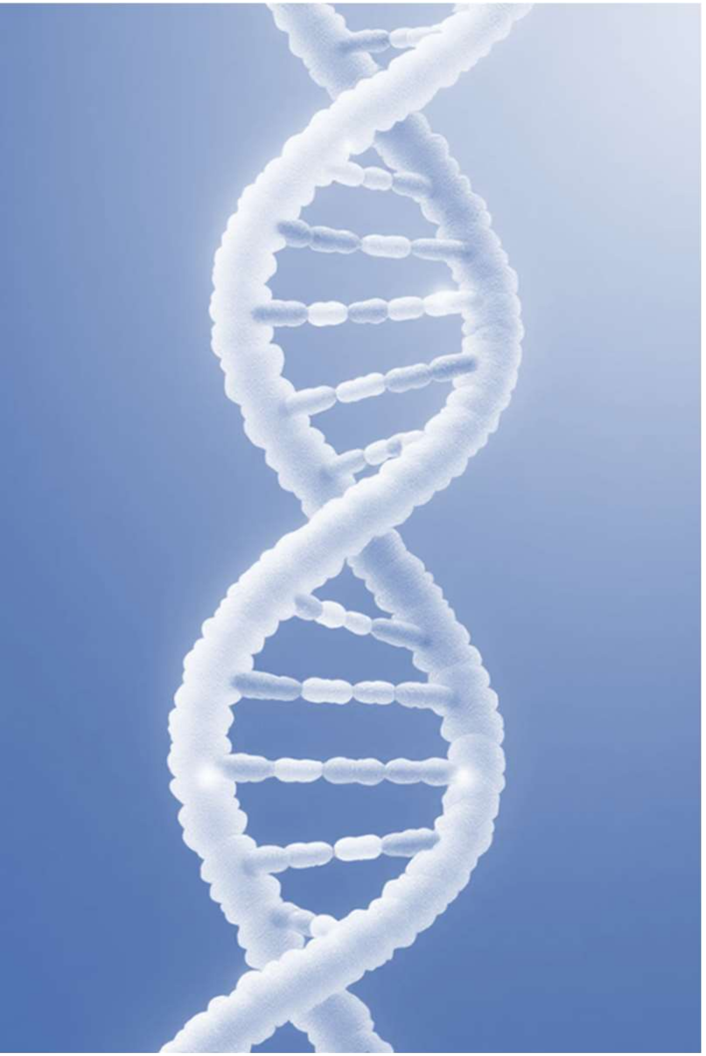
Single Allele Expression

Males express the only allele present on the X chromosome.

Recessive Disorders

X-linked recessive disorders are more common in males.

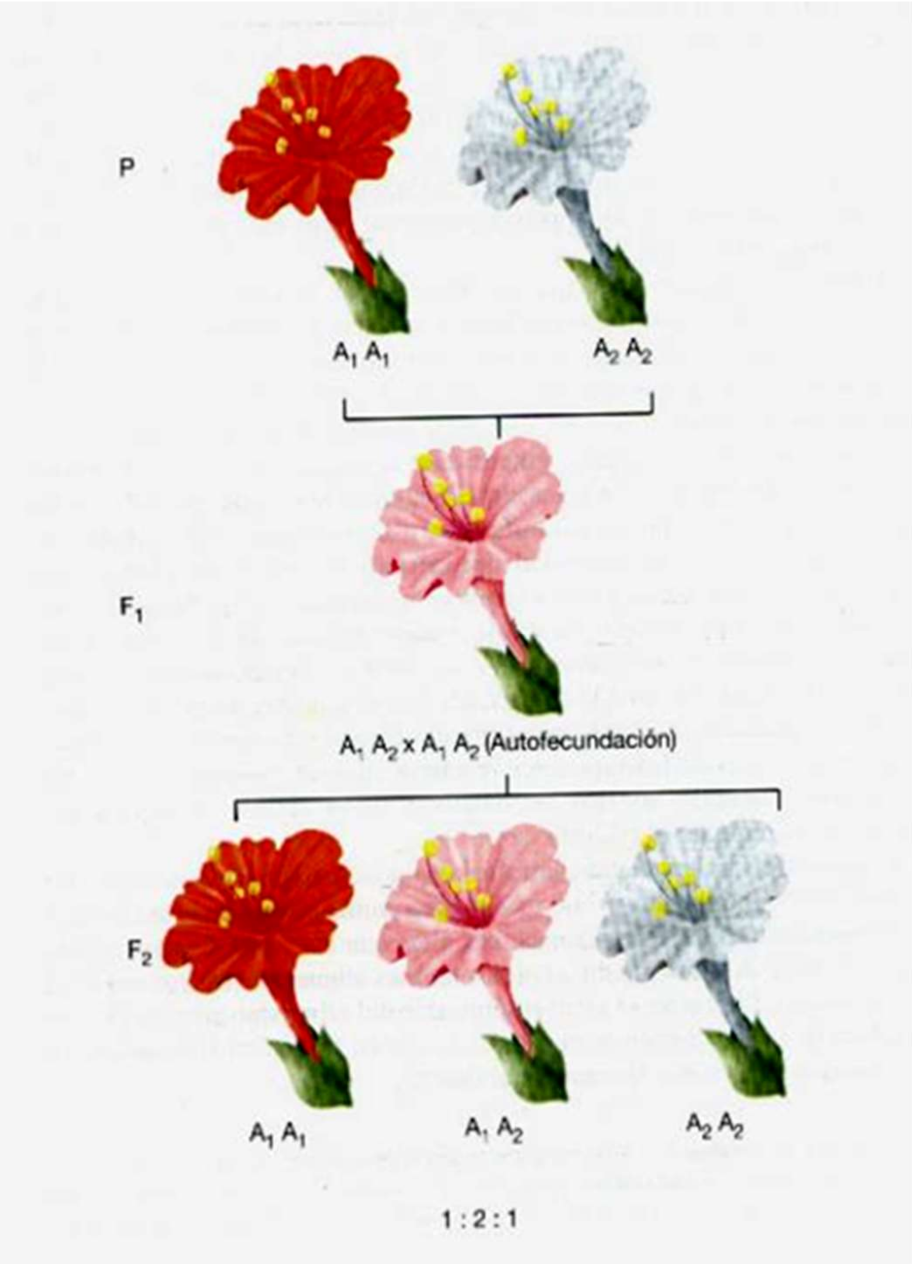
Exceptions in Mendelian Inheritance



Mendelian inheritance patterns are not universally universally applicable, as certain genetic traits demonstrate notable exceptions.

These include phenomena such as:

- Intermediate dominance.
- Multiple allelism.
- Codominance.



Intermediate Dominance

1

Parental generation

Homozygous red (AA) and white (aa) snapdragon plants are plants are crossed. Each parent contributes one allele to to offspring.

2

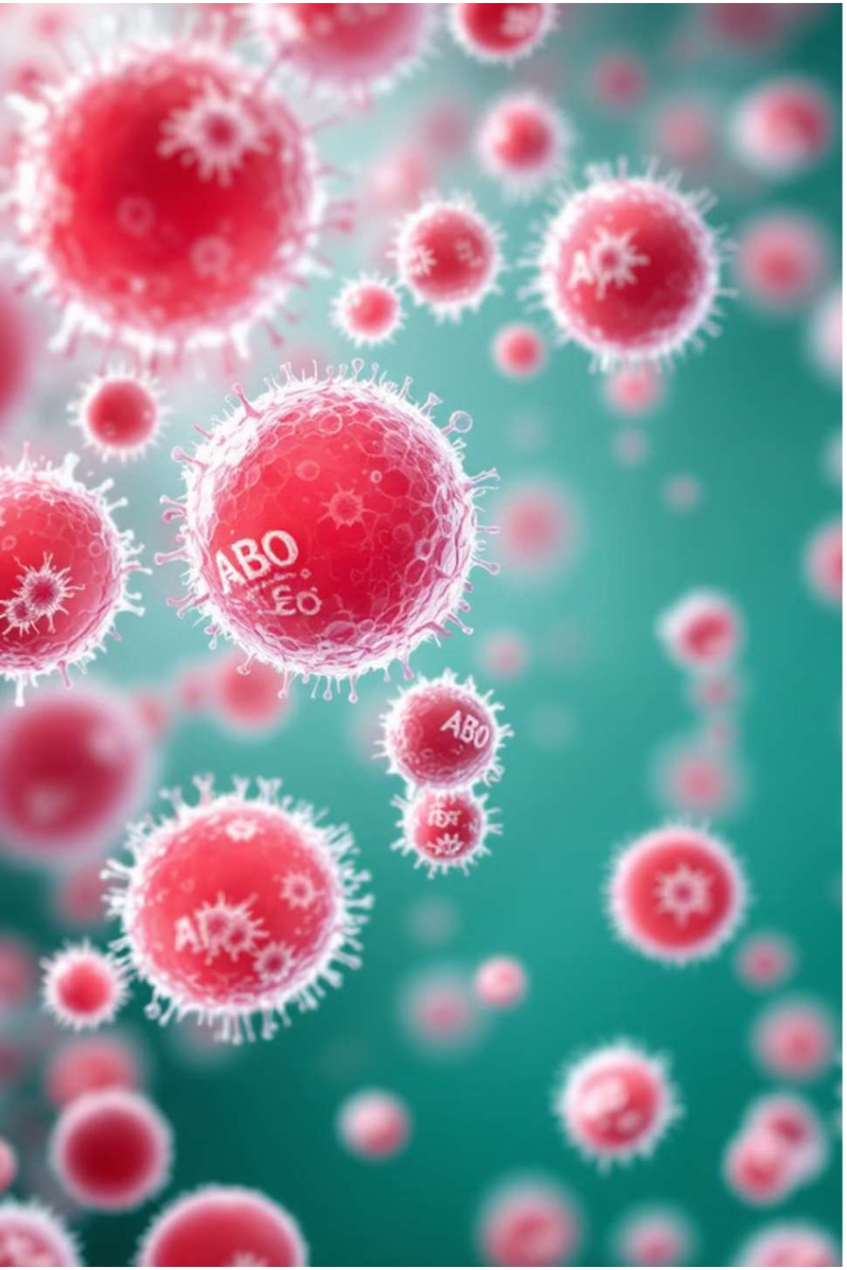
F1 Generation

All offspring are heterozygous (Aa). They exhibit an intermediate pink phenotype that is different from both both parents.

3

F2 Generation

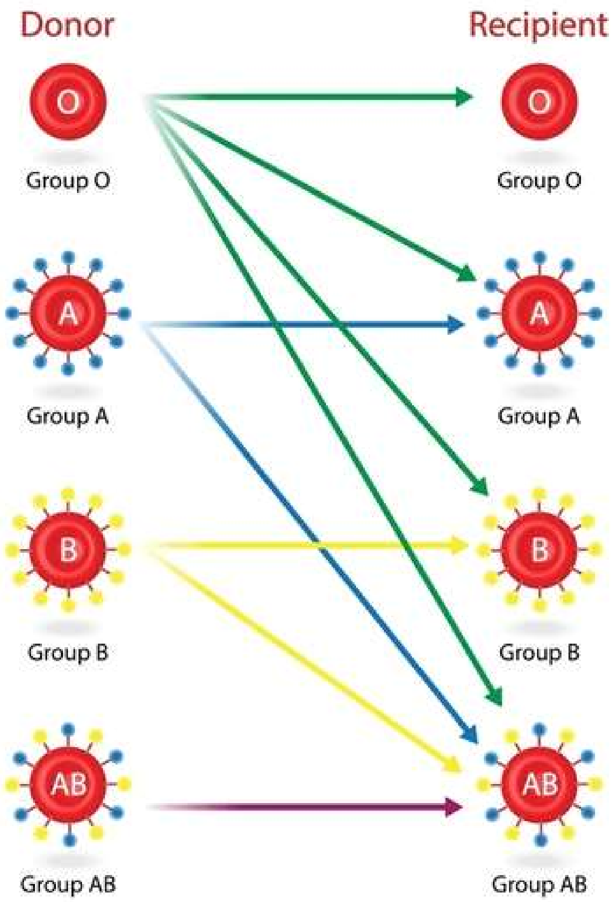
Crossing F1 plants produces a 1:2:1 ratio of red (AA), pink pink (Aa) and white (aa) flowers.



Multiple Allelism

Gene → MORE than 2 alleles.

Number of alleles alleles	Possible genotypes genotypes	Example
One (A).	1 (AA).	Rare in ABO system.
Two (A,B).	3 (AA, AB, BB).	A and B blood types.
Three (A,B,0).	6 (AA,AB,BB, A0, B0,00).	Complete ABO system.



Codominance

Both alleles are dominant.

A Blood Type

Genotypes: A,B,0. Red blood cells express only A antigens on their surface.

B Blood Type

Genotypes: BB or B0. Red blood cells express only B antigens on their surface.

AB Blood Type

Genotypes: A,B. Red blood cells express both A and B antigens, thus thus demonstrating codominance.

Principles of Mendelian Inheritance

1. **Single Gene Pair.**

   Traits are governed by one gene pair located on autosomes or sex chromosomes.

2. **Dominant vs. Recessive.**

   Inheritance is influenced by either dominant or recessive alleles of the gene. gene.

3. **Predictable Patterns.**

   Follows Mendelian laws, thus enabling precise prediction of offspring traits. traits. KPC0

Slide 39

KPC0 It would be clearer (and more parallel) to begin with the subject of this verb. Is it “Inheritance follows …”? (The repetition from 2 above is not a problem).

Kevin Costello, 2024-11-20T14:48:57.774

Polygenic Inheritance: Beyond Mendel

1 **Multiple Genes**.

Traits are influenced by two or more genes, each of which contributes to the phenotype. phenotype.

2 **Continuous Variation**.

This results in a spectrum of phenotypes rather than discrete categories.

3 **Environmental Influence.**

Trait expression can be modified by environmental factors.

Approximately 99.9% of behavioral traits are inherited through polygenic inheritance.

Polygenic Inheritance: Beyond Mendel

DNA → Proteins → Neural Circuit → Behavior

Chapter 2: Genetics of Behavior

2.1 Introduction

2.2 Chromosomal theory of inheritance

2.3 Types of gene transmission

2.4 Epigenetics

Gene-Environment Interaction: Nature Meets Nurture

Genetic Potential.

DNA serves as the blueprint for for the development of traits and and characteristics.

Environmental Influence.

Environmental factors have the the potential to influence gene gene expression and the development of traits.

Phenotypic Outcome.

The expression of the final trait is trait is a product of the interplay interplay between genetic and environmental factors.

Epigenetics

1 **Gene Regulation**

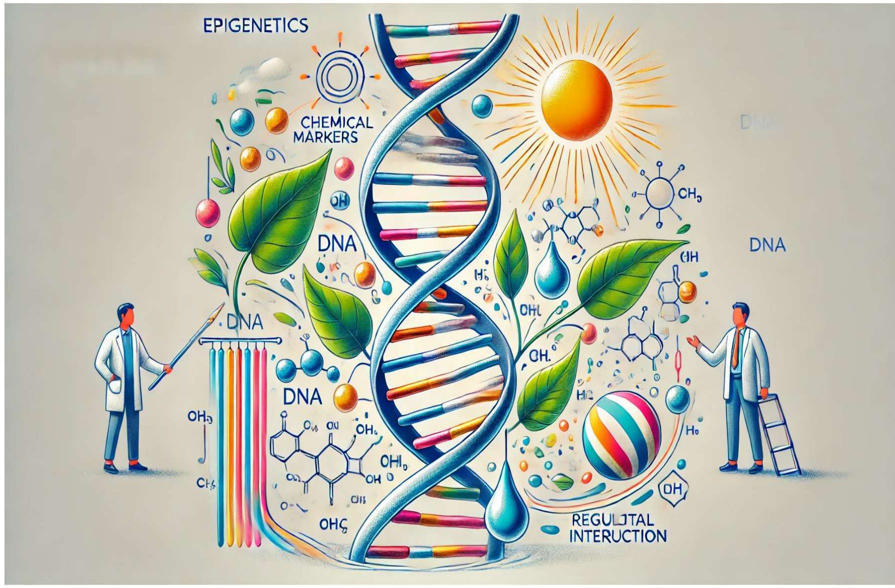
Epigenetics modifies gene expression without changing the DNA sequence.

