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CCE – BIOS 345 Chapter Overview

Chapter 1 – Homeostasis

Physiology
- Two approaches to understanding Physiology
  - Mechanistic or Control & Regulatory → Homeostasis
  - Teleological

Physiology
- Levels or Methods of Study
  - Biochemical and Molecular → Cell Physiology → Organ Physiology → System Physiology → Organism

Anatomical Organization

1) Cell
- Basic functions of all
- exchange
- metabolism → catabolism and anabolism
- sense and respond
- reproduction (some but not all, stem cells)
- Unicellular organisms
- Multicellular organisms
- Extracellular fluid – interstitial and plasma
  → Specialized Cellular Functions → Tissues

2) Tissue – 4 tissues

a) muscle
b) nervous
c) connective
d) epithelial

3) Organs

4) Organ systems

HOMEOSTASIS

Negative Feedback System
- Sensor
- Integration Center – Set point and Gain
- Effector

Negative Feedback Loop
» Example: Thermostat
In physiological feedback systems, communication is critical
Intrinsic
Extrinsic
1. nervous – very fast
2. humoral (blood) – slow, hormones.
» Physiological examples of feedback systems:
Cellular Level – Allosteric Inhibition (End product inhibition)
Genetic Level
Hormone System
System Level

Positive feedback

General Adaptation Syndrome – 3 stages

Chapter 2 – Cellular Physiology

Cell Structure and Function (Skip p. 31-32) Know table 2-3

1) Cell membrane

2) Nucleus – DNA & RNA (transcription and translation)

3) Cytoplasm – organelles and cytosol

» Organelles and their function:

1) Endoplasmic reticulum
a) rough ER – ribosomes
b) smooth ER
2) Golgi complex
3) Lysosomes – hydrolytic enzymes

4) Peroxisomes – oxidative enzymes
5) Mitochondria
- Energy Metabolism
- Glycolysis, Citric Acid Cycle and Electron Transport Chain (ATP, NADH, FADH)
- ATP and its use
6) Vaults

» Cytosol

3 general categories of activities:
Cytoskeleton
1. Microtubules – Axonal transport
2. Intermediate filaments
3. Microfilaments
4. Microtrabecular lattice

Chapter 3 – Plasma Membrane and Membrane Potential

Cell Membrane structure and transport

Plasma membrane
- trilaminar or lipid bilayer or fluid mosaic
- Composition

» Lipids

» Membrane proteins

1) Channels
2) Carrier molecules
3) Docking marker proteins
4) Membrane bound enzymes
5) Receptor sites
6) Self-recognizing proteins
7) Cell adhesion molecules
   a) desmosome
   b) tight junctions
   c) gap junctions

- Extracellular matrix
  - Collagen, Elastin and Fibronectin

» Membrane carbohydrates

Intercellular Communications (p. 66-71)

Signal Transduction

» Extracellular chemical messengers
- Paracrines, Neurotransmitters, Hormones, Neurohormones

» Target Cells (Receptors)
a) channel regulation
b) 2nd messenger
- G protein – adenylate cyclase – cAMP – effector protein
- G protein – Ca mobilization (PIP_2 & IP_3) – effector protein

Membrane Transport

2 factors effecting membrane permeability:
- solubility of the substance in lipid and size

Methods of transport:
passive forces and active forces
- assisted and unassisted (all active are also assisted)

» Unassisted Membrane Transport

1) Diffusion
- The rate of diffusion is effected by 5 factors:
- Equilibrium or steady state
- Net Diffusion
- Fick's Law of Diffusion

2) Osmosis
- Requires 2 things
- Osmotic Pressure
- Importance to living Cells (Tonicity)
- Isotonic Solution
- Hypertonic Solution → Crenation
- Hypotonic Solution → Lysis

3) Electrical
Electrochemical Gradient

» Assisted Membrane Transport

Carrier Mediated Transport
- Properties: Specificity, Saturation (Transport maximum) and Competition

Assisted Passive Membrane Transport
a) facilitated diffusion

Assisted Active Membrane Transport
1) active transport → Pumps. (Na/K pumps)
- Secondary Active Transport (CoTransport Carrier)
2) vesicular transport
- Endocytosis
- pinocytosis
- phagocytosis
- Exocytosis
3) Caveolae – Potocytosis

