14 PART D

The Digestive System and Body Metabolism

PowerPoint® Lecture Slide Presentation by Jerry L. Cook, Sam Houston University

ESSENTIALS OF HUMAN ANATOMY & PHYSIOLOGY

EIGHTH EDITION

ELAINE N. MARIEB

Metabolic Pathways Involved in Cellular Respiration

- Glycolysis – energizes a glucose molecule so that it can be split into two pyruvic acid molecules and yield ATP

Metabolic Pathways Involved in Cellular Respiration

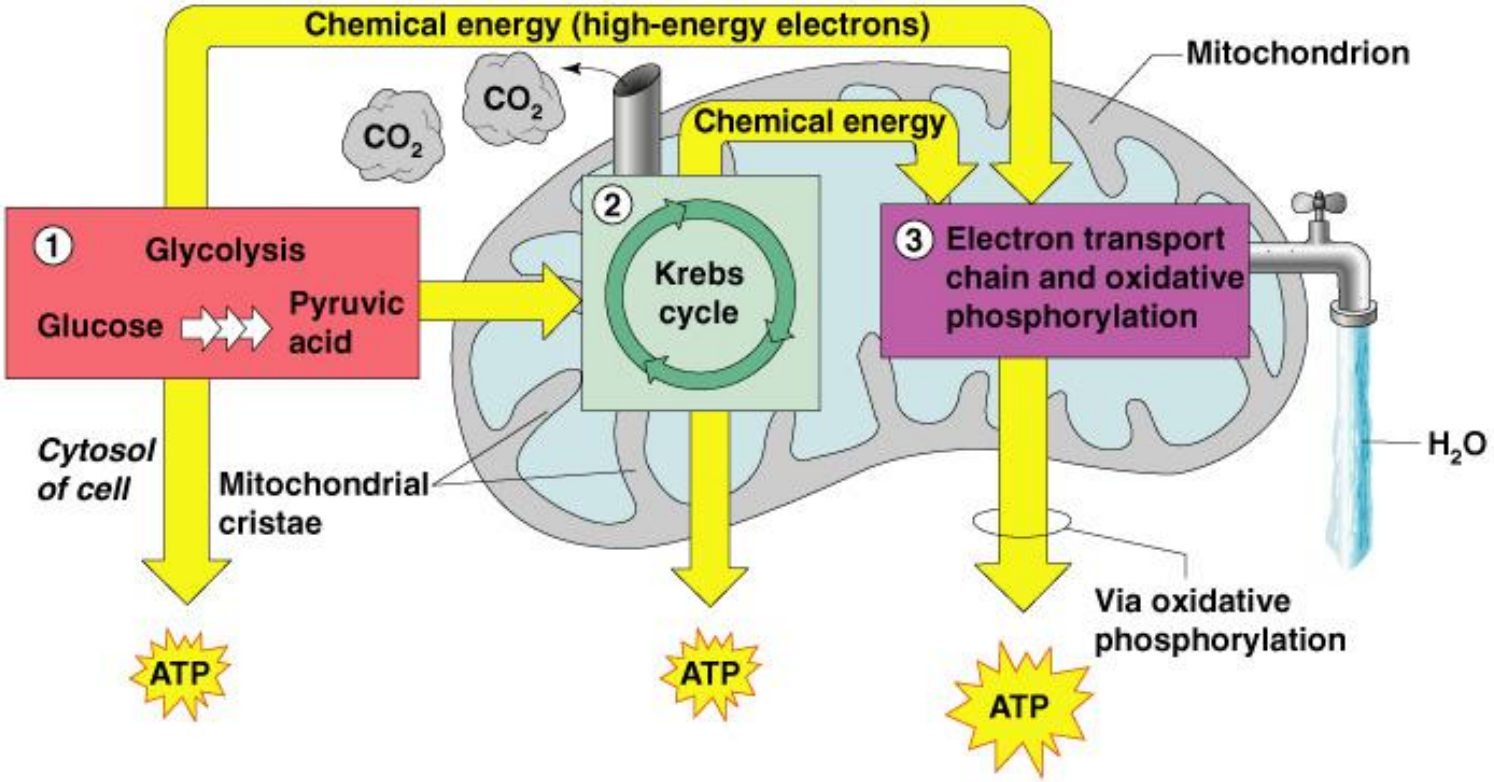

Figure 14.18

Metabolic Pathways Involved in Cellular Respiration

- Krebs cycle
  - Produces virtually all the carbon dioxide and water resulting from cell respiration
  - Yields a small amount of ATP