2 **Reversible Changes**

Epigenetic modifications can be added or removed removed throughout life.

3 **Heritable Patterns**

Some epigenetic marks can be passed onto offspring.



Epigenetics

1

Acetylation

The addition of acetyl groups relaxes chromatin chromatin structure, thereby enhancing gene accessibility and modulating gene expression.

2

Methylation

The addition of methyl groups can either activate or activate or repress gene expression, contingent upon upon their specific location on the genome.

DNA Methylation: The Off Switch

Gene Silencing

Methyl groups attach to DNA, thus inhibiting gene expression.

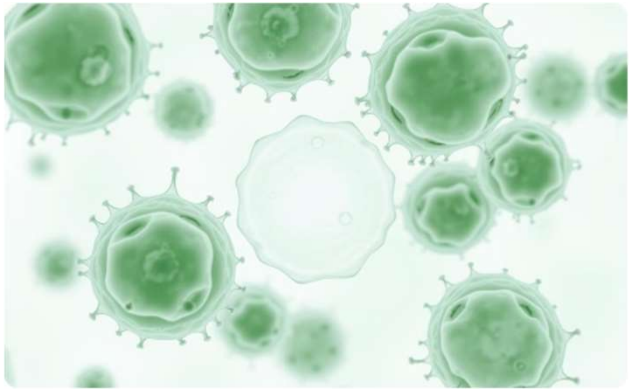
CpG Islands

Methylation often occurs at specific DNA regions called *CpG islands*.

Cellular Differentiation

Methylation patterns help determine cell types and functions.

Epigenetics in Action: Real-World Applications



Cancer Research

Epigenetic therapies are designed designed to target aberrant gene gene expression patterns in cancer cancer cells.

Prenatal Development

Maternal diet and stress levels have have the potential to modulate epigenetic patterns in offspring. offspring.

Aging Studies

Epigenetic modifications accumulate progressively over time, time, thus exerting an influence on on the aging process.

Core Concepts of Genetics in Behavior

Studying Genetic Factors

A comprehensive understanding of genetic influences on behavior necessitates the precise precise identification of the hereditary components involved.

Inheritance of DNA, not Behavior

Behavior, *per se*, is not directly inherited. Instead, DNA is transmitted across generations, encoding proteins that form neural circuits that ultimately give rise to behavioral manifestations.

Differences could be Continuous or Discontinuous

Most behaviors exhibit continuous variation among individuals of the same species. This phenomenon is largely attributed to polygenic inheritance and environmental influences.

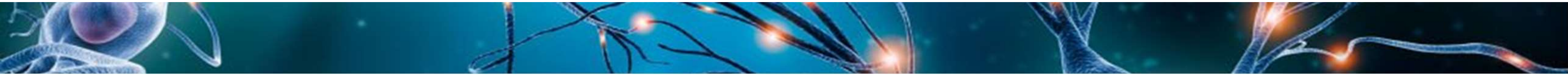
Core Concepts of Genetics in Behavior

Polygenic Nature of Behavior

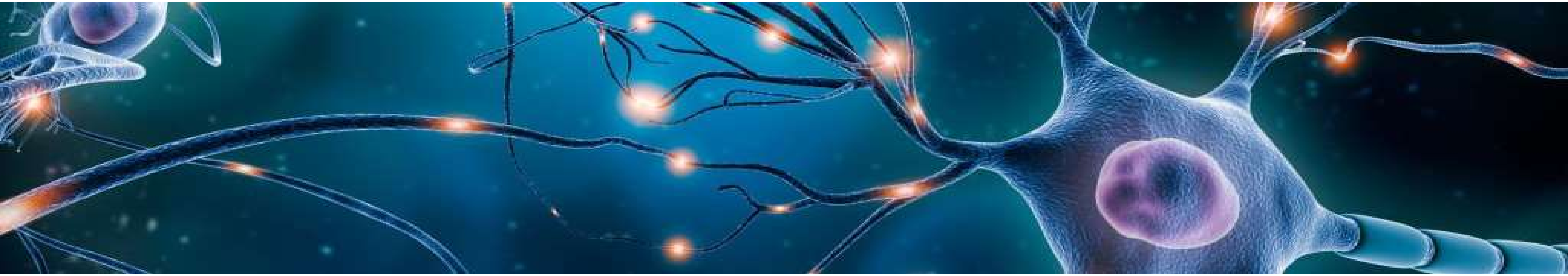
The inheritance of behavioral traits is predominantly polygenic, with numerous genes exerting minor effects on individual variability and susceptibility.

Role of the Environment

The environment plays a crucial role in the development of individual characteristics, interacting with genetic factors to shape behavioral outcomes.



End of Chapter 2



Chapter 11: The Autonomic Nervous System System

The Autonomic Nervous System (ANS) is a component of the peripheral peripheral nervous system responsible for regulating involuntary involuntary physiological functions including heart rate, respiratory rate, respiratory rate, digestion, and blood pressure.

The basis of the Teaching Guide for this chapter

Autonomic nervous system. Sympathetic nervous system. Parasympathetic nervous system. Similarities and differences between these systems. Vegetative functions.

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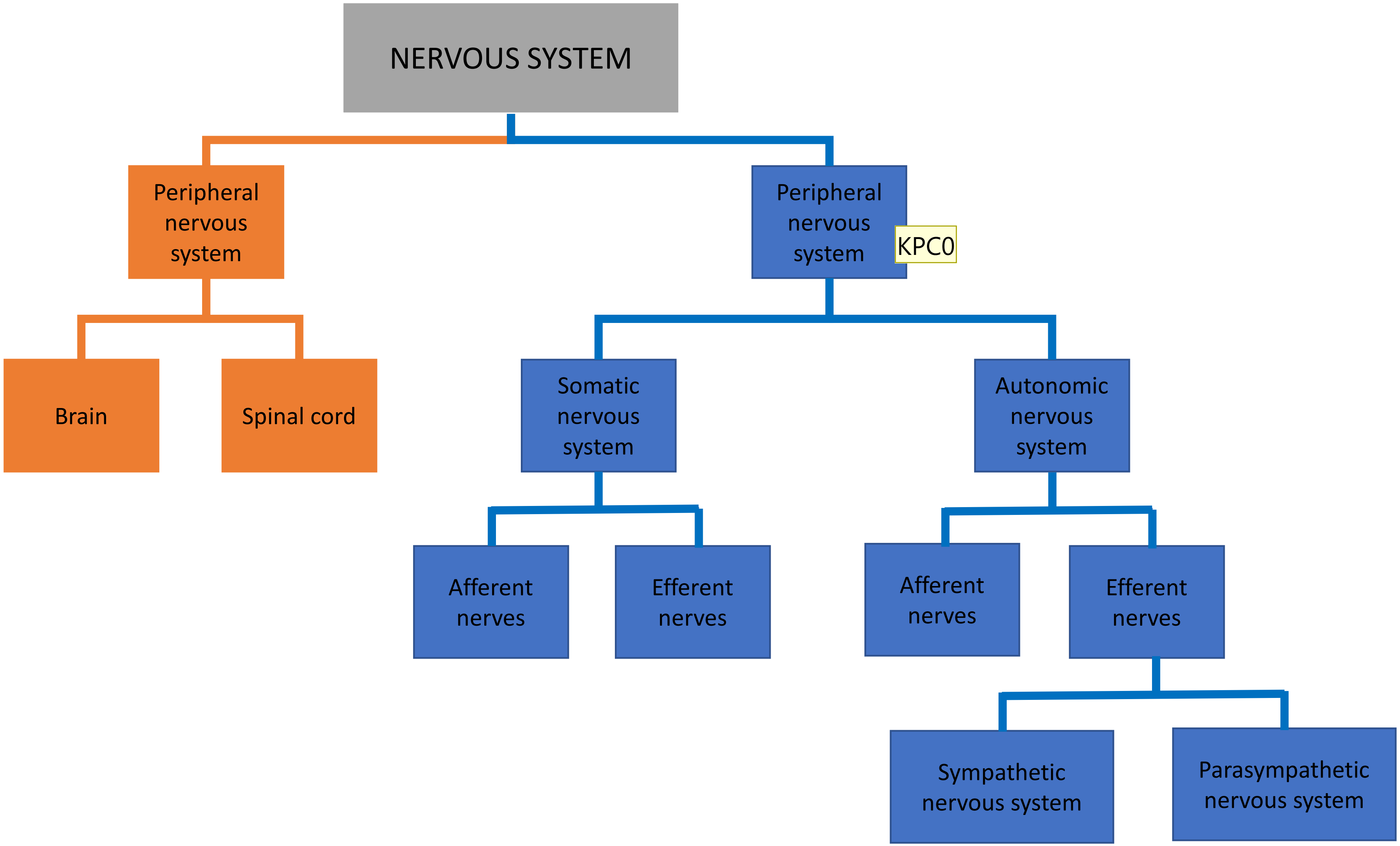
Chapter 11: The Autonomic Nervous System System

11.1 Introduction.

11.2 Sympathetic Nervous System (SNS).

11.3 Parasympathetic Nervous System (PNS).

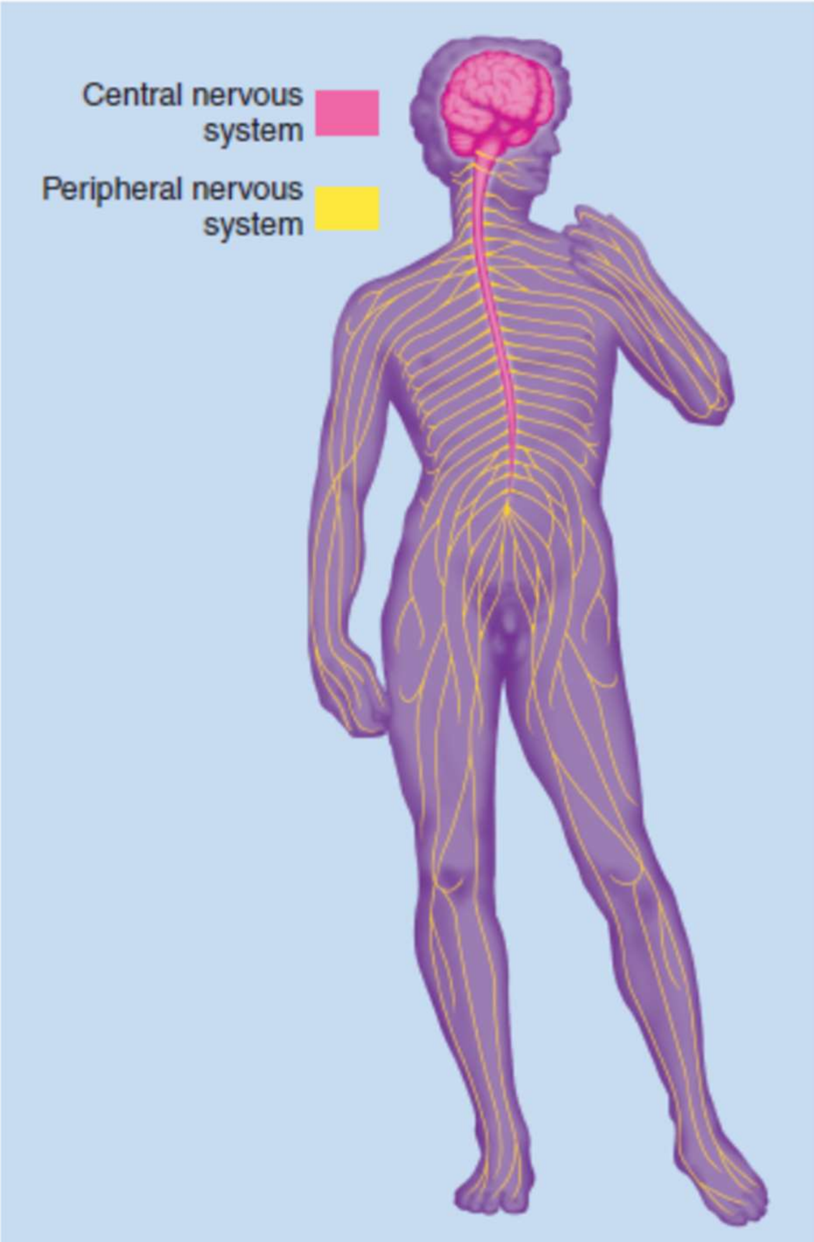
11.4 Differences between SNS and PNS.


NERVOUS SYSTEM
Peripheral nervous system
Peripheral nervous system
KPC0
Brain
Spinal cord
Somatic nervous system
Autonomic nervous system
Afferent nerves
Efferent nerves
Afferent nerves
Efferent nerves
Sympathetic nervous system
Parasympathetic nervous system

Slide 53

KPC0 “Peripheral nervous system” appears on both sides of the graphic. Is this correct?

Kevin Costello, 2024-11-26T11:18:09.975



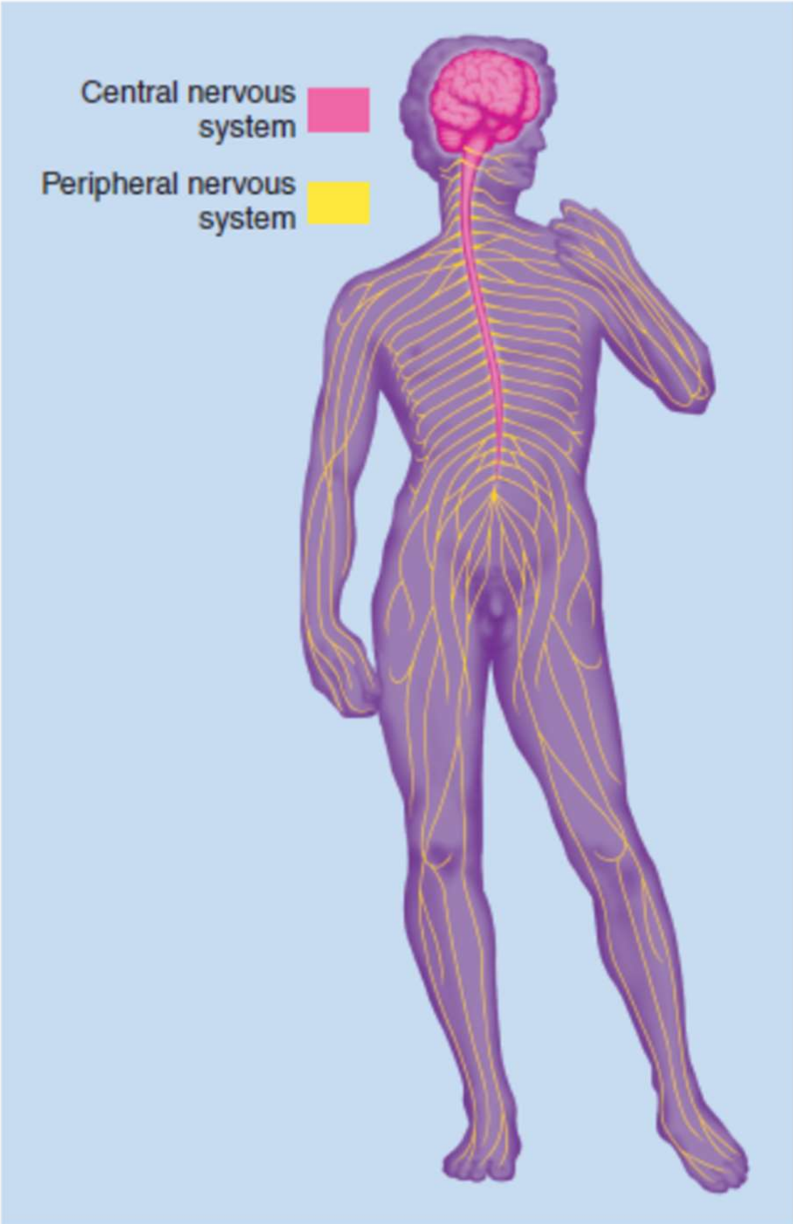
Central Nervous System

Brain

Housed in the skull, the brain is responsible for processing sensory inputs and coordinating bodily functions. It serves as the center for cognition, emotional processing, and memory storage.