Membrane Potential (p. 87-93 only)

- Millivolts

- 3 Factors
Selectively Permeable Membrane
Na/K Pump
Intracellular Proteins
- resting membrane potential
- Polarized

Chapter 4 – Neuronal Physiology

Excitable Tissues

Nerve and Muscle
- Gated Channels
  - Gates exist is three states
    - Closed but can be opened, Open (activated), and Closed but cannot be opened (inactivated)
  - Why do they open?
    - Voltage Gated Channels, Chemical Gated Channels and Mechanically Gated Channels

Two levels of Excitability
1) Graded Potential
   - Terminology
     - Polarization, Hypopolarization and Hyperpolarization
2) Action Potential
   - Terminology
     - Polarization, Depolarization and Repolarization
   - Events

Nerve Tissue

Structure – Neuron

- Soma, Axon, Axon hillock, Dendrites, Synaptic Knob, Synaptic vesicles, neurotransmitters,
- Myelin – Myelinated Fibers (Schwann cells and Oligodendrocytes) – Nodes of Ranvier

Nerve Properties and Characteristics

- Threshold
  - All or nothing Principle
- Impulse Propagation
  1) Contiguous Conduction (local current flow)
  2) Saltatory Conduction
- Refractory Period
  - Absolute Refractory period
  - Relative Refractory period
- Nerve Regeneration
  - Schwann cells and Oligodendrocytes
- Synapses
  - Anatomy of a Synapse
    - presynaptic neuron, synaptic knob, synaptic vesicles, neurotransmitters, synaptic cleft and subsynaptic membrane
    - Synaptic Delay
  - Two types of synapses
    1) Excitatory Synapses → EPSP – Excitatory Post Synaptic Potential
    2) Inhibitory Synapses → IPSP – Inhibitory Post Synaptic Potential
  - Synapse Types and Neurotransmitters
  - Neurotransmitter Removal
  - Fast and Slow Synapses
  - Summation

    Grand Postsynaptic Potential – GPSP
    - Temporal Summation, Spatial Summation and cancellation
    - Neuropeptides and Neuromodulators
- Cell to cell relationships
  - Convergence and Divergence

Chapter 5 – Central Nervous System

Central Nervous System

Neuroendocrine function

Nerves → neurotransmitters
Endocrine → hormones
→ Neurohormones

Nervous System Organization

- Central Nervous system
- Peripheral Nervous system

A) Afferent
a) Sensory
b) Visceral

B) Efferent
a) Motor (Somatic) neurons
b) Autonomic Nervous system
a) Sympathetic Nervous System
b) Parasympathetic Nervous System

Three Classes of Neurons

Afferent (receptor), Interneurons and Efferent

CNS

Glial Cells

- Astrocytes, oligodendrocytes, ependymal cells and micoglial cells
- Protection

Brain (Encephalon)

- Brain requirements
- Brain Structure – Anatomy Review

1) Forebrain (prosencephalon)
   - Telencephalon and Diencephalon
2) Midbrain (mesencephalon)
3) Hindbrain (rhombencephalon)
   - Metencephalon and Myelencephalon
4) Brain Stem

- Brain – Function

1) Cerebrum
a) Cerebral Cortex
- Lobes
· Occipital
· Temporal

· Parietal
1) Somatosensory Cortex
- Sensory Homunculus
2) Posterior Parietal Cortex
3) Parietal – Temporal – Occipital Association Cortex
4) Wernicke's Area

· Frontal
1) Primary Motor Cortex
- Motor Homunculus
2) Pre (and Supplemental) Motor Cortex
3) Pre Frontal Association Cortex
4) Broca's Area
Aphasia
- Hemisphere Differences

b) Basal Nuclei (ganglia)

2) Thalamus

3) Hypothalamus → Homeostasis center

4) Limbic System
- Hippocampus → consolidation
- Amygdala

5) Cerebellum – (Vestibulo, Spino and Cerebro)