Metabolic Pathways Involved in Cellular Respiration

- Electron transport chain
  - Hydrogen atoms removed during glycolysis and the Krebs cycle are delivered to protein carriers

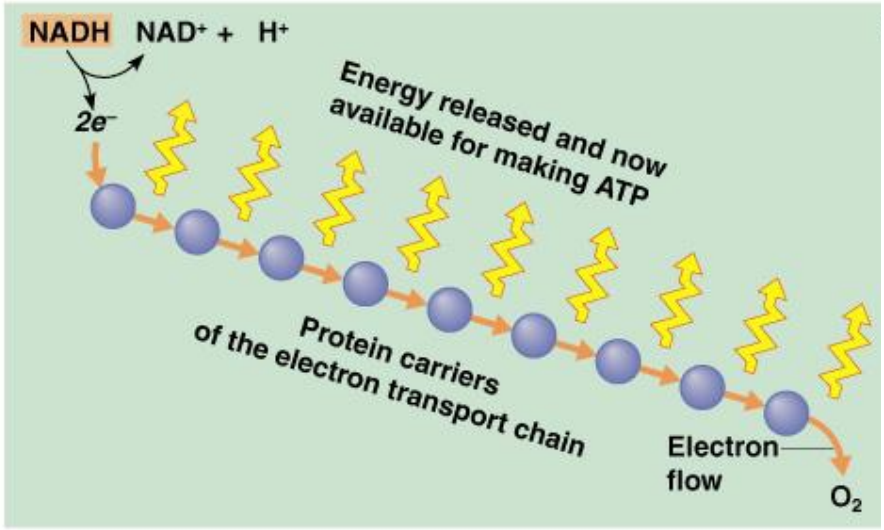

Figure 14.19a

Metabolic Pathways Involved in Cellular Respiration

- Electron transport chain (continued)
  - Hydrogen is split into hydrogen ions and electrons in the mitochondria

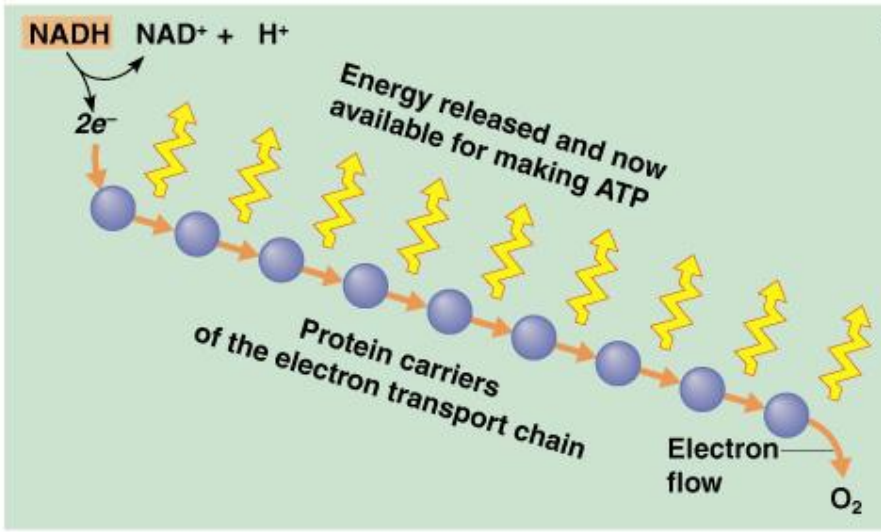

Figure 14.19a

Metabolic Pathways Involved in Cellular Respiration

- Electron transport chain (continued)
  - Electrons give off energy in a series of steps to enable the production of ATP