Spinal Cord

Encased within the vertebral column, the spinal cord serves as the primary conduit for transmitting signals between the brain and the peripheral nervous system. It is essential for reflexive responses and the coordination of movement.



Peripheral Nervous System

1 **Location**

The PNS extends beyond the cranial and spinal regions, innervating all areas of the body.

2 **Function**

It autonomously regulates the body's internal environment, environment, operating involuntarily and unconsciously to unconsciously to maintain homeostasis.

3 **Coordination**

The PNS collaborates with the endocrine system to modulate modulate reproductive functions.

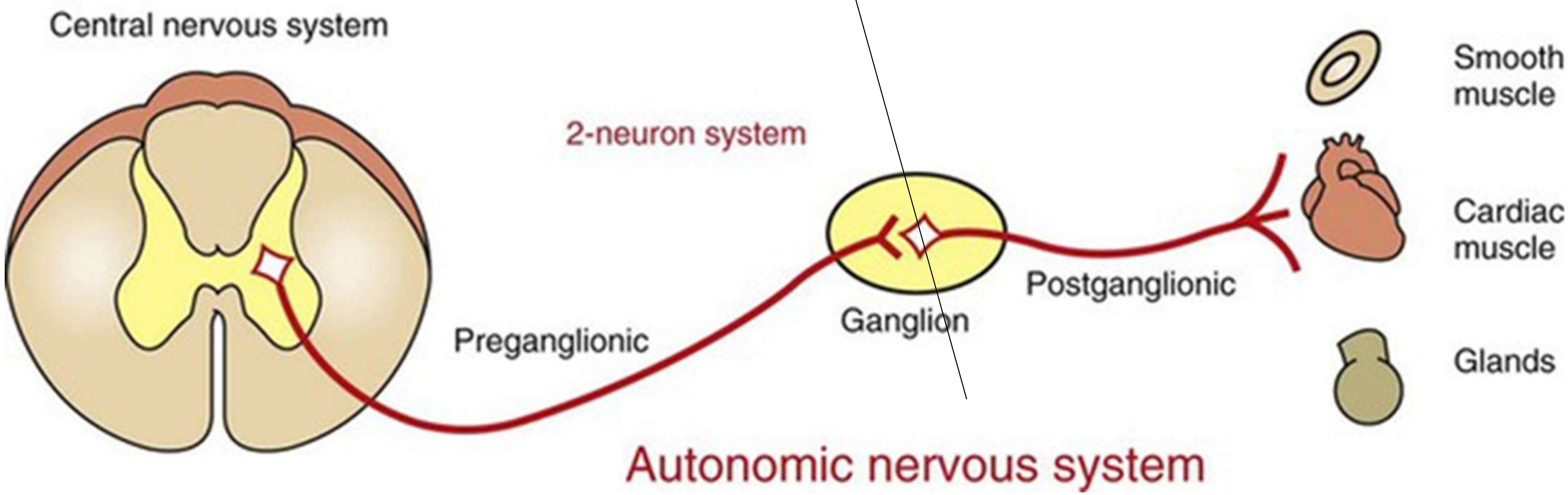
Structure of the Autonomic Nervous System

1 **<u>Preganglionic neuron</u>**

The cell body resides within the grey matter of the of the central nervous system, with its myelinated myelinated axon forming a synapse with a secondary neuron located in an autonomic ganglion.

2 **<u>Postganglionic Neuron</u>**

The postganglionic neuron, with its axon unmyelinated, extends from the autonomic ganglion to the target effector organ.



Structure of the Autonomic Nervous System

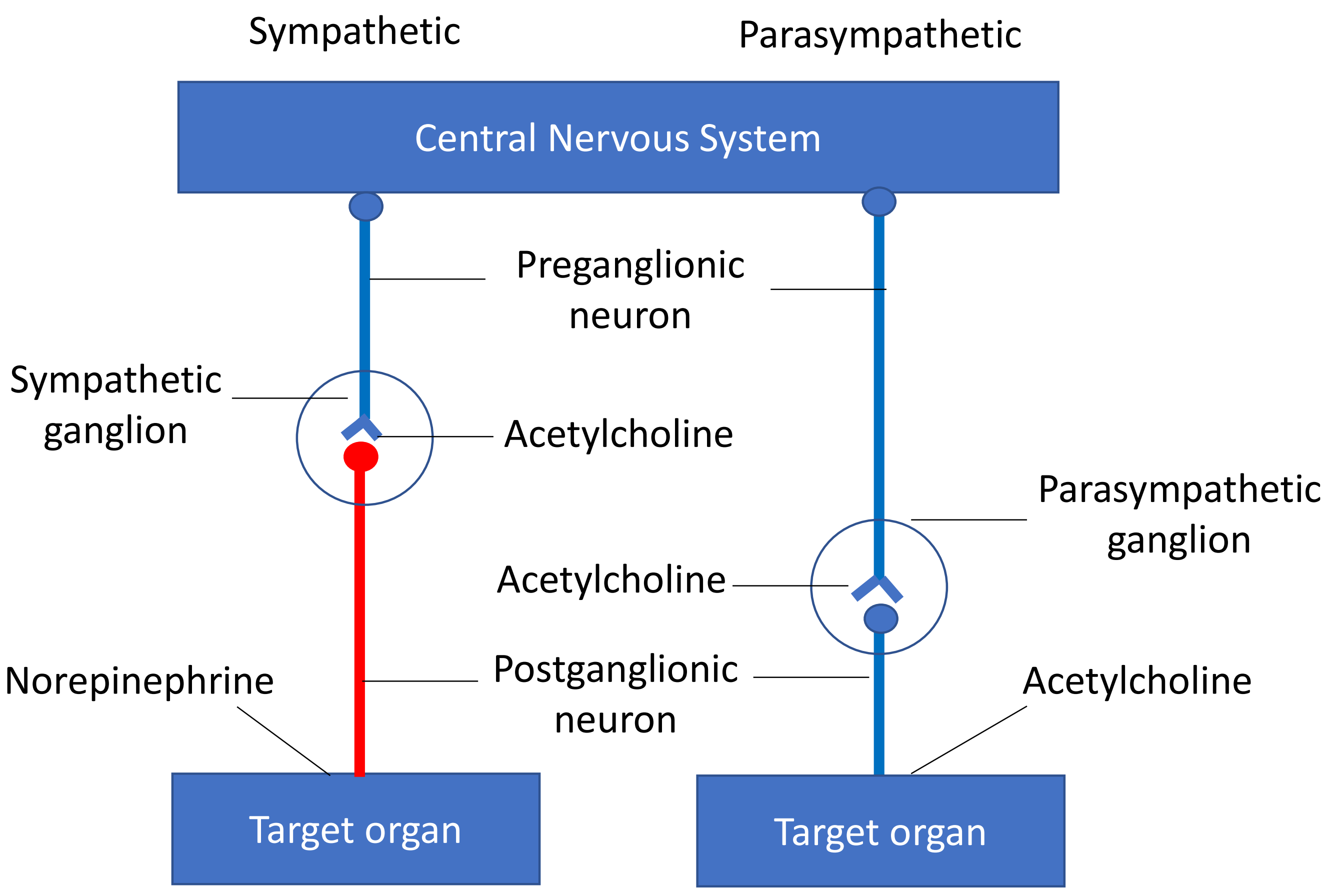
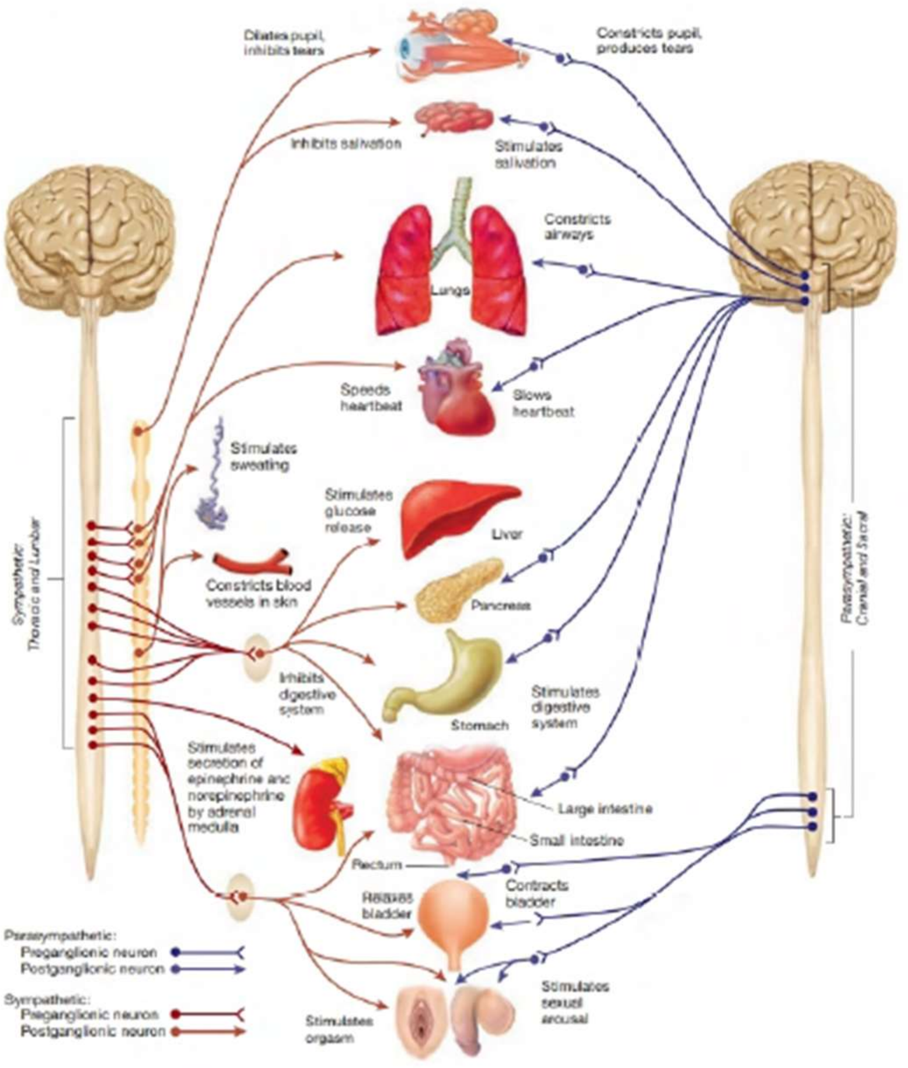


Figure 3.21 The Autonomic Nervous System

The target organs and functions served by the sympathetic and parasympathetic branches of the autonomic nervous system.



Functions of the ANS

Cardiac Function

The ANS regulates heart rate and contractility, adapting to the body’ s needs.

Ocular Control

It controls pupil size and lens accommodation, adjusting to light and focus.

Digestive Regulation

The ANS manages intestinal walls, sphincters, and gallbladder function.

Urinary Control

It regulates the urinary bladder, controlling urination processes.

Chapter 11: The Autonomic Nervous

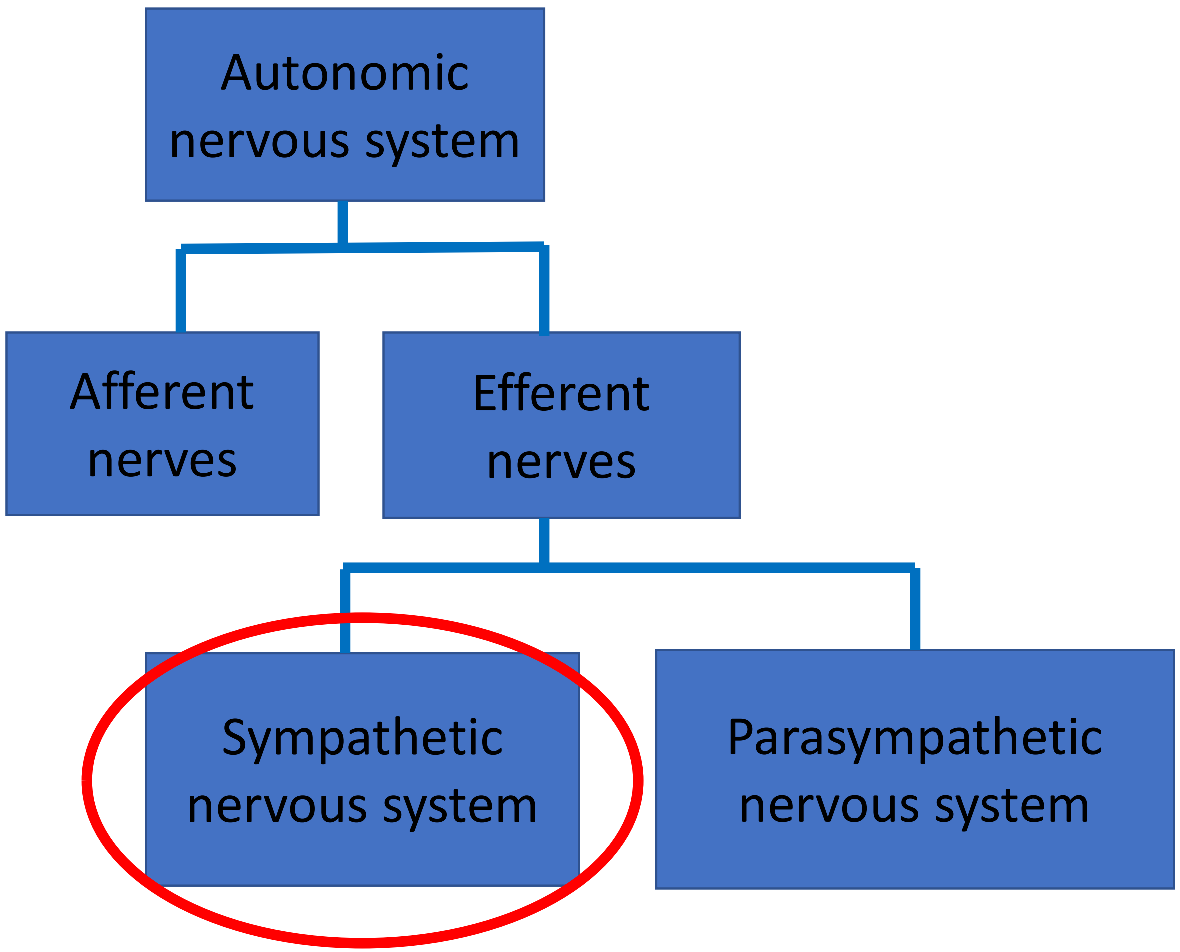
11.1 Introduction

11.2 Sympathetic Nervous System (SNS)

11.3 Parasympathetic Nervous System (PNS)

11.4 Differences between SNS and PNS

Sympathetic Nervous System (SNS)



SNS: Fight or Flight

1

Activation

Exposure to stress or perceived danger activates the sympathetic nervous system, system, priming the body for a rapid response.

2

Energy Mobilisation

SNS facilitates the mobilization of energy reserves, enhancing glucose availability in availability in the bloodstream.

3

Physiological Changes

The heart rate increases, the pupils dilate, and digestion slows down, etc.

SNS: Anatomical Organization

Spinal Cord Origin

Sympathetic motor neurons neurons arise from the thoracic and lumbar segments segments of the spinal cord, cord, with their cell bodies residing within the grey matter.