6) Brain Stem
- Reticular Formation and Reticular Activating System

Spinal Cord
Anatomy
Physiology
- Sensory Tracts
- Dorsal Column – Lemniscal System
- Anterolateral Spinothalamic System
- Motor Tracts
- Corticospinal (Pyramidal Tracts)
  - Extrapyramidal Tracts
    (reflex function later)

Chapter 6 – Peripheral Nervous System – Afferent Division

Peripheral Nervous System

Afferent

Sensory

· Somatic

proprioception and Special senses

» Receptors → receptor potential
- Modality → Adequate Stimulus
  - Law of Specific Nerve Energies
- Projection – (Phantom limb pain)
- Adaptation
- Tonic Receptors and Phasic Receptors
- Sensory Interpretation (perception)
- Location and Type
- Acuity – receptive field lateral inhibition
  - Intensity – Frequency Code and Population Code

» Pain (nociceptors, prostaglandins and substance P)
- Fast and Slow

· Visceral
- Visceral Pain - Referred Pain

(Skip p. 194-236)

Chapter 7 – Peripheral Nervous System – Efferent Division

Peripheral Nervous System

Efferent

Motor Somatic
- (Alpha) Motor neurons
- Neuromuscular Junction – terminal button
  - motor end plate
  - Function of Junction (Synapse)

Summary of Somatic sensory and motor functions

Sensory function

Motor Functions

Three levels of function

1) Cord Reflexes
   - Reflex Arc
   - Monosynaptic – Stretch Reflex
     - Reciprocal Inhibition or innervation
   - Withdrawal (Flexor) Reflex and Crossed Extensor reflex
2) Brain Stem Functions
3) Voluntary movement
   - Controlled body movements and skilled activities

Autonomic Nervous System

2 Divisions → counter regulatory

Control Centers

Sympathetic Nervous System

- Thoracolumbar

Parasympathetic Nervous System

- Craniosacral

Different effects are the result of the type of NT released and the type membrane receptor proteins

- Drug effects

Chapter 8 – Muscle

Muscle

3 types of muscle

Other means of classification

Striated

Voluntary vs involuntary

Skeletal Muscle

Anatomical Review

Connective tissue – Epimysium, Perimysium (Fascuculus), and Endomysium

Muscle Fiber

» Sarcolemma, T – tubules (Dihydropyrodine), Sarcoplasm, Mitochondria, Sarcoplasmic Reticulum and lateral sacs, (Ryanodine), Triad, Myofibrils

» Myofibrils
- Myofilaments
  - Myosin and Actin
  - Sarcomere
    - Z - line — M - line — A - band — I - band — H - zone

» Myofilaments
- Myosin
  - tail and head (contains 2 sites)
- Cross bridges
- Actin
  - G - Actin and F - Actin
  - regulatory proteins
    - Tropomyosin
    - Troponin – three parts

Muscle Contraction

Sliding Filament Theory

Excitation Contraction coupling (should be excitation coupling contraction)

- Excitation – Neuromuscular Junction
- Coupling – Actomyosin → Cross bridges
- Contraction → Power Stroke
- Relaxation
- rigor mortis

Step-wise shortening

Muscle Properties

1) Threshold
2) Refractory period
3) Twitch
   Latent Period → Contraction Time → Relaxation Time
4) All or Nothing Property
   Treppe
5) Tension regulation
   a) Twitch summation (Wave Summation) → Tetanus
   b) Motor Unit Recruitment (Synchronous-Asynchronous) – (Motor Unit)
6) Length Tension Relationship
   a) Passive Force – Parallel and Series Elastic Components
   b) Active Force
7) Force Velocity Curve
8) Leverage

Muscle "Contraction" "Actions"

Isometric, Isotonic – (concentric and eccentric), and Isokinetic

Control of Muscle Function

Muscle Proprioceptors

1) Muscle Spindles – extrafusal fibers and intrafusal fibers
2) Golgi tendon organ

Muscle Metabolism

ATP Recycling

1) Oxidative
2) Anaerobic Energy Production
    a) Creatine Phosphate – Phosphocreatine
    b) Anaerobic Glycolysis – Lactic Acid System

