Slide 1

So far.....

1. Biology is the study of life
   - All life is based on the cell
   - The Earth, organisms, cells are all aqueous
2. Water's uniqueness stems from its internal polarity
   - Solvent, Co/Adhesion, Temperature regulation, Insulation
   - Spontaneous dissociation allows for pH changes and buffering
3. The chemistry of life is tetravalent carbon-based
   - Four covalent bonds allows simple to very complex molecules
   - Several key reactive groups found in biological carbon mols.

Slide 2

Structure and Function of Large Biological Molecules

- All living things are primarily made up of four classes of **Macromolecules**
  - _____
  - _____
  - _____
  - _____
- Molecular structure and function are inseparable

Slide 3

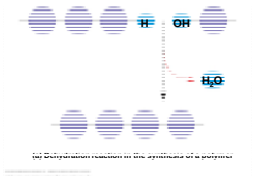
Most Macromolecules are polymers, built from monomers

- A **polymer** is a long molecule consisting of many similar building blocks
- These small building-block molecules are called **monomers**
- Three of the four classes of life's organic molecules are polymers:
  - Carbohydrates
  - Proteins
  - Nucleic acids

Slide 4

The Synthesis and Breakdown of Polymers

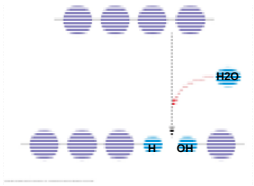
- A **condensation reaction** or more specifically a **dehydration reaction** occurs when two monomers bond together through the loss of a water molecule



Slide 5

The Synthesis and Breakdown of Polymers

- Polymers are disassembled to monomers by **hydrolysis**, a reaction that is essentially the reverse of the dehydration reaction



Slide 6

The Diversity of Polymers

- Each cell has thousands of different kinds of macromolecules
- Macromolecules vary among cells of an organism, vary more within a species, and vary even more between species
- An immense variety of polymers can be built from a small set of monomers

Slide 7

Carbohydrates serve as fuel and building material

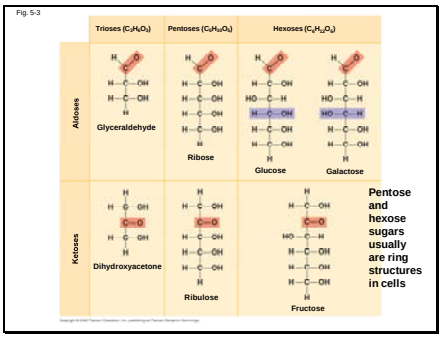
- Monosaccharides
- Disaccharides
- Oligosaccharides
- Polysaccharides

Slide 8

Sugars

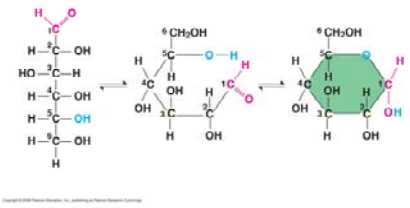
- **Monosaccharides** have molecular formulas that are usually multiples of CH_2O
- Glucose ($C_6H_{12}O_6$) is the most common monosaccharide
- Monosaccharides are classified by
  - The location of the carbonyl group (as aldose or ketose)
  - The number of carbons in the carbon skeleton

Slide 9



Slide 10

Fig. 5-4a

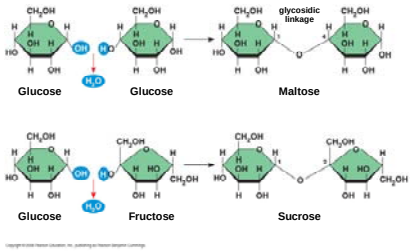


Linear and ring forms in Glucose

Slide 11

Fig. 5-5

Dehydration reaction in the synthesis of disaccharides



Slide 12

Polysaccharides

- Energy storage vs. structural role
- Structure and function determined by:
  - types of sugar monomers
  - positions of glycosidic linkages