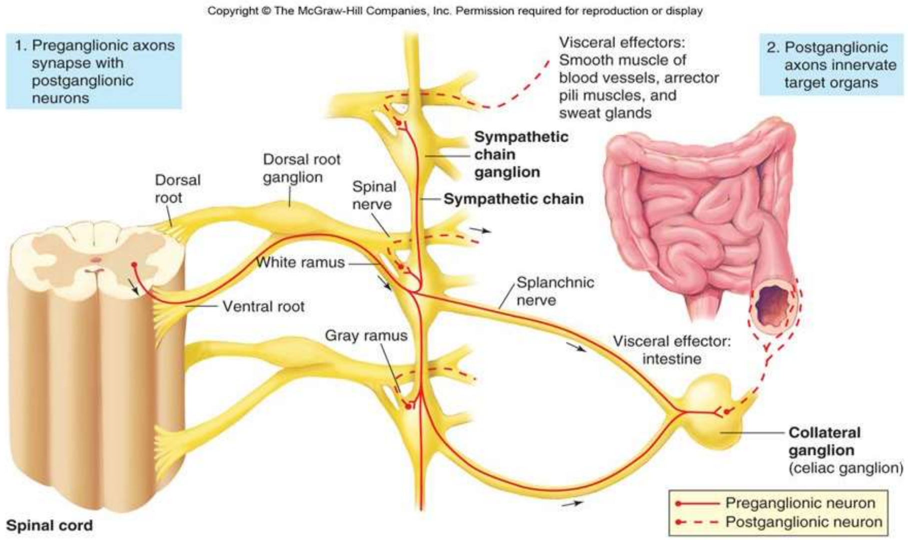
Nerve Pathways

Sympathetic fibers exit via the the ventral roots, merging with spinal nerves before diverging. Subsequently, they they reach the sympathetic sympathetic ganglia, establishing the sympathetic sympathetic chain ganglia.

Broad Response

Second-order neurons are positioned at a considerable considerable distance from from target organs. This spatial arrangement facilitates facilitates a swift and extensive sympathetic response across the body.

SNS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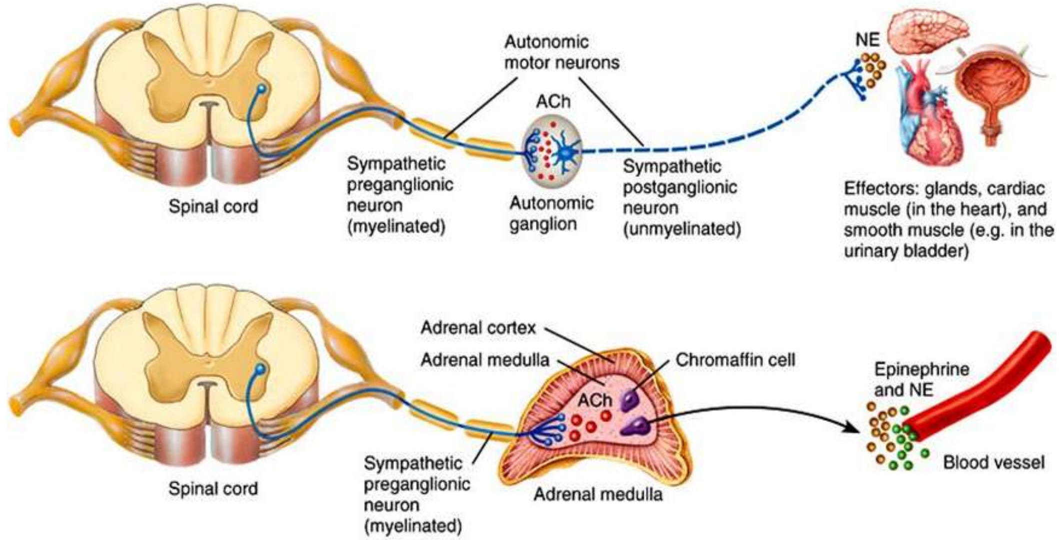
1. Preganglionic axons synapse with postganglionic neurons
2. Postganglionic axons innervate target organs
Visceral effectors: Smooth muscle of blood vessels, arrector pili muscles, and sweat glands
Sympathetic chain ganglion
Sympathetic chain
Dorsal root ganglion
Dorsal root
Spinal nerve
White ramus
Ventral root
Splanchnic nerve
Gray ramus
Visceral effector: intestine
Collateral ganglion (celiac ganglion)
Spinal cord
Preganglionic neuron
Postganglionic neuron


Autonomic motor neurons
ACh
NE
Spinal cord
Sympathetic preganglionic neuron (myelinated)
Autonomic ganglion
Sympathetic postganglionic neuron (unmyelinated)
Effectors: glands, cardiac muscle (in the heart), and smooth muscle (e.g. in the urinary bladder)
Adrenal cortex
Adrenal medulla
Chromaffin cell
ACh
Epinephrine and NE
Spinal cord
Sympathetic preganglionic neuron (myelinated)
Adrenal medulla
Blood vessel

Functions of the SNS

- It dilates the pupil.
- It increases the heart rate.
- It dilates the bronchi.
- It reduces stomach contractions.
- It stimulates the adrenal glands.
- It reduces intestinal contractions.
- It relaxes the bladder.
- It contracts the rectum.

Chapter 11: The Autonomic Nervous

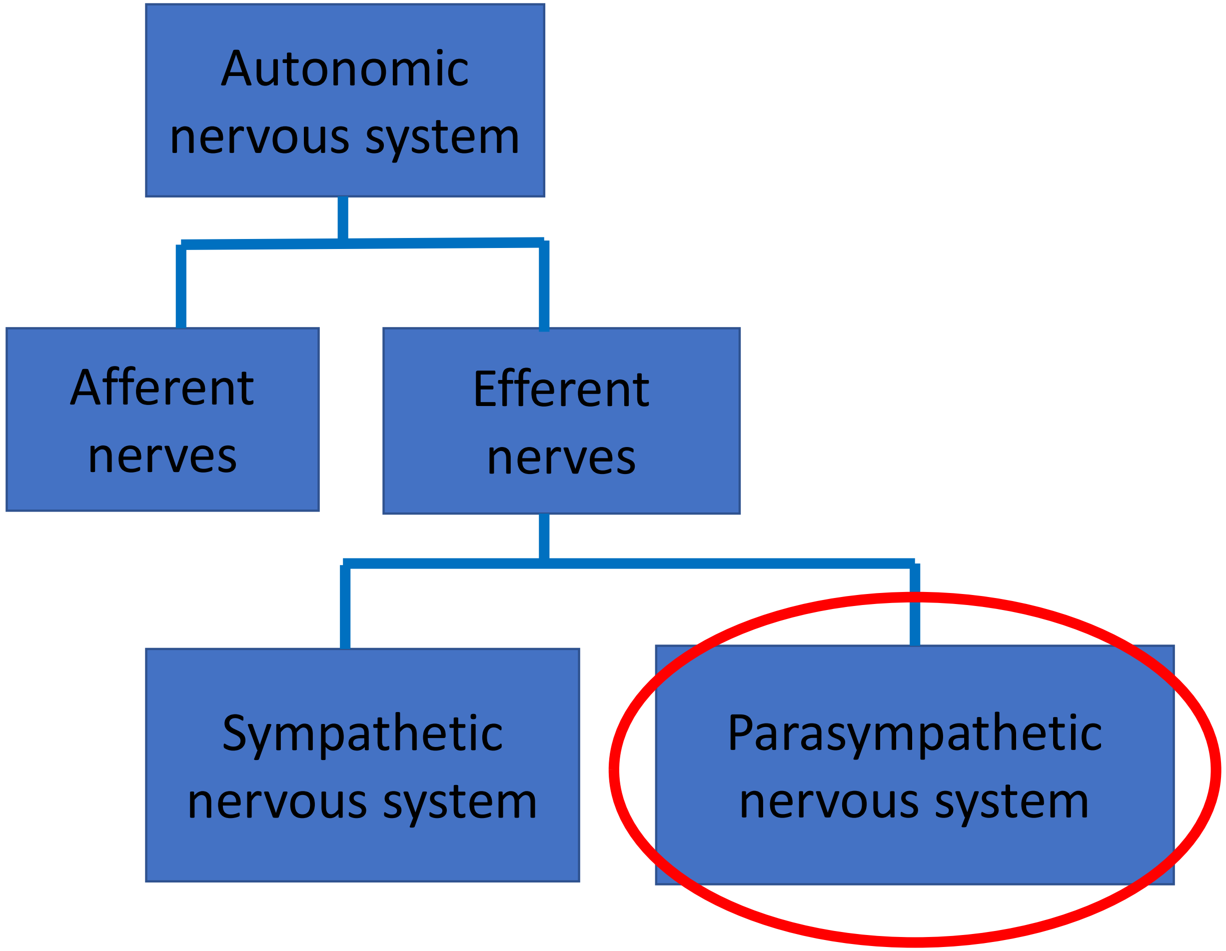
11.1 Introduction

11.2 Sympathetic Nervous System (SNS)

11.3 **Parasympathetic Nervous System (PNS**)

11.4 Differences between SNS and PNS

Sympathetic Nervous System (SNS)



PNS: Rest and Restore

1 Function

The parasympathetic system promotes relaxation and the conservation of energy.

2 Activation

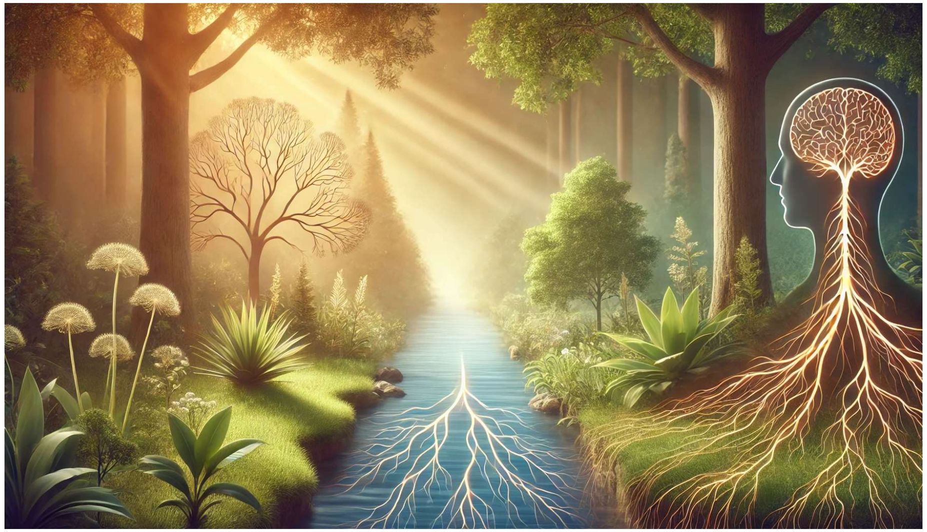
The PNS is dominant during rest, after eating, and in non-stressful situations.

3 Effects

The PNS slows the heart rate, increases digestion and promotes urination.

PNS: Our Body's Balancer

The parasympathetic nervous system plays a crucial role in maintaining bodily homeostasis. It counterbalances the sympathetic system, promoting relaxation and energy conservation. This division is essential for our overall health and well-being.



Origins and Structure

1

Cranial Nerves

Parasympathetic fibers originate from cranial nerves III, VII, IX, and X. These regulate various head and neck functions

2

Sacral Region

Fibers also originate from the sacral region of the spinal cord, where they regulate the functions of pelvic organs.

3

Ganglia Location

Parasympathetic ganglia are located near the target organs, resulting in short postganglionic fibers that facilitate localized control. This close proximity enables precise regulation.

PNS Functions

1
Energy Conservation

The parasympathetic nervous system facilitates energy storage and tissue repair by decreasing heart rate and enhancing digestive activity.

2
Relaxation Response

The PNS induces a state of calm, thereby reducing reducing stress and enhancing overall well-being. being.

3
Homeostasis Maintenance

The system assists in maintaining internal equilibrium equilibrium by regulating various bodily functions to functions to ensure optimal performance.

Regulation of Smooth Muscle

Blood Vessels

Parasympathetic stimulation induces induces vasodilation in specific regions, regions, thereby increasing blood flow flow to organs such as the digestive digestive tract.

Eyes

Parasympathetic stimulation also constricts the pupil and relaxes the ciliary muscle, facilitating near vision and providing protection to the retina.

Urinary Bladder

Parasympathetic nerves stimulate bladder contraction and relax the internal urethral sphincter, facilitating facilitating urination.

Cardiac Muscle Control

Heart Rate Reduction

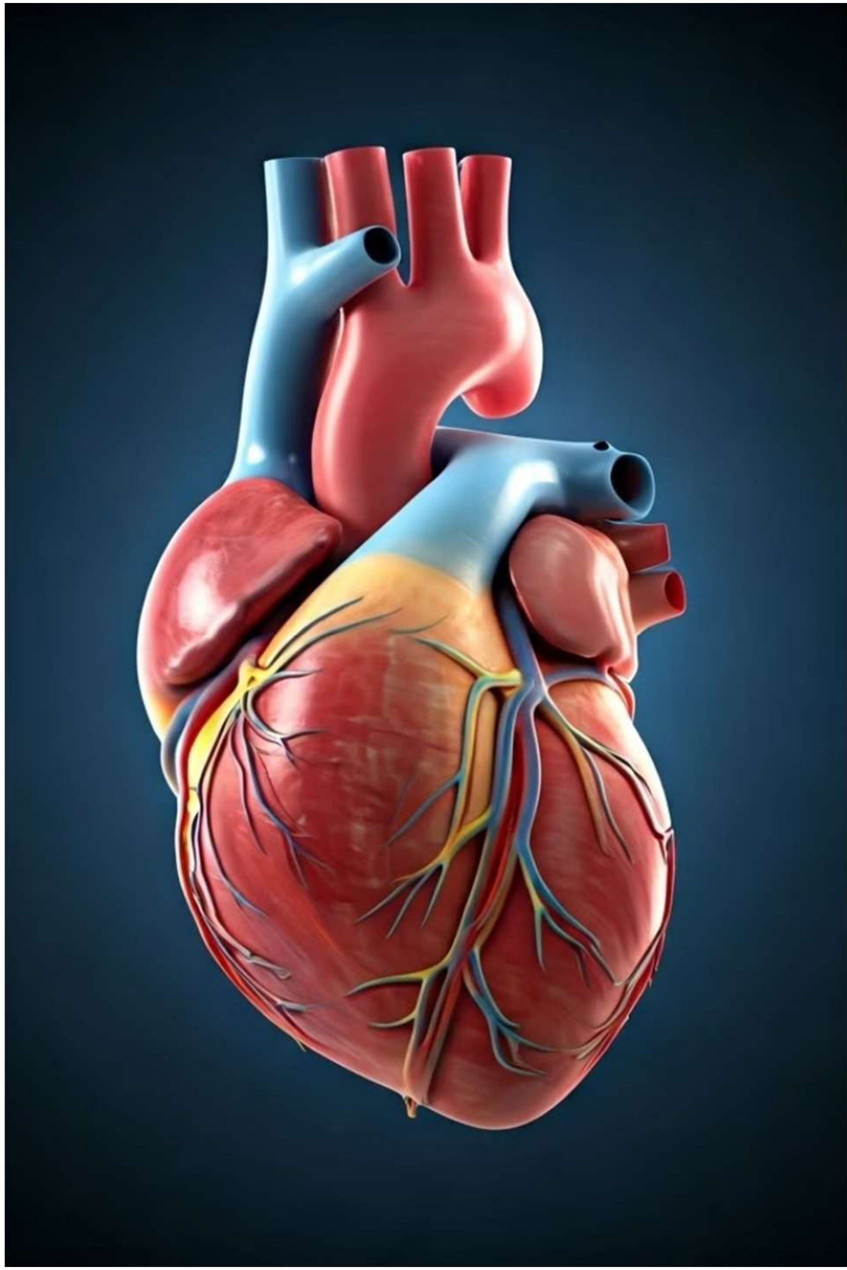
Parasympathetic stimulation decreases the heart rate by releasing acetylcholine through the vagus nerve, which slows the slows the firing of the sinoatrial node.