Fatigue – Muscle and Central

Muscle Fiber Types

Speed, Color, Biochemical properties

Fiber types

TYPE I – slow oxidative, TYPE IIa – fast oxidative, TYPE IIb – fast glycolytic = couch potato

Muscle Adaptations

Hypertrophy, Hyperplasia, Atrophy (Training)

Smooth and Cardiac Muscle

Smooth Muscle – ANS stimulation

Characteristics

Contraction

- phosphorylation
- Latch Phenomenon

Two Types

- Multiunit Smooth Muscle → Neurogenic
- Single-Unit Smooth Muscle (unitary, visceral)
- Functional Syncytium
- Myogenic
- Pacemaker activity
- Slow Wave Potential

Cardiac Muscle – next

Chapter 9 – Cardiac Physiology

Cardiovascular System

Three Parts
Central, Peripheral and Blood

Central Mechanisms

» Anatomical Review – heart
Chambers – (Atria and Ventricles)
Valves
- Atrioventricular valves – (Bicuspid and Tricuspid)
- Semilunar valves – (aortic and pulmonic)
Conduction system (contractile vs autorhythmatic tissues)
- SA node → AV node → Common AV bundle → Rt and Lt bundle branches → Purkinje fibers (Fibrous Skeleton of the heart)
Layers
- Pericardium (Epicardium), Myocardium, Endocardium

» Cardiac Muscle (Myocardium)
Intercalated Discs – Functional syncytium
Slow Ca channels

» Electrical Event
EKG – Electrocardiogram (ECG)
- Three Properties
- Automaticity or Autorhythmicity (Pacemaker), Functional Syncytium, Conduction System

EKG Pattern
- P wave → QRS complex → T wave

EKG Intervals
- PR interval, QRS interval, QT interval

» Mechanical Events
Twitch
- Tetanus

Cardiac Cycle
- Systole and Diastole

Events
- Passive filling → Atrial contraction → Ventricular contraction → Ventricular relaxation

Control of central function

Cardiac Output
» Control of Heart Rate
Autonomic control of heart rate

» Control of SV
1) Autonomic control of SV (Extrinsic control)
2) Frank-Starling Law of the Heart (Intrinsic control)
3) Increase Blood Volume
4) Afterload
5) Increase Venous Return (from Chapter 10, p. 371-375)
How is VR increased
1) Venoconstriction
2) Muscle Pump
3) Thoracic Pump
4) Cardiac Suction

Coronary Artery Disease (CAD)

- atherosclerosis
- coronary arteries
- coronary artery blood flow
- angina pectoris
- myocardial infarction

Chapter 10 – Blood Vessels and Blood Pressure

Peripheral Vasculature

Anatomical Review
Layers
Vessels

Physical Properties that define function
Ohm's Law, Poiseuille's Law, Capacitance (distensibility)

Physiological Properties

Arteries
- Arterial blood pressure
  - Systolic pressure (Dicrotic Notch), Diastolic pressure, Pulse Pressure, MAP

Arterioles
- Vasodilation, Vasoconstriction
- 3 Mechanisms that control Vasomotor Tone
    - Autonomic Nervous system, Autoregulation, Hormonal

Metarterioles

Capillaries
- function in bulk flow
    1) Hydrostatic pressure
    2) Plasma Colloid osmotic pressure
    3) Interstitial fluid hydrostatic
    4) Interstitial fluid colloid osmotic pressure

ultrafiltration
reabsorption
Lymphatic System
- Lymph and Lymph nodes (functions)

Venules

Veins

Blood Pressure
Baroreceptors → Baroreceptor reflex

Chapter 11 – Blood

Blood

2 Parts

1) Plasma
2) Formed Elements
    - Erythrocytes, Leukocytes, Platelets
    - Hematocrit

Plasma
plasma proteins
- albumins, globulins, fibrinogen (Serum)

Erythrocytes = RBC

Hemoglobin

2 parts

- globin portion and heme group

» Erythropoiesis

→ Hypoxia → Erythropoietin → Undifferentiated pluripotent stem cells

- Abnormal Cell counts
  - Polycythemia
  - Anemia
  - Nutritional anemia and Pernicious anemia (others)