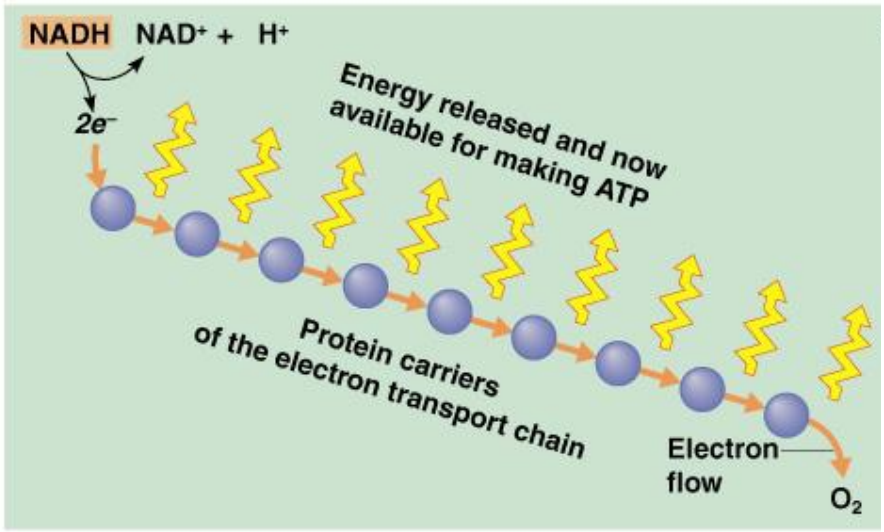

Figure 14.19a

Fat Metabolism

- Handled mostly by the liver
  - Use some fats to make ATP
  - Synthesize lipoproteins, thromboplastin, and cholesterol
  - Release breakdown products to the blood
- Body cells remove fat and cholesterol to build membranes and steroid hormones

Use of Fats for ATP Synthesis

- Fats must first be broken down to acetic acid
- Within mitochondria, acetic acid is completely oxidized to produce water, carbon dioxide, and ATP

Protein Metabolism

- Proteins are conserved by body cells because they are used for most cellular structures
- Ingested proteins are broken down to amino acids

Protein Metabolism

- Cells remove amino acids to build proteins
  - Synthesized proteins are actively transported across cell membranes
- Amino acids are used to make ATP only when proteins are overabundant or there is a shortage of other sources

Production of ATP from Protein

- Amine groups are removed from proteins as ammonia
- The rest of the protein molecule enters the Krebs cycle in mitochondria
- The liver converts harmful ammonia to urea which can be eliminated in urine

Role of the Liver in Metabolism

- Several roles in digestion
- Detoxifies drugs and alcohol
- Degrades hormones
- Produce cholesterol, blood proteins (albumin and clotting proteins)
- Plays a central role in metabolism

Metabolic Functions of the Liver

- Glycogenesis
  - Glucose molecules are converted to glycogen
  - Glycogen molecules are stored in the liver
- Glycogenolysis
  - Glucose is released from the liver after conversion from glycogen
- Gluconeogenesis
  - Glucose is produced from fats and proteins