Contractility Modulation

Parasympathetic stimulation reduces cardiac muscle contractility, thereby lowering blood pressure and cardiac cardiac output during rest.

Coronary Blood Flow

Parasympathetic activity can increase coronary blood flow, thus flow, thus ensuring an adequate oxygen supply to the heart heart muscle.



Glandular Function Oversight

Lacrimal Glands

Parasympathetic stimulation increases tear production, maintaining eye lubrication and aiding in the aiding in the removal of foreign particles.

Salivary Glands

Parasympathetic stimulation promotes saliva secretion. This aids in digestion and maintains oral health.

Pancreas

Parasympathetic nerves stimulate insulin and digestive enzyme secretion. This regulates regulates blood sugar and aids digestion.

Chapter 11: The Autonomic Nervous

11.1 Introduction

11.2 Sympathetic Nervous System (SNS)

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11.4 Differences between SNS and PNS

SNS vs PNS

Aspect	SNS	PNS
Activation	Stress, danger	Rest, relaxation
Heart Rate	Increases	Decreases
Digestion	Slows down	Increases
Pupil Size	Dilates	Constricts
Energy	Expenditure	Conservation

Higher Control Centers

1

Hypothalamus

The hypothalamus acts as the main integrator of autonomic functions. It regulates the medulla oblongata and other autonomic centers.

2

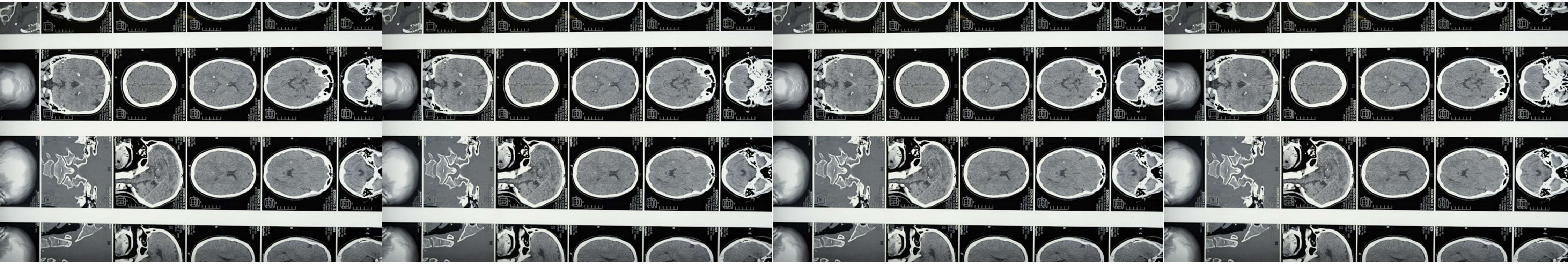
Medulla Oblongata

The medulla oblongata controls vital functions such as heart rate and breathing. It receives input from higher brain regions and peripheral sensors.

3

Limbic System

The limbic system processes emotions affecting autonomic responses. It influences the heart rate, blood pressure and digestion based on emotional states.



Cortical Influence

1

Frontal Lobe

The frontal lobe is involved in decision-making and emotional regulation. It can influence autonomic responses through cognitive processes.

2

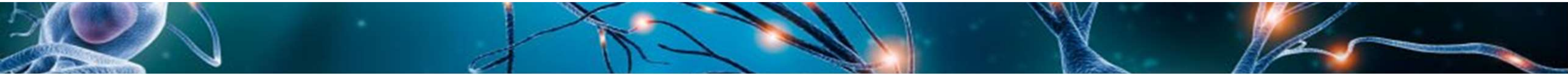
Temporal Lobe

The temporal lobe processes processes sensory input and and memory formation. It contributes to autonomic regulation through emotional emotional and memory associations.

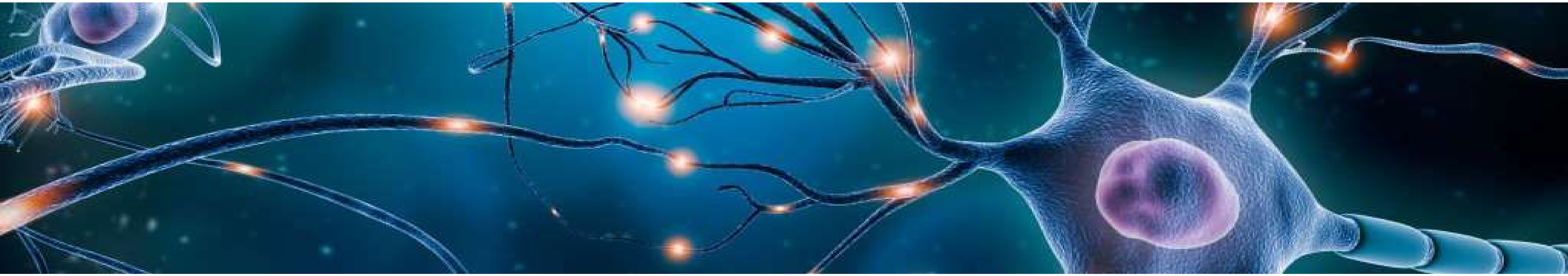
3

Cortical-Autonomic Integration

Higher cognitive functions can can modulate autonomic responses. This allows for complex, situation-specific bodily reactions.



End of Chapter 11

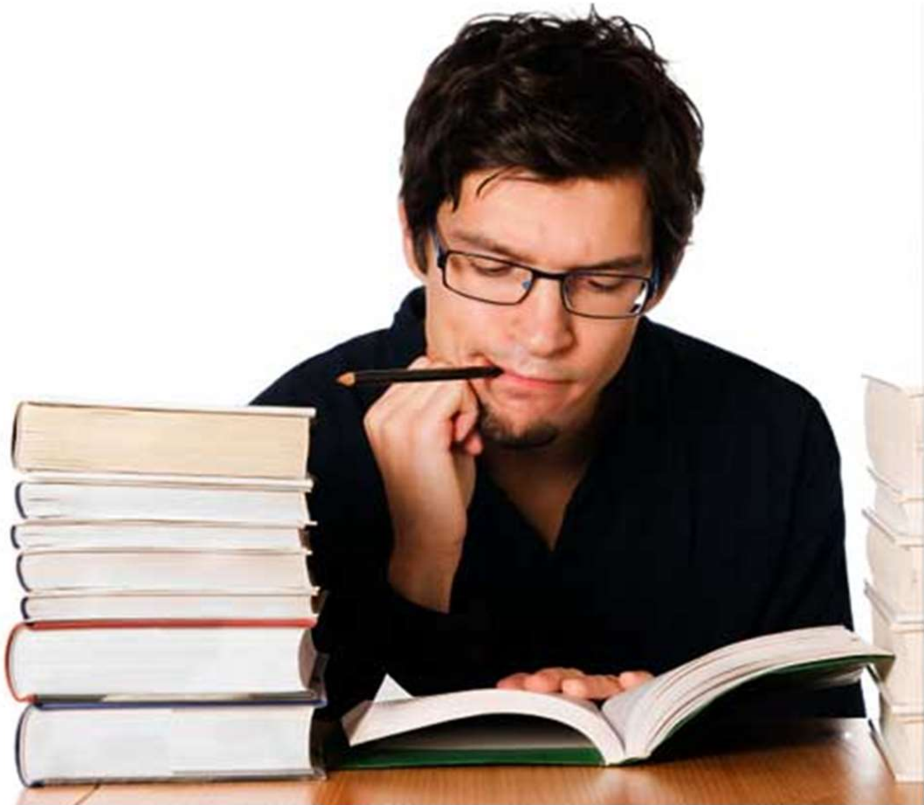


Chapter 12: Relationships between the nervous system and other control systems

The basis of the Teaching Guide for this chapter

Anatomy and messengers of the endocrine system. Anatomy and messengers of the immune system.
Relationships between the nervous, endocrine and immune systems.

Pablo Rivas
Pablo.rivas@uv.es

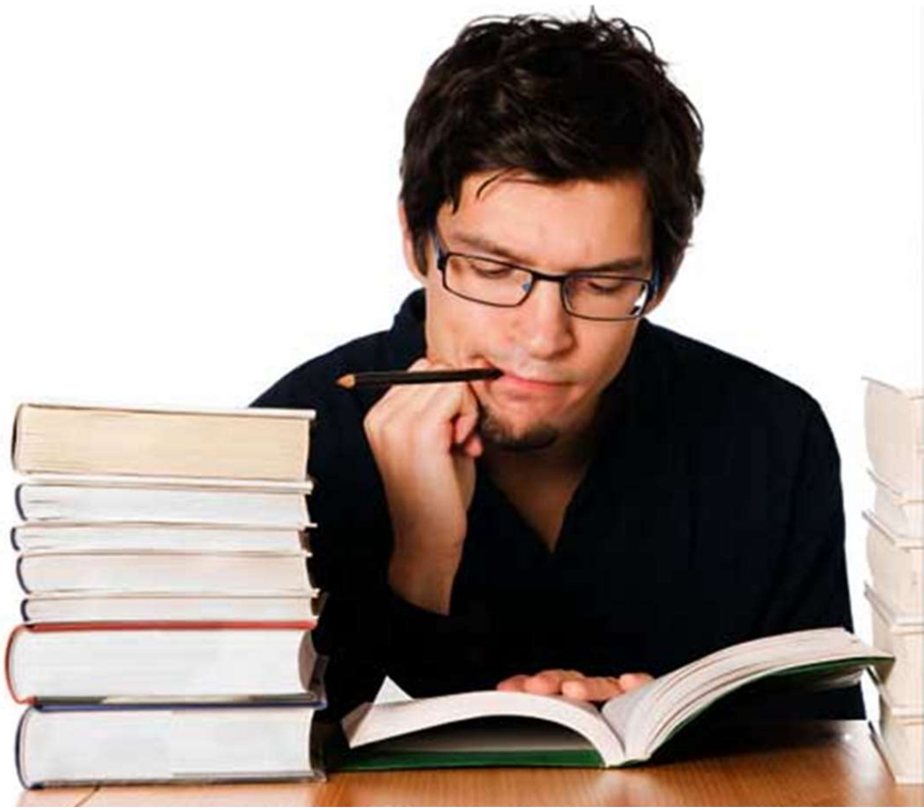


Chapter 12: Relationships between the nervous system and other control systems

12.1 Introduction

12.2 The endocrine system

12.3 The immune system



Psychoneuroendocrinoimmunology (PNEI)

The Nervous System

The nervous system facilitates rapid communication through electrical signals, enabling immediate responses.

The Endocrine System

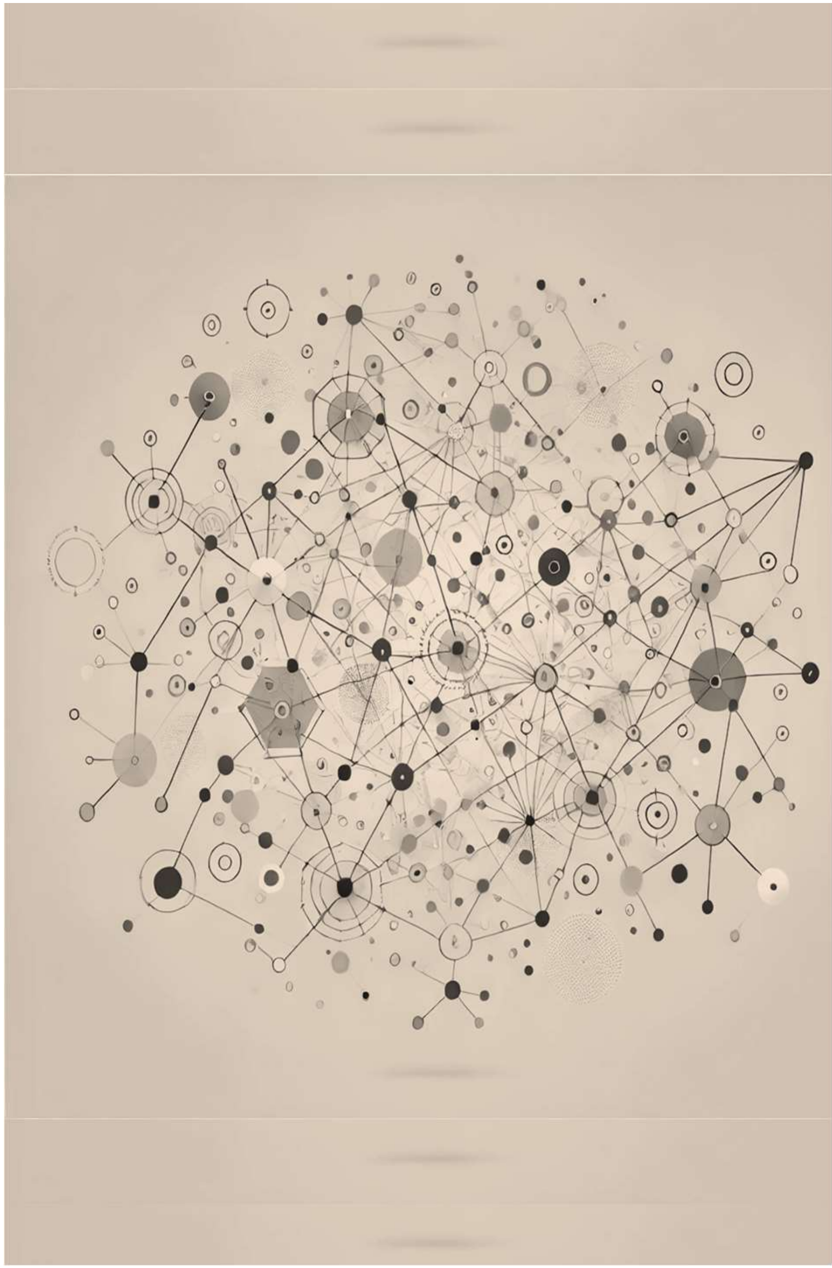
The endocrine system utilizes hormones for slower, longer-lasting communication, impacting various physiological processes.

The Immune System

The immune system protects the body from pathogens and foreign invaders by invaders by employing specialized cells and molecules for defense.