» Iron homeostasis

- Apotranferrin → Transferrin
- Apoferritin → Ferritin
- Bilirubin

Platelets – Thrombocytes – megakaryocytes

Hemostasis

Three levels for Hemostasis

1) vascular spasm
2) formation of platelet plug
   - prostacyclin
3) Blood coagulation or clotting
   1) intrinsic pathway
   2) extrinsic pathway – Tissue Thromboplastin
      - Plasmin

Abnormal Clotting

- thrombus, embolus
- Hemophilia

Leukocytes – WBC

- Immunity
- Five Types of Leukocytes
  - Two Classifications
    1) Polymorphonuclear – Granulocytes
       - Neutophils, Eosinophils, Basophils
    2) Mononuclear – Agranulocytes
- Monocytes – Tissue Macrophages
- Lymphocytes – Specific immune response
- Two types
- B cells and T cells

Leukemia

Chapter 12 – Body Defenses

Defense mechanisms

External Defenses

Innate (Nonspecific) Immune responses

1) Inflammation
   - Chemotaxis – Ameboid Movement – Diapedesis – Phagocytosis
2) Interferon
3) Natural Killer Cells
4) Complement System
   Membrane Attack Complex (MAC)

Adaptive (Acquired or Specific) Immune Responses

Two types

1) Antibody mediated (humoral) immunity
   » Procedure

- Clone B cells

antigen

Interleukin 1

B Cell growth factor

Primary Response

- Plasma Cells and Memory Cells

Secondary Response

» Vaccination

» Antibodies – Gamma Globulins – Immunoglobulins

2 Regions

- antigen binding fragment and constant region

Functions

1) neutralization
2) Agglutination – precipitation
3) Activation of Complement System
4) Opsonization
5) Labeling for Killer (K) cells

2) T Cell – Cell mediated Immunity (Thymosin)

Two subpopulations

a) Cytotoxic T cells (CD8) – Perforin
b) Helper T Cells (CD4)
- Lymphokines
  - B Cell growth factor
  - Interleukin 2
  - Chemotaxins

Tolerance (Limited reading: p. 440-446)
Autoimmune diseases

Allergies → Hypersensitivity
- Allergen

Immediate hypersensitivity and Delayed Hypersensitivity

Chapter 13 – Respiratory System

Respiratory System

Respiration
Internal Respiration
External Respiration
Two mechanisms
- Ventilation and Diffusion

Anatomical Review

Air Pathway – Respiratory tract

Type 1 Alveolar Cell and endothelial cell

Type II Alveolar Cell → Pulmonary Surfactant

Upper respiratory tract
Functions
Lower respiratory tract
Gross Anatomy
- Thoracic Cavity and structures
- Lungs and related structures
- Pleural Cavities
  Pleural membrane and intrapleural fluid

Ventilation

Three pressure Areas

1) External environment
2) Intra-alveolar pressure
3) Intrapleural pressure
   Pneumothorax

Inspiration

Diaphragm and External intercostals

- pressure changes

Expiration

passive event
pressure changes

Bronchodilation and Bronchoconstriction

Spirometry

4 Volumes, 4 Capacities, Flow rates

Abnormal Lung conditions

restrictive and obstruction
Asthma, Chronic Bronchitis, Emphysema

Pulmonary Ventilation (minute)

- V_E = TV X RR
- Anatomical Dead Space

Alveolar Ventilation (volume)

- V_A = (TV - 150ml) X RR

Gas Exchange

Partial Pressures

Diffusion rates

Partial pressures that exist in the alveolus of the lung

Why are lower?