Metabolic Functions of the Liver

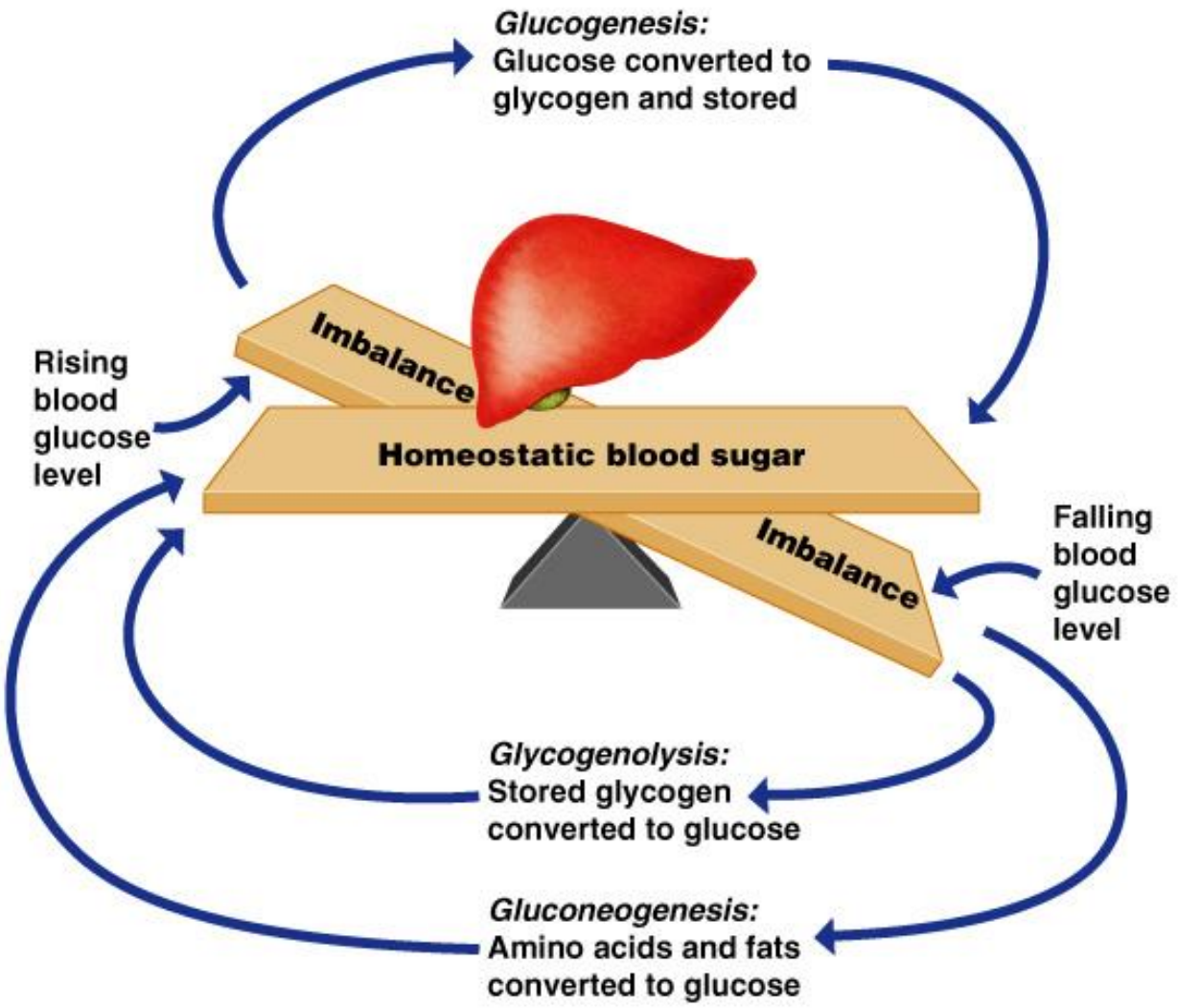

Figure 14.21

Metabolic Functions of the Liver

- Fats and fatty acids are picked up by the liver
  - Some are oxidized to provide energy for liver cells
  - The rest are broken down into simpler compounds and released into the blood

Cholesterol Metabolism

- Functions of cholesterol
  - Serves as a structural basis of steroid hormones and vitamin D
  - Is a major building block of plasma membranes
- Most cholesterol is produced in the liver and is not from diet

Cholesterol Transport

- Cholesterol and fatty acids cannot freely circulate in the bloodstream
- They are transported by lipoproteins (lipid-protein complexes)
  - Low-density lipoproteins (LDLs) transport to body cells
  - High-density lilpoproteins (HDLs) transport from body cells to the liver

Body Energy Balance

- Energy intake = total energy output (heat + work + energy storage)
  - Energy intake is liberated during food oxidation
  - Energy output
    - Heat is usually about 60%
    - Storage energy is in the form of fat or glycogen

Regulation of Food Intake

- Body weight is usually relatively stable
  - Energy intake and output remain about equal
- Mechanisms that may regulate food intake
  - Levels of nutrients in the blood
  - Hormones
  - Body temperature
  - Psychological factors

Metabolic Rate and Body Heat Production

- Basic metabolic rate (BMR) – amount of heat produced by the body per unit of time at rest
- Factors that influence BMR
  - Surface area – small body usually has higher BMR
  - Gender – males tend to have higher BMR

Metabolic Rate and Body Heat Production

- Factors that influence BMR (continued)
  - Age – children and adolescents have a higher BMR
  - The amount of thyroxine produced is the most important control factor
    - More thyroxine means higher metabolic rate

Total Metabolic Rate (TMR)

- Total amount of kilocalories the body must consume to fuel ongoing activities
- TMR increases with an increase in body activity
- TMR must equal calories consumed to maintain homeostasis and maintain a constant weight

Body Temperature Regulation

- Most energy is released as foods are oxidized
- Most energy escapes as heat

Body Temperature Regulation

- The body has a narrow range of homeostatic temperature
  - Must remain between 35.6° to 37.8°C (96° to 100° F)
  - The body's thermostat is in the hypothalamus
    - Initiates heat-loss or heat-promoting mechanisms

Heat Promoting Mechanisms

- Vasoconstriction of blood vessels
  - Blood is rerouted to deeper, more vital body organs
- Shivering – contraction of muscles produces heat