Integrated Control Systems

1. Interconnectedness
2. Shared Messengers
3. Integrated Function

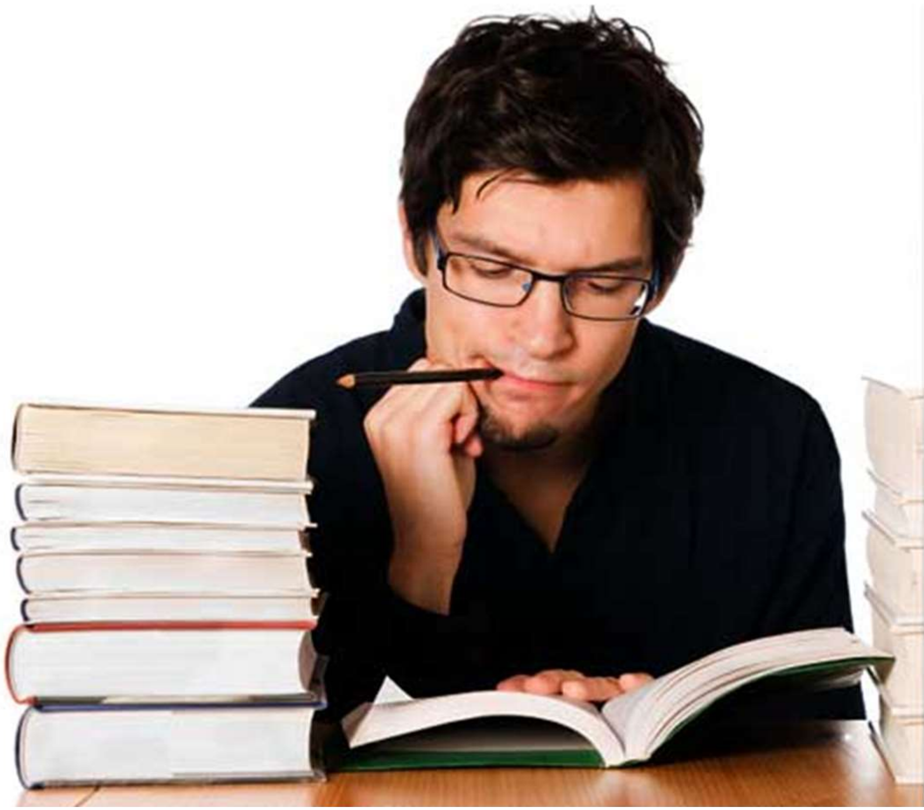


Chapter 12: Relationships between the nervous system and other control systems

12.1 Introduction

12.2 The Endocrine System

12.3 The Immune System



Endocrine System

Key Features

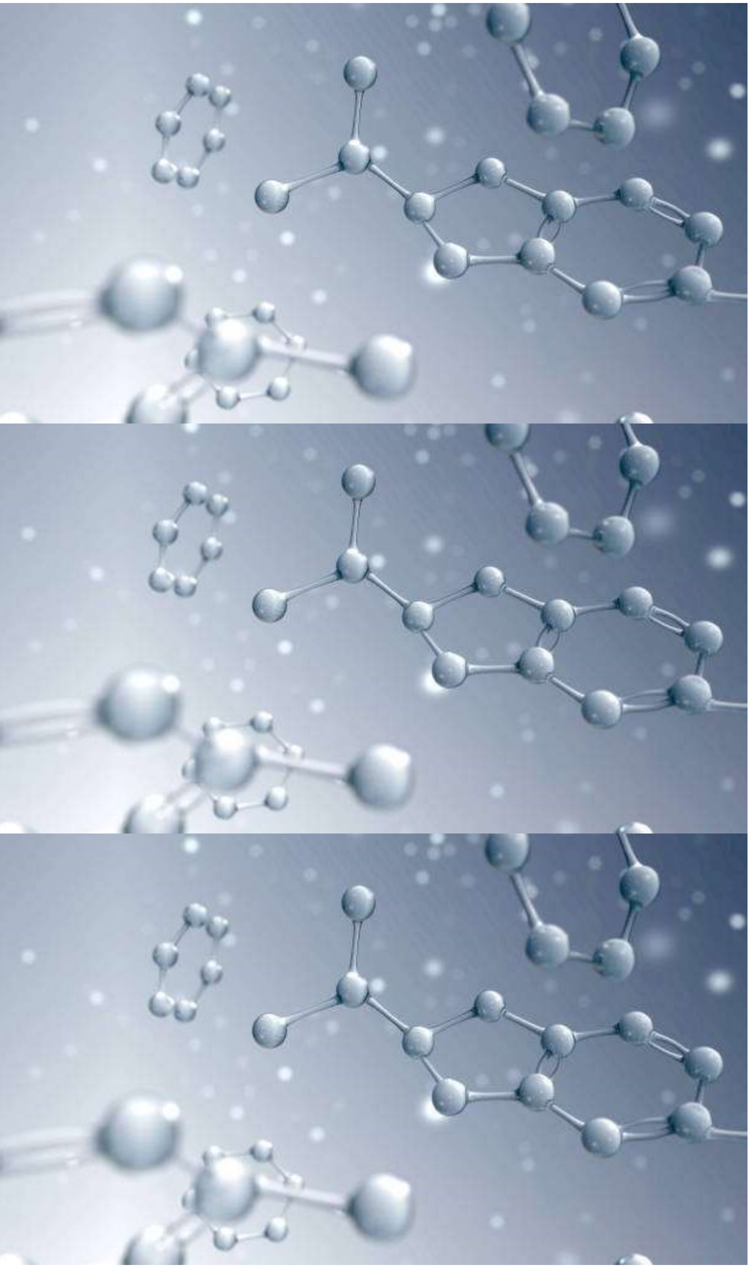
The endocrine system regulates slow, long-lasting physiological processes through the secretion of hormones.

Hormones

Hormones are chemical messengers produced by endocrine glands and transported through the bloodstream.

Target Organs

Hormones target specific organs and tissues, exerting exerting their influence on particular cellular functions. functions.



Endocrine Pathway: Signal Transmission

1

Endocrine Glands

Specialized cells secrete hormones, which are then released into the bloodstream.

2

Hormones Travel

Hormones circulate through the bloodstream, reaching their target organs.

3

Target Organs Respond

Hormones bind to receptors on target cells, triggering triggering specific responses and alterations in cellular cellular function.

Hypothalamic-Pituitary-Glandular Axis

This key regulatory system controls endocrine functions through a series of interconnected glands.

Neurohormones

Trophic hormones

1 Hypothalamus

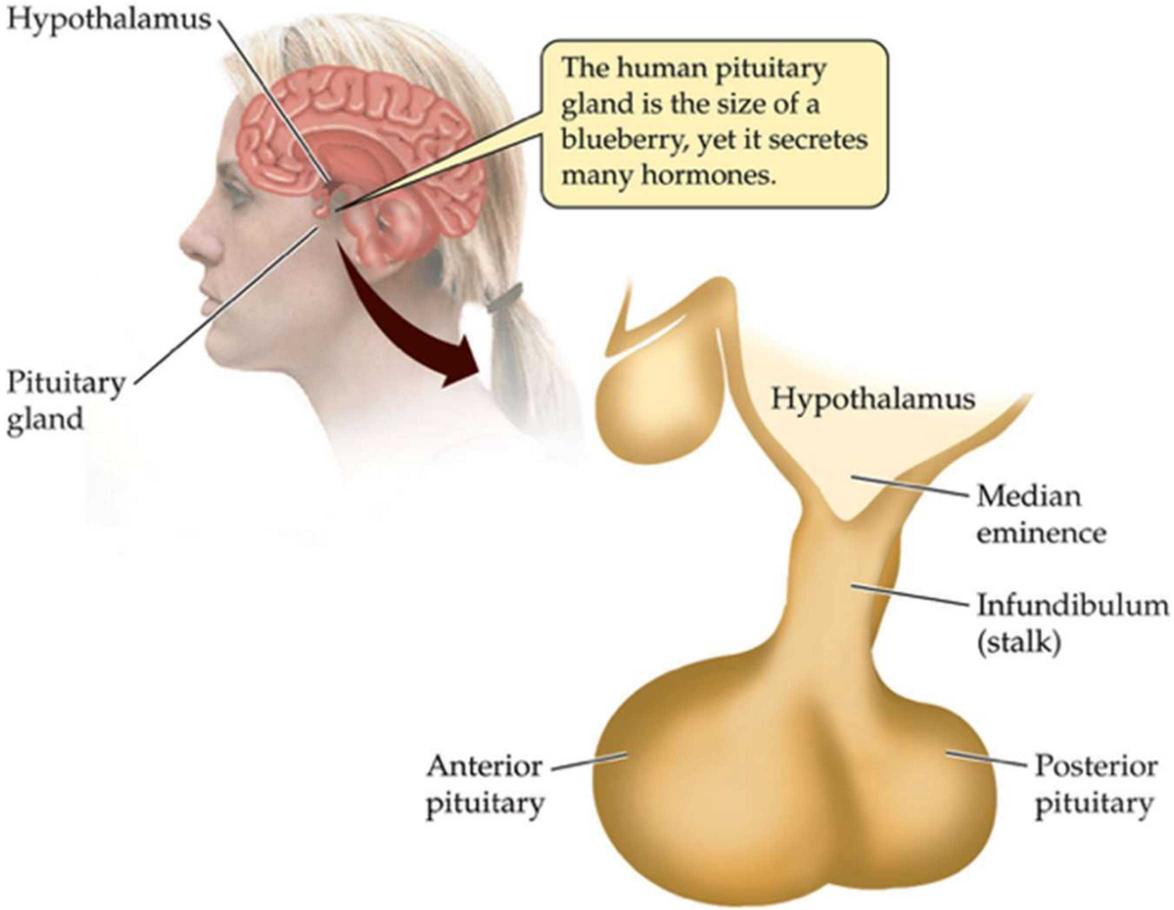
The hypothalamus functions as the control center, releasing hormones that regulate the activity of the pituitary gland.

2 Pituitary Gland

The pituitary gland, situated below the hypothalamus, secretes hormones that regulate various bodily functions.

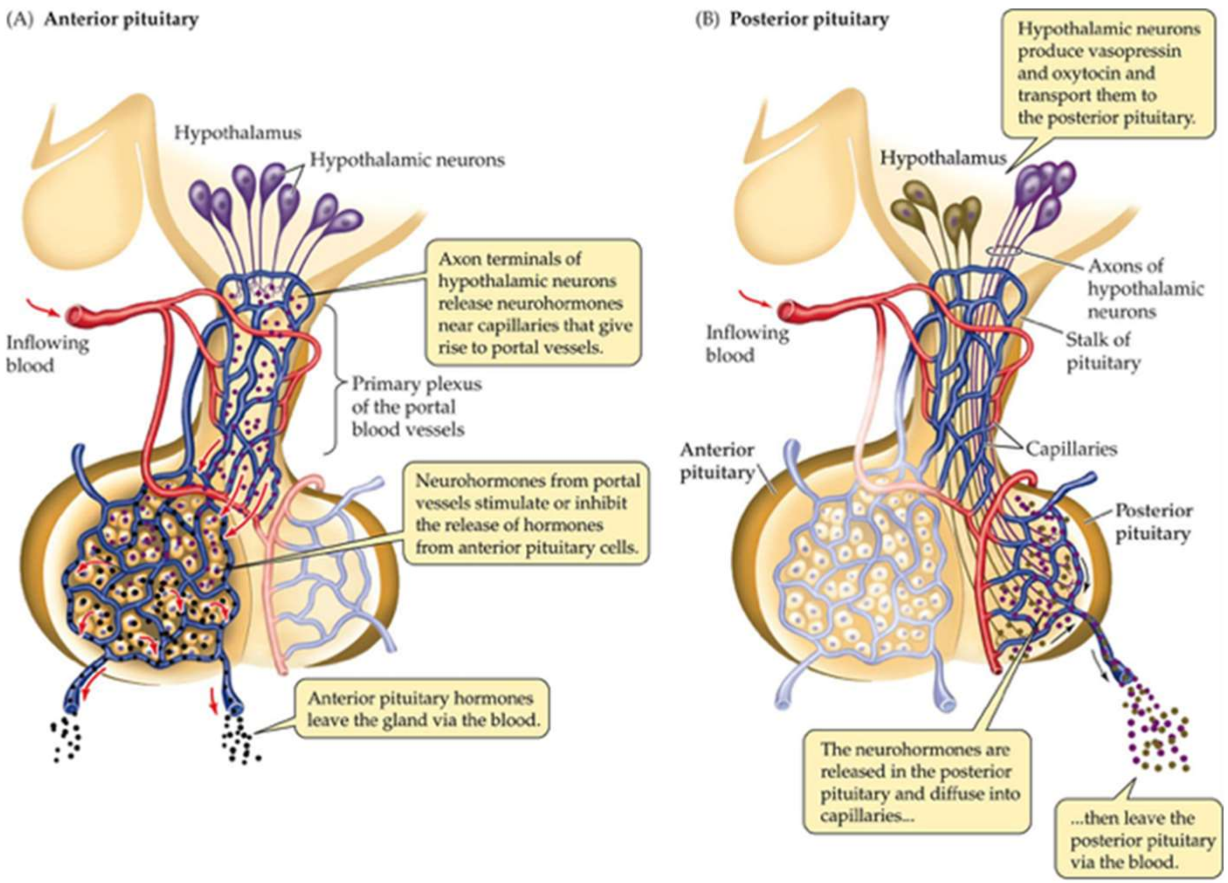
3 Glands

Hypothalamic-Pituitary-Glandular Axis



AN INTRODUCTION TO BEHAVIORAL ENDOCRINOLOGY 4e, Figure 2.28

Hypothalamic-Pituitary-Glandular Axis

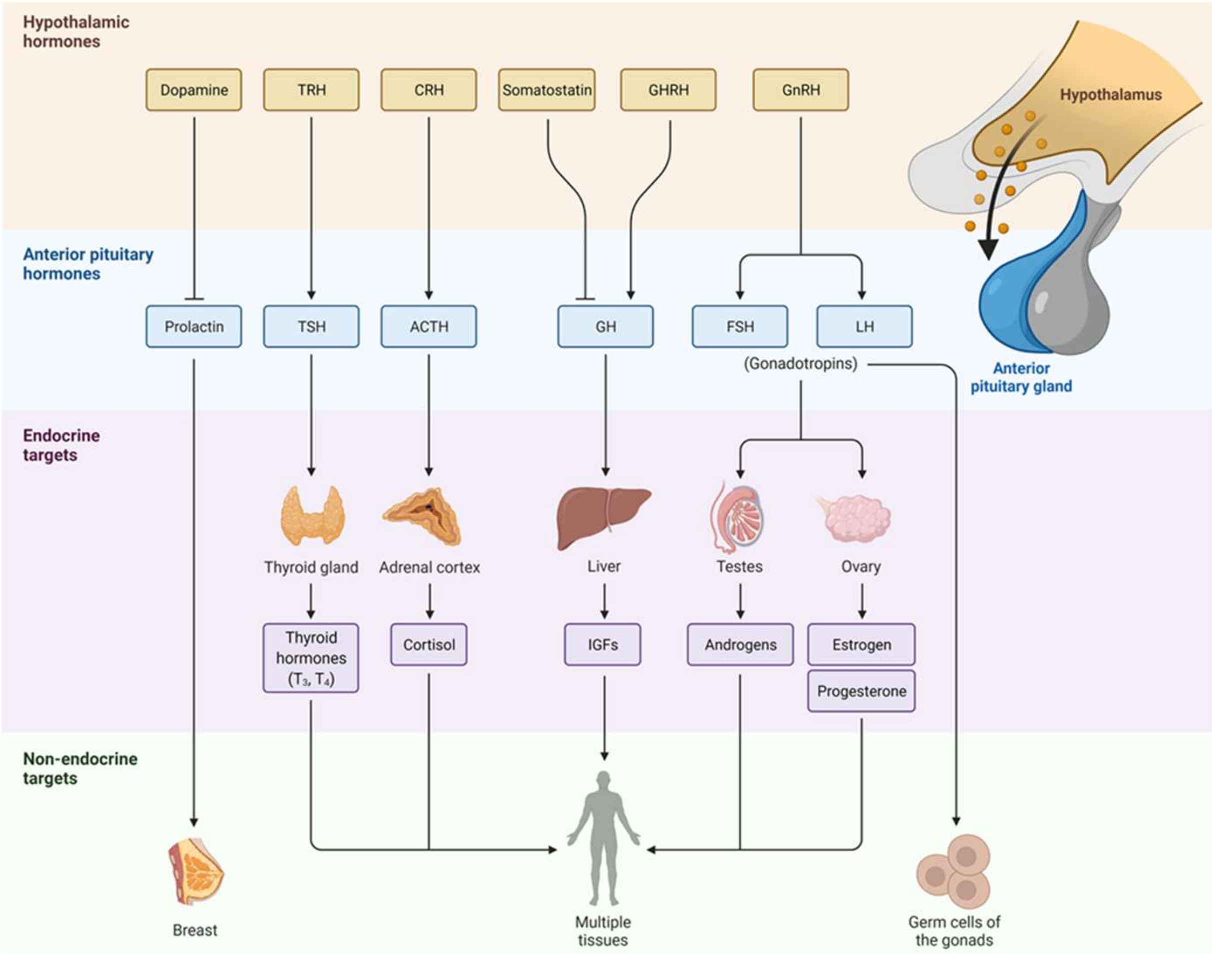


AN INTRODUCTION TO BEHAVIORAL ENDOCRINOLOGY 4e, Figure 2.29

Major Hypothalamic-Pituitary Axes

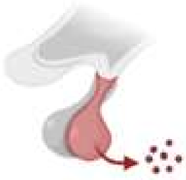
Axis	Hormones	Functions
Hypothalamic-Pituitary-Thyroid Thyroid (HPT)	Thyroid-stimulating hormone (TSH), (TSH), thyroxine (T4), and triiodothyronine (T3)	This axis regulates metabolism, growth, and development.
Hypothalamic-Pituitary-Adrenal Adrenal (HPA)	Corticotropin-releasing hormone (CRH), adrenocorticotropic hormone hormone (ACTH), and cortisol.	This axis manages stress response, energy balance, and immune function.
Hypothalamic-Pituitary-Gonadal (HPG)	Gonadotropin-releasing hormone (GnRH), follicle-stimulating hormone (FSH), luteinizing hormone (LH), estrogen, and testosterone.	This axis regulates sexual development, reproduction, and sexual characteristics.