Exchange

In lung (pressure gradients)
At tissues (pressure gradients)

Gas Transport

Oxygen

Hemoglobin

- Reduced hemoglobin, Oxyhemoglobin, Carboxyhemoglobin, Carbaminohemoglobin

Oxygen Hemoglobin Dissociation Curve

Factors Effecting the Curve

Bohr Effect, 2, 3 Diphosphoglycerate, Temperature

Carbon Dioxide

Three means of transport in blood

- Dissolved, Carbamino Hemoglobin, Bicarbonate ions (Haldane effect)

Respiratory Control

Medullary Respiratory Center

- Dorsal Respiratory Group and Ventral Respiratory Group

Controlling Variables

1) Carbon dioxide
2) [H +]
3) Oxygen
4) Muscle use

Chapter 14 – Urinary System

Functions:

Gross Anatomy:

- Kidney → Ureter → Urinary Bladder → Urethra

Kidney Anatomy:

- Layers – Cortex and Medulla
- Renal Columns
- Renal Pyramids → Minor Calyces → Major Calyces → Pelvis

Nephron:

2 parts

Vascular:

Afferent Arteriole → Glomerulus → Efferent Arteriole
Peritubular Capillaries

Tubular:

Bowman's Capsule → Proximal Tubule →
Loop of Henle (descending limb and ascending limb) →
Distal Tubule → Collecting Duct (Tubule)
Juxtaglomerular Apparatus → Renin

Kidney Function is the result of three Processes

Glomerular Filtration, Tubular Reabsorption, and Tubular Secretion
The end result is Urine Excretion

Glomerular Filtration
Renal Blood Flow – RBF
- Renal Plasma Flow – RPF

Glomerular Filtration Rate – GFR
glomerular membrane (Filtration Slits)

GFR is the result of 3 pressures
1) Glomerular Capillary Blood pressure
2) Plasma Colloid Osmotic Pressure
3) Bowman's Capsule Hydrostatic pressure

Net Filtration Pressure
- regulation of pressure

Changes in Filtration Coefficient

Tubular Reabsorption

Transepithelial transport
- 5 steps
- Passive or Active

Na Reabsorption → Na/K pump
Renin – Angiotensin – Aldosterone System
- Juxtaglomerular Apparatus

Glucose and Amino Acid Reabsorption
- Carrier mediated transport
- Cotransport carriers
→ Secondary Active Transport
- saturation → transport maximum
→ Tubular maximum
Inorganic Ions
- Phosphates and Calcium

Passive Reabsorption
- Cl , Water , Urea

Tubular Secretion
- Transepithelial transport – 5 steps in reverse
Potassium secretion
Hydrogen Ion Secretion → regulation of pH
Organic materials and foreign materials

Renal Clearance

Production of hypertonic and hypotonic urine

Countercurrent Multiplier

- Function due to differences in descending and ascending limbs
- results is vertical concentration gradient

Countercurrent Exchanger

- the arrangement of the peritubular capillaries
- Functions to sustain the vertical concentration gradient produced by the multiplier

Concentration and volume regulation by Vasopressin (ADH)

Hypothalamus → Posterior Pituitary Gland → Vasopressin (Antidiuretic Hormone) → increases water permeability in the Distal Tubule and Collecting Duct

Urine – is the filtrate as it leaves the Collecting Duct

Ureter → Bladder (Internal Urethral Sphincter and External Urethral Sphincter)

Micturition or Urination

- Micturition reflex or Voluntary urination

Chapter 15 – Body Fluids and Acid-Base Balance

Body Fluids

2 compartments

- Intracellular and Extracellular (Plasma and Interstitial)

Acid - Base Balance

Normal pH – acidosis – alkalosis

pH Maintenance

a) Buffers
   - Bicarbonate, Proteins, Hemoglobin, and Phosphates
b) Respiratory system
c) Urinary system

Chapter 16 – Digestive System

Basic function

Gross Anatomy
- Gastrointestinal Tract
- Accessory digestive organs

General Anatomical structure of the tract

Digestive tube in 4 layers

1) Mucosa
2) Submucosa
   - Submucosal plexus
3) Muscularis Externa
   - circular and longitudinal
   - Myenteric Plexus
4) Serosa

Digestive system function

Four basic Processes
- Motility, Secretion, Digestion (Carbohydrates, Fats, Proteins), and Absorption

Control of Processes

1) Autonomous Smooth muscle Function – (slow wave potential and Functional Syncytium)
2) Intrinsic Nerve Plexuses – submucosal and myenteric plexuses
3) Extrinsic Nerves – Sympathetic and Parasympathetic
4) Gastrointestinal Hormones