Heat Loss Mechanisms

- Heat loss from the skin via radiation and evaporation
  - Skin blood vessels and capillaries are flushed with warm blood
  - Evaporation of perspiration cools the skin

Body Temperature Regulation

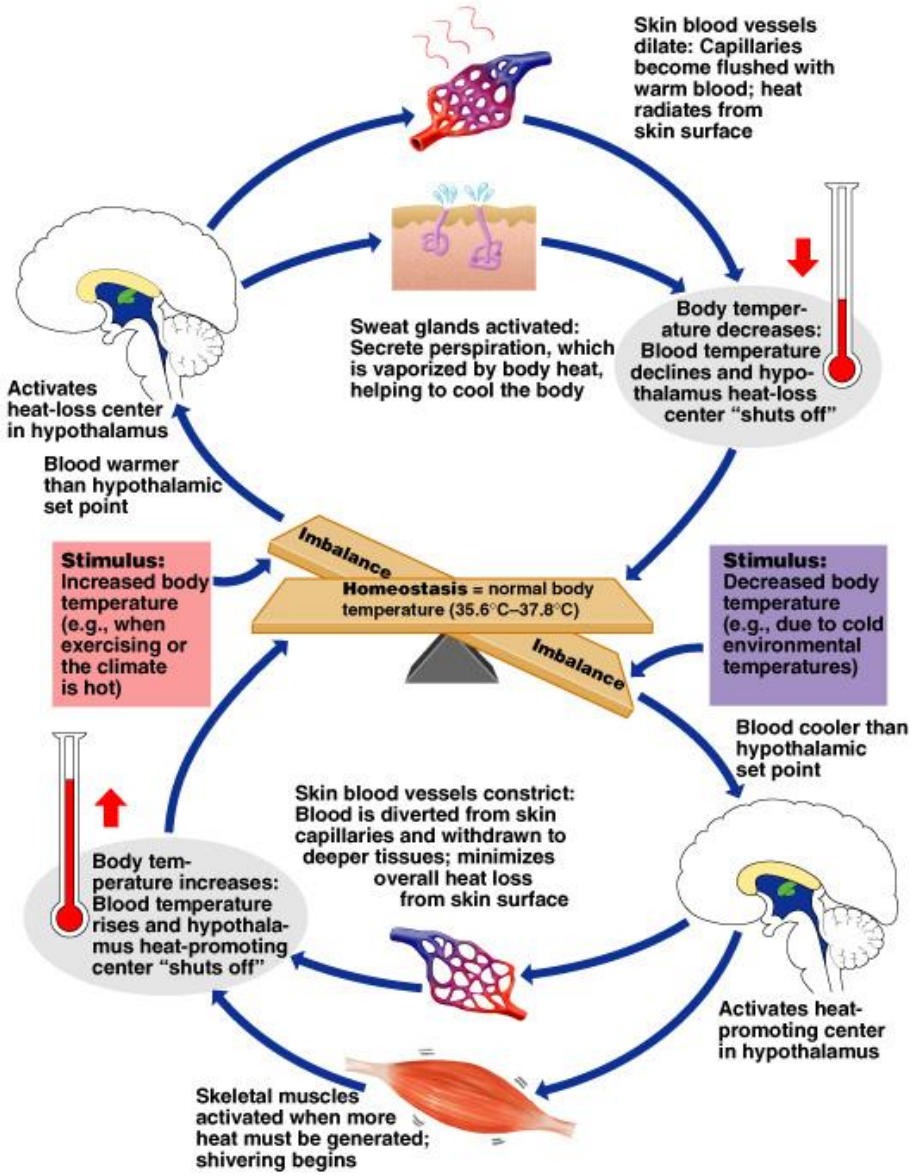

Figure 14.22

Developmental Aspects of the Digestive System

- The alimentary canal is a continuous tube by the fifth week of development
- Digestive glands bud from the mucosa of the alimentary tube
- The developing fetus receives all nutrients through the placenta
- In newborns, feeding must be frequent, peristalsis is inefficient, and vomiting is common

Developmental Aspects of the Digestive System

- Teething begins around age six months
- Metabolism decreases with old age
- Middle age digestive problems
  - Ulcers
  - Gall bladder problems

Developmental Aspects of the Digestive System

- Activity of digestive tract in old age
  - Fewer digestive juices
  - Peristalsis slows
  - Diverticulosis and cancer are more common