Major Hypothalamic-Pituitary Axes



Major Hypothalamic-Pituitary Axes

Neurohypophysis



Hypothalamus hormone	Pituitary hormone	Target	Effects
ADH (production)	ADH (release)	Kidneys, Sweat glands, Circulatory system	Water balance
Oxytocin (production)	Oxytocin (release)	Female reproductive system	Uterine contractions during birth

Adenohypophysis

Hypothalamus hormone	Pituitary hormone	Target	Effects
GnRH	FSH/LH	Reproductive system	Sex hormone/ gamete production
TRH	TSH	Thyroid gland	Thyroid hormone production
PRH	PRL	Mammary glands	Milk production
GHRH	GH	Liver, Bone, Muscles	IGF production
CRH	ACTH	Adrenal glands	Glucocorticoid production

Endocrine System Signaling Mechanisms

Neural Signals

All endocrine cells receive innervation from either
the Central Nervous System or the Autonomic Nervous System.

Endocrine Chemical Signals

Hormones, tropic-releasing hormones, and negative feedback mechanisms.

Non-Endocrine Chemical Signals

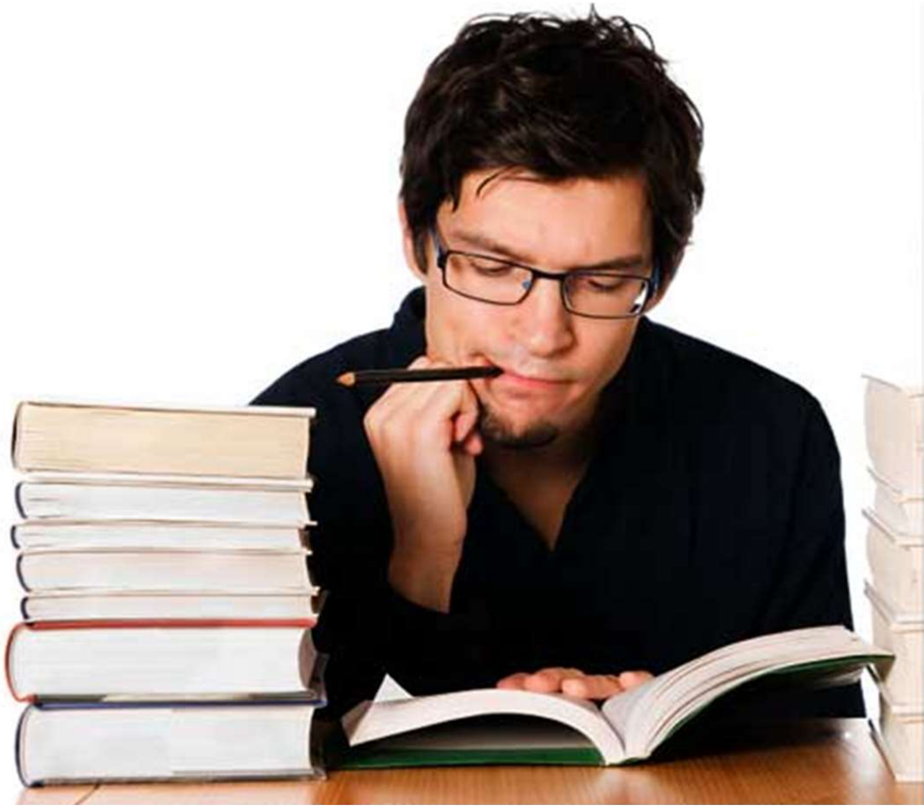
Factors such as glucose, calcium, and sodium influence endocrine function and response.

Chapter 12: Relationships between the nervous system and other control systems

12.1 Introduction

12.2 Endocrine system

12.3 Immune system



Immune system

The immune system plays a crucial role in maintaining the integrity of the organism, protecting it from potential threats and recognizing cellular degeneration to counteract internal alterations.

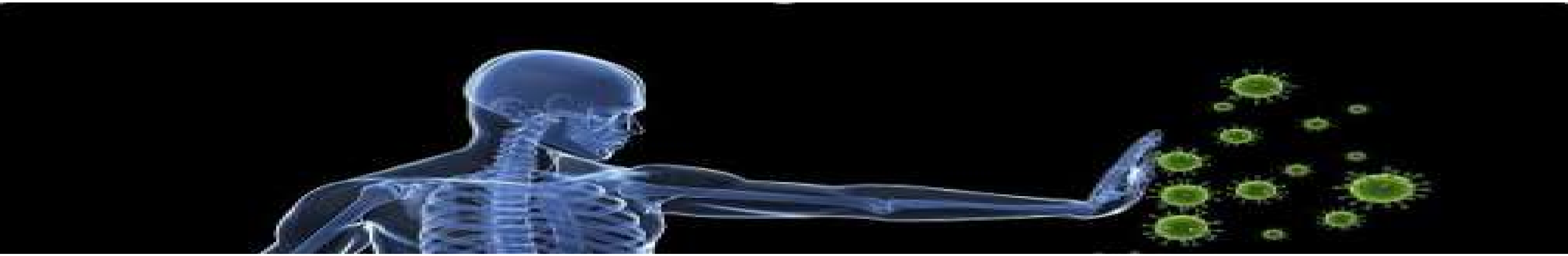
Threats Addressed by the Immune System

External Threats

Bacteria, fungi, viruses, and parasites pose external threats. These microorganisms can cause infections and diseases.

Internal Threats

Tumor cells, cellular aging, and cell death represent internal challenges.



Functions of the Immune System

1. **Detection and Defense**

   The immune system identifies and neutralizes antigens, employing various cellular and molecular mechanisms to combat threats.

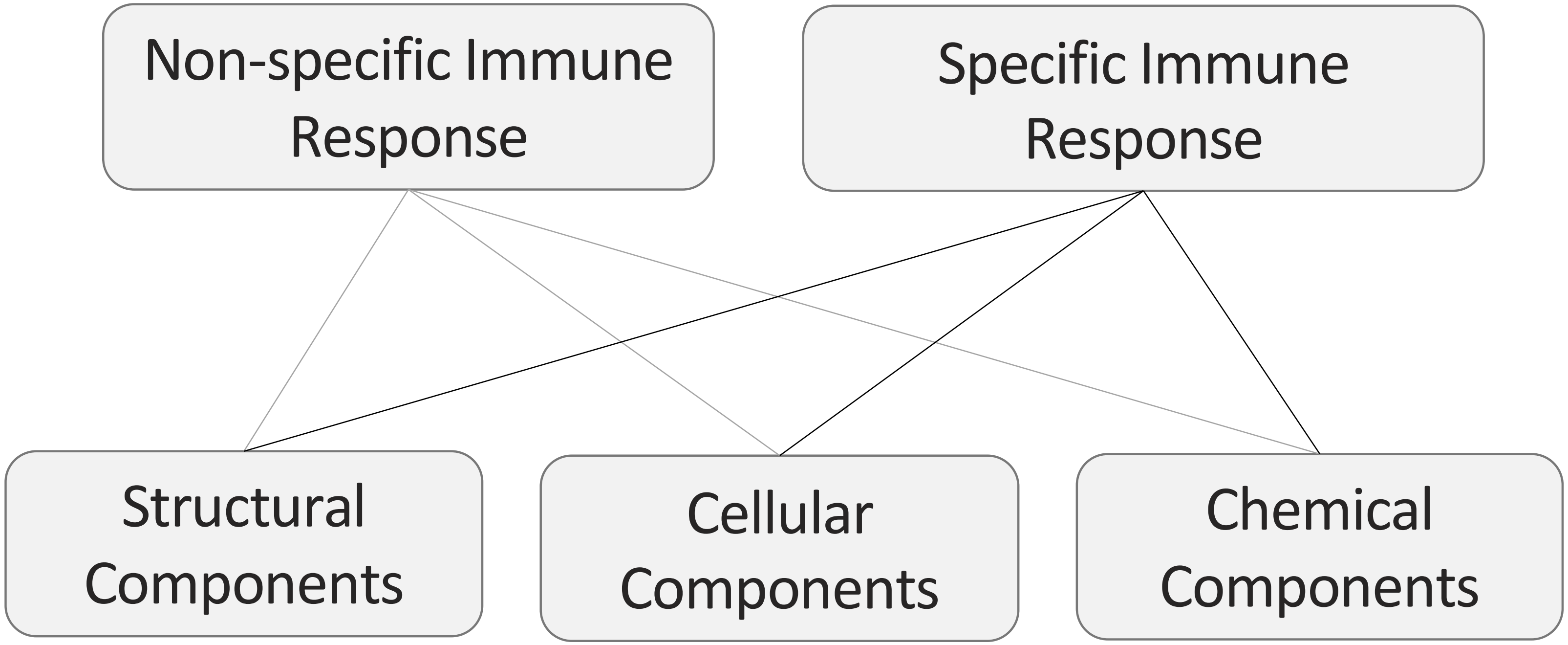
2. **Integrity Maintenance**

   By protecting against pathogens, the immune system ensures organismal survival, maintains homeostasis, and prevents systemic infections.

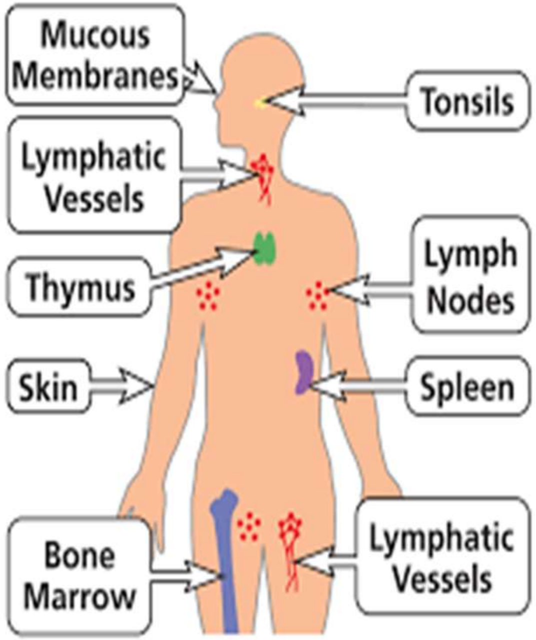
3. **Tumor Suppression**

   Recognizing cellular degeneration is crucial for preventing tumor growth, as the immune system eliminates potentially cancerous cells.

Mechanisms of Immune Response

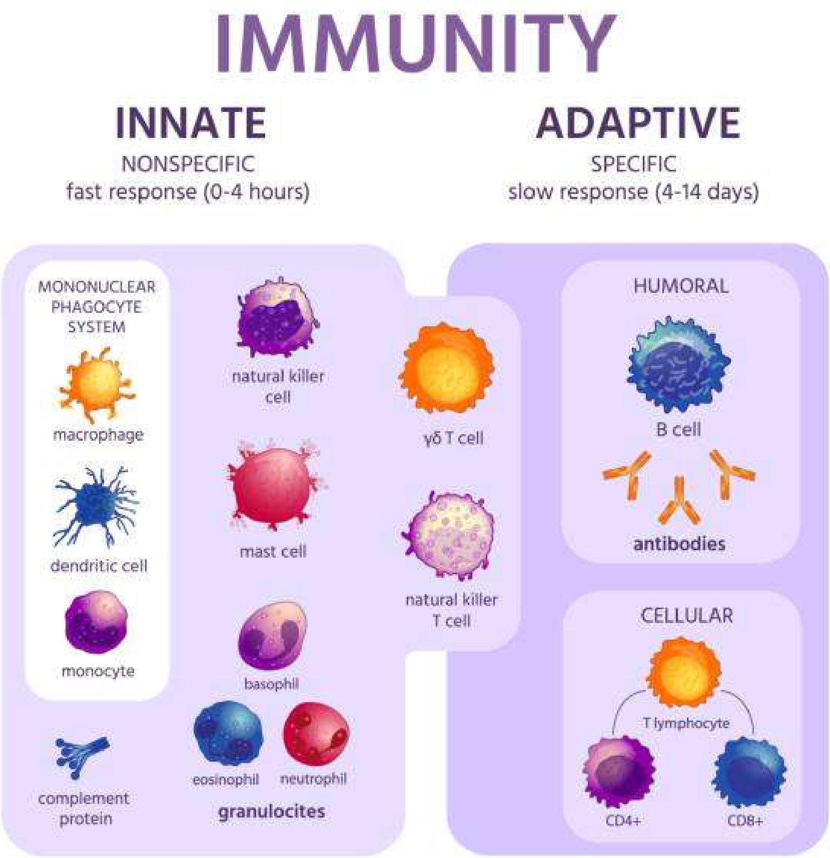


Structural Components of IS



First line	Skin	Non-specific Immune Response Response
	Mucous membranes	
Second line (inflammation)	Neutrophils	
	Macrophages	
	Dendritic cells	
Third line	Natural Killers (NK)	
	B Lymphocytes	Specific Immune Response
	T Lymphocytes	

Innate Immune Response (Non-specific)



1

Rapid Reaction

The innate response activates quickly against any potential threat.

It provides immediate, non-specific protection against pathogens.

2

No Memory

This response does **NOT** retain information about past encounters.

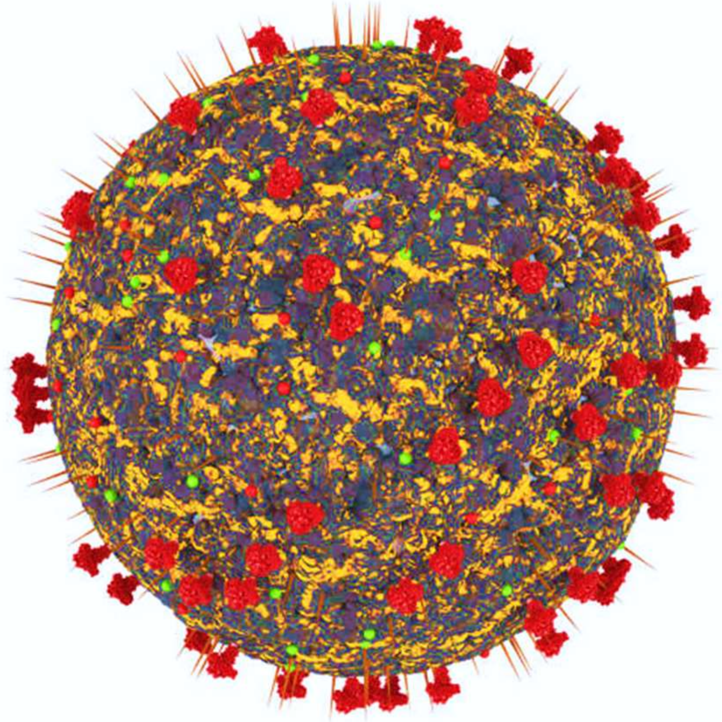
Each activation is independent of previous exposures.

3

Cytokine Coordination

Chemical messengers called cytokines regulate the innate response.

They recruit and activate immune cells to combat threats.



Adaptive Immune Response (Specific)

Less Rapid Reaction

The adaptive immune response takes longer to develop compared to the innate response.