The four function together and receive feedback from receptors
chemoreceptors, mechanoreceptors, osmoreceptors

Passage through tract with reference to all 4 functions

Mouth – Oral Cavity

1) Motility – M
   a) mastication
   b) swallowing
2) Secretion – S
   Salivary Glands → saliva
   - Mucous, Salivary amylase, Lysozyme

   Stimulus
   salivary reflex (Conditioned)
3) Digestion – D
   salivary amylase
4) Absorption – A

Pharynx and Esophagus

1) Motility – M
    - Swallowing – three phases
        - oral → pharyngeal → esophageal
2) Secretion – S
    - Mucous
3) Digestion – D
4) Absorption – A

Stomach

1) Motility – M
    - 4 types
        - Gastric Filling
        - Gastric Storage
        - Gastric Mixing → Chyme
        - Gastric Emptying
            - Regulations – stomach contents, intrinsic and extrinsic, and gastrin
                - duodenum contents
                - by → intrinsic and extrinsic control and hormones – Secretin, CCK (cholecystokinin), Gastric Inhibitory peptide → Glucose – Dependent Insulinotrophic Peptide
2) Secretion – S
    - Types
        - Gastric Pits
            - Mucous neck cells → gastric mucosal barrier
            - Chief Cells – pepsinogen
            - Parietal Cells – HCl and intrinsic factor
        - Endocrine Cells
            - Gastrin, Somatostatic, Histamine
    - Regulation
        - Cephalic Phase
        - Gastric Phase
        - Intestinal Phase
3) Digestion – D
    - Proteins and Carbohydrates
4) Absorption – A

Small Intestines

1) Motility – M
   Segmentation and migrating motility complex
   regulation

2) Secretion – S
   Types
   - Intestinal mucosa
   - Pancreas – 2 secretions
     1) alkaline solution ($NaHCO_3$)
     2) Enzymatic secretion
        - Pancreatic Amylase
        - Pancreatic Lipase
        - Trypsinogen, Chymotrypsinogen and carboxypeptidase
        - enterokinase (luminal enzyme)

     Regulation
   - Liver Secretion
     - Liver function
     - Bile production from (4 components)
     - Storage in the Gall Bladder
     - Function
       - Emulsification
       - Micelles

3) Digestion – D
   - Carbohydrates (Disaccharidase), Proteins (Aminopeptidases), Lipids

4) Absorption – A
   - Villi
     central lacteal
     Crypts of Lieberkuhns
   - Microvilli – brush border
   - Process is Transepithelial Transport
     - Na and Water
     - Carbohydrate
     - Protein
     - Lipids → Chylomicrons → Exocytosis → central lacteal
     - Vitamins
     - Minerals (others)

Large Intestines

1) Motility – M
   - Haustrations, Mass Movements, Defecation Reflex
2) Secretion – S
   - Alkaline mucous
3) Digestion – D
4) Absorption – A

Chapter 17 – Energy Balance and Thermoregulation

Metabolism

Anabolic and Catabolic

Laws of thermodynamics
Nutrients -- ATP -- Work
Work → External work and Internal work Both result in heat
Heat
- calorie
- Calorie or Kilocalorie or Kcal

Measuring Metabolic Rate
- Direct Calorimetry
- Indirect Calorimetry
  - RQ – respiratory quotient

Basal Metabolic rate

Thermoregulation

Central core and outer shell

Control – Hypothalamus
- Anterior nucleus
- Posterior nucleus

Heat exchange mechanisms
- Radiation, Conduction, Convection, Evaporation

Affecting Heat Loss
- Blood Flow, Sweating and Behavior

Affecting Heat Production
- muscle tone → shivering, Hormonal changes and Behavior

Fever
- endogenous pyrogens → prostaglandins (local messengers) → effect Hypothalamus to increase the set point

Energy Balance

Positive, Negative, Neutral

Control – hypothalamus → hunger center and satiety center
- Leptin (Neuropeptide Y, Melanocortins → Orexins)

How - ? (Theories) – Lipostat, Glucostat,
GI distention, CCK theory, Ischymetric,
Psychosocial

- Obesity and Anorexia

Chapters 18 and 19 – Endocrine System

Endocrine system

Hormones
Neuroendocrine system
Nerves → neurotransmitters
Endocrine → hormones
Neuroendocrine function → feedback mechanisms of body

Hormones – three structural types
- peptides, amines, Steroids

Hormone transport – to allow solubility in blood
- Peptides and catecholamines
- Thyroid and Steroids

Effect on Target Tissues
- Specificity
- membrane protein receptors
Two effect
1) Membrane permeability – gated channels
2) Secondary Messenger System
Adenylate Cyclase → Cyclic AMP
- Lipid soluble (thyroid and steroids) – effect DNA directly

Hormone Regulation
- Secretion Rate
negative feedback
Circadian Rhythm – 24 hr cycle
- Removal Rate
- Bound or unbound
- Receptors (numbers)
- up regulation, down regulation, permissiveness, synergism, antagonism

Endocrine Glands
1) Pineal Gland
Melatonin

2) Pituitary gland
Directly related to the Hypothalamus by nerves
→ Posterior Pituitary or Neurohypophysis and
by blood vessels Hypothalamic – Hypophyseal
Portal system – from hypothalamus to the
Anterior Pituitary or Adenohypophysis

» Posterior Pituitary
- 2 secretions

1) Vasopressin
2 effects
2) Oxytocin
2 effects

» Anterior Pituitary
- 6 hormones
- Tropic Hormones
1) Thyroid Stimulating Hormone – TSH
2) Adrenocorticotropic Hormone – ACTH → Cortisol
Gonadotropic Hormones
3) Follicle-Stimulating Hormone – FSH
4) Luteinizing Hormone – LH
- Other 2
Prolactin
Growth Hormone
Somatomedins
→ Metabolic function
- Dwarfism, Giantism, Acromegaly

3) Thyroid Gland
Follicular cells → Tyrosine + Iodine → Tetraiodothyronine
thyroxine or (T4) and Triiodothyronine (T3)
C - cells → Calcitonin

4) Parathyroid Glands
Parathyroid Hormone

5) Adrenal Glands
Two layers – Cortex – outside and Medulla – inside
· Cortex
Mineralocorticoids
- Aldosterone
Glucocorticoids
- Cortisol
Sex Hormones
- Androgens (male) and Estrogens (female)
· Medulla
- Catecholamines – 80% Epinephrine and 20% Norepinephrine

6) Pancreas

Nutrient storage and utilization

Eat → store → fast → gradual utilization of store

- Maintenance of blood glucose to support brain function

Islets of Langerhans

Beta cells – Insulin

Alpha cells – Glucagon

Insulin

Major stimulus for secretion → elevated blood glucose (hyperglycemia)

Effects – storage

- major → increase glucose transport across cell membrane into the cell
- Three target tissues
  1) Muscle
     - increase glucose and AA transport
     - increase Glycogenesis
     - increase protein synthesis
  2) Adipose
     - increase glucose and FFA transport
     - increase TG synthesis
     - decrease lypolysis
  3) Liver
     - all the above
     - decrease Gluconeogenesis

Glucagon

Major Stimulus for secretion → low levels of blood glucose (hypoglycemia)

Effects – utilization (counter regulatory)

- opposite of insulin
  - inhibit Glycogenesis
  - increase Glycogenolysis
  - inhibit TG synthesis
  - increase Lypolysis
  - inhibit protein synthesis
  - increase protein degradation and Gluconeogenesis

7) Gonads

Testes (under control of FSH and ICSH from pituitary → hypothalamus)

- Testosterone
    - sexual maturation → physical and spermatogenesis
    - Secondary Sexual characteristics –
        - anabolic effects – protein synthesis → muscle
        - male pattern body hair
        - body shape (shoulders)
        - voice

Ovaries (under control of FSH and LH from pituitary → hypothalamus)

- Estrogen and Progesterone
    - sexual maturation → physical and oogenesis
    - Secondary Sexual characteristics –
        - fat deposition
        - body shape (hips)
        - breast development
        - normal cycling of hormones to produce the menstrual cycle
            - complex timing of FSH, LH and progesterone secretion (Hypothalamus → pituitary)