1

Memory

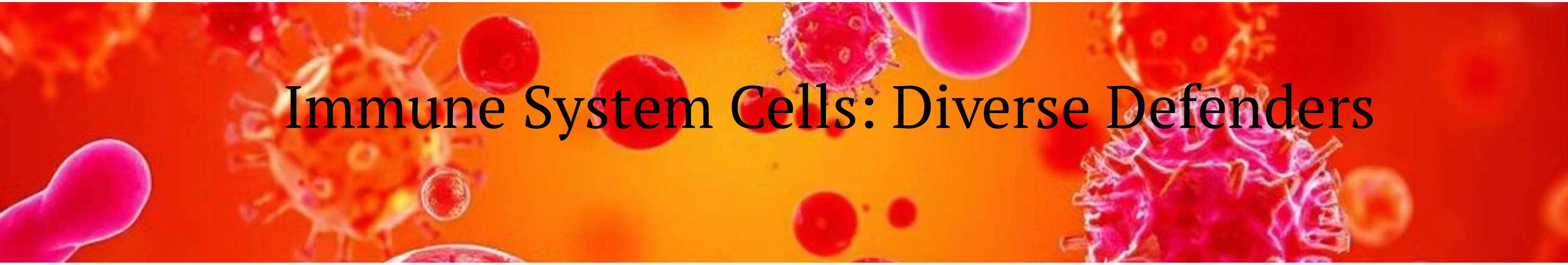
The adaptive immune system is activated only upon encountering a previously recognized antigen, which forms the basis for vaccination

2

Immune Proteins

Cytokines function like hormones, with examples including interferons, interleukins, and tumor necrosis factor.

3

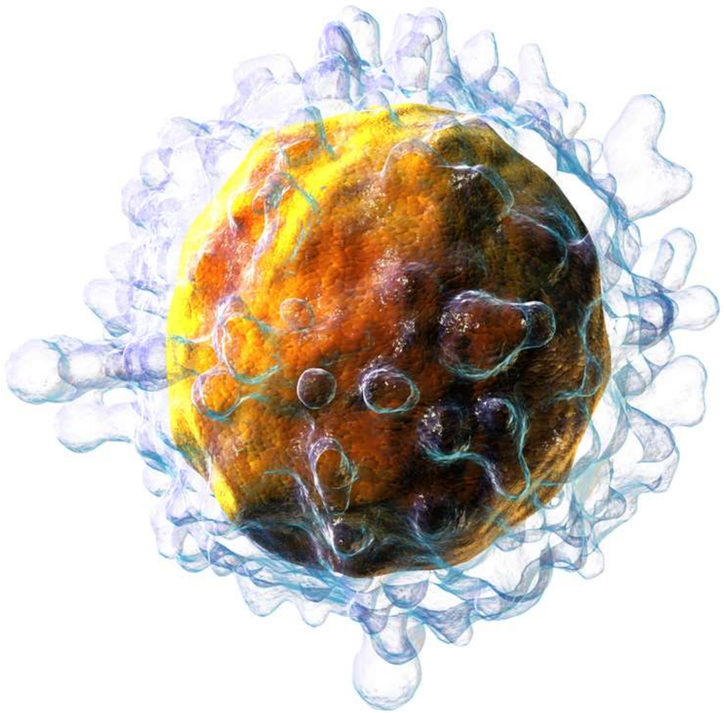


Immune System Cells: Diverse Defenders

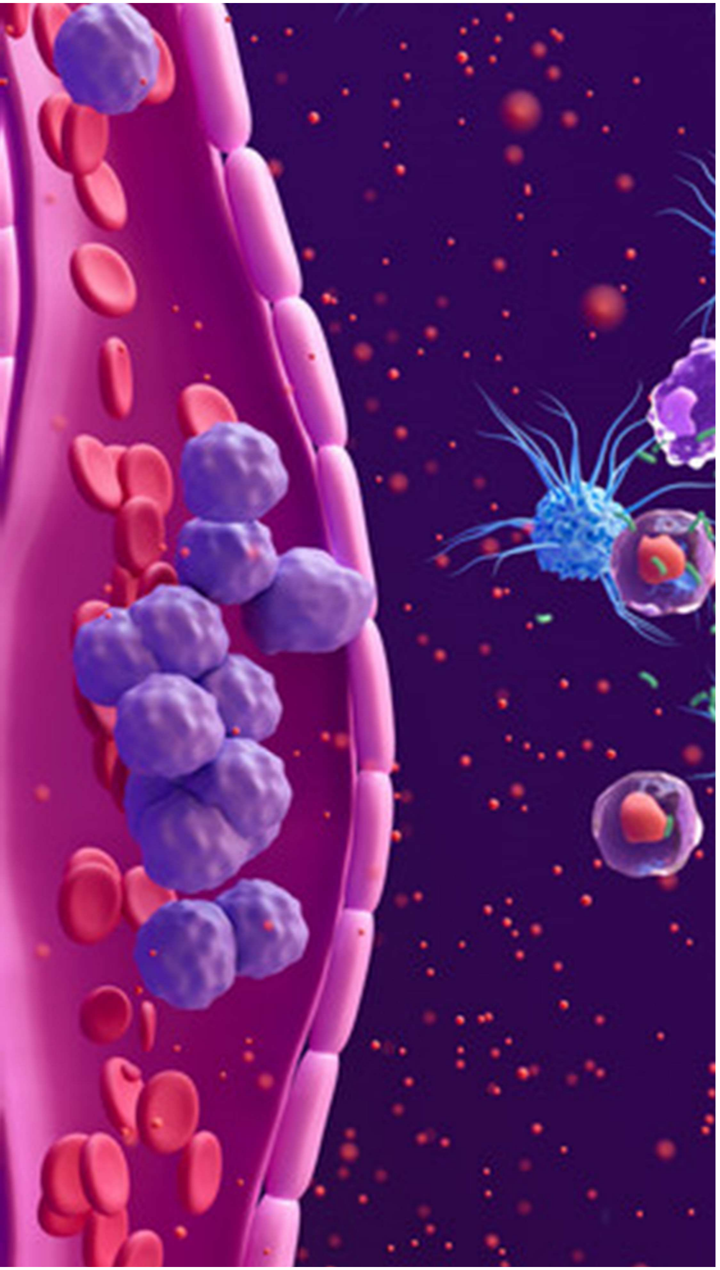
- Granulocytes
  - Basophils: Are involved in allergic reactions.
  - Eosinophils: Respond to parasitic infections.
  - Neutrophils: Are key players in inflammation.
- Monocytes/Macrophages: Perform phagocytosis and secrete cytokines.
- Lymphocytes
  - Natural Killer (NK) Cells: Destroy infected or tumor cells.
  - T Lymphocytes: Are responsible for cell-mediated immunity.
  - B Lymphocytes: Are responsible for antibody-mediated immunity.

Lymphocytes

Lymphocytes include B and T cells, which serve as mediators of the adaptive immune response. They are characterized by specificity and memory, becoming active only upon a subsequent encounter with the same antigen.



Lymphocyte
T cell



Cytokines

1 **Role**

Cytokines coordinate immune responses similarly to hormones, facilitating communication between different immune cells and systems.

2 **Types**

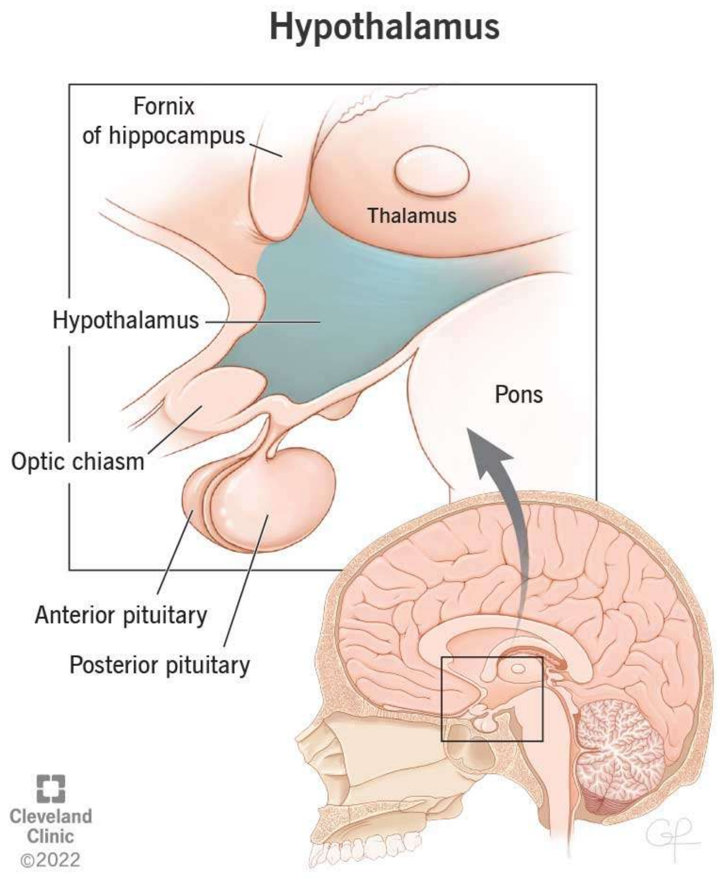
- Interleukins
- Interferons
- Tumor necrosis factors

Cytokines (II)

3 **Location**

- **Central Expression**:
Cytokines are found in the hypothalamus and anterior pituitary cells, where they play a role in hormonal regulation.

- **Neuronal Production Sites**:
Cytokines are synthesized in specific brain regions, including the hippocampus and hypothalamus, where they influence both brain and immune responses.



Cytokines (III)

4 Functions

- **Immunological, Neurochemical, and Neuroendocrine Roles**

Cytokines play a crucial role in regulating immune responses and coordinating neurochemical and neuroendocrine processes.

- **Pituitary Development**

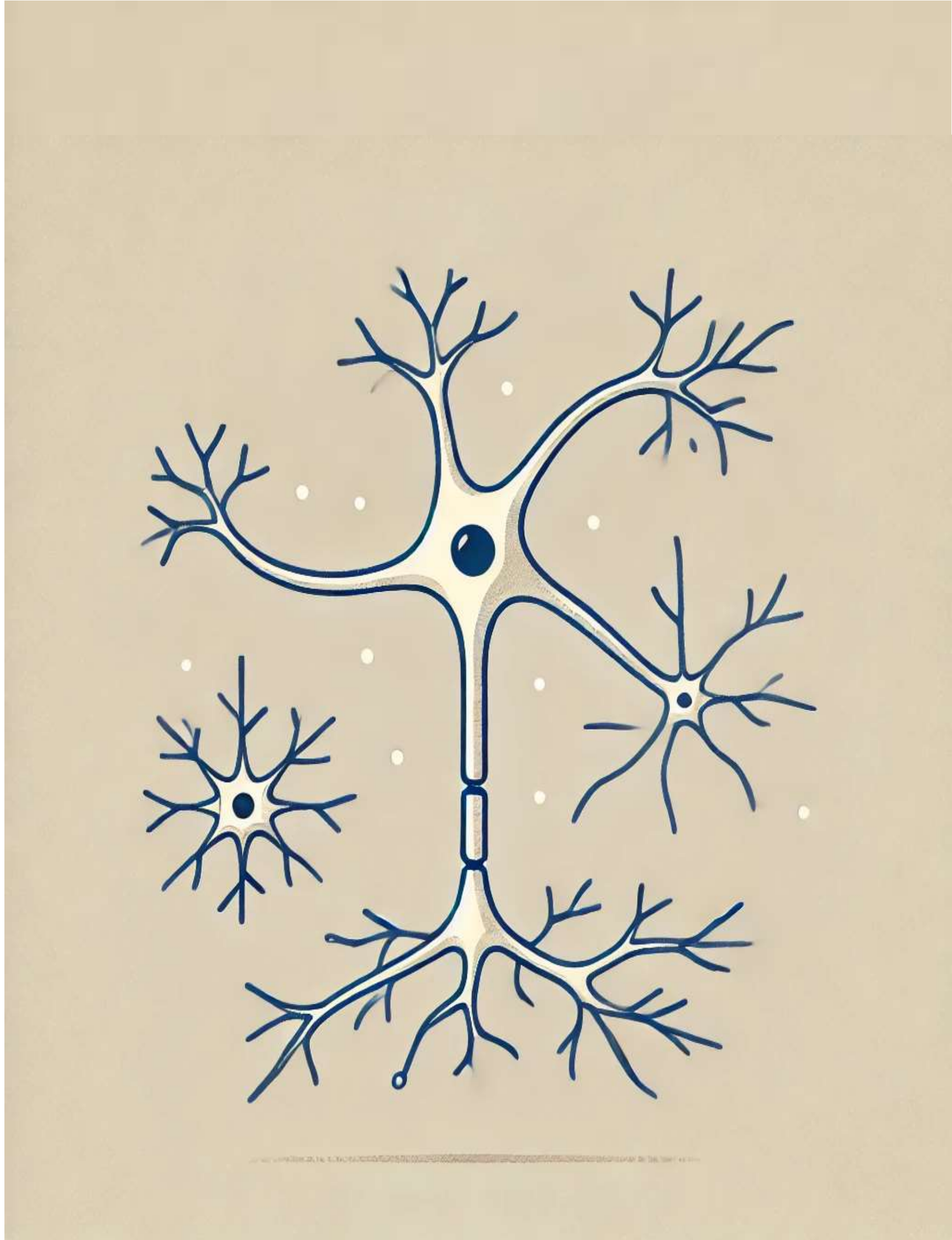
Cytokines are involved in early ontogeny, influencing the development of the pituitary gland.

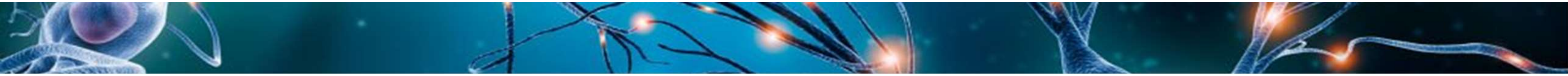
Cytokines (IV)

4 **Functions (II)**

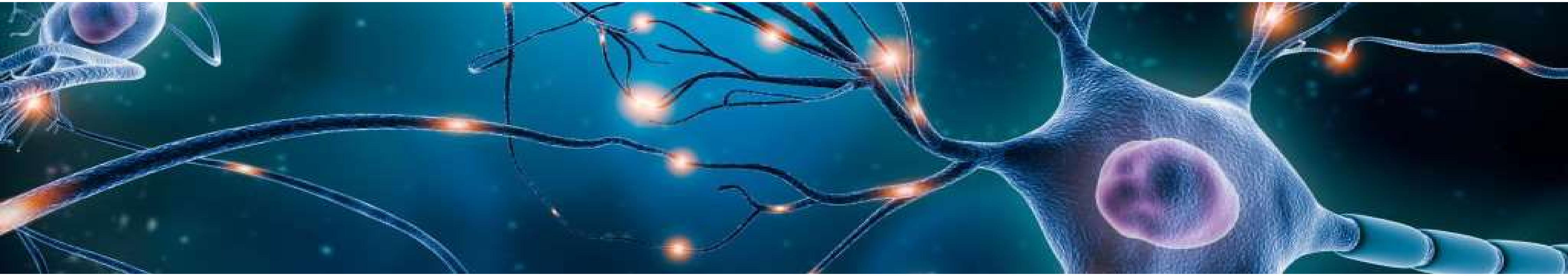
- **Inflammatory Processes**
Cytokines are produced by neurons, particularly in the hippocampus and hypothalamus. They trigger sickness behaviors and fever responses.

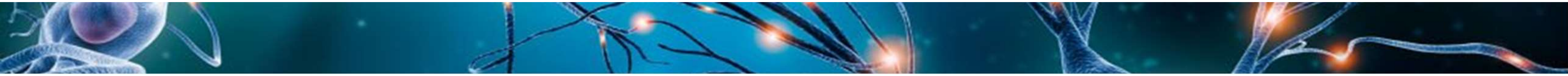
- **Neuronal Health**
Cytokines play a key role in processes related to neuronal death and survival, which is especially significant in diseases such as Alzheimer's.





End of Chapter 12





End of the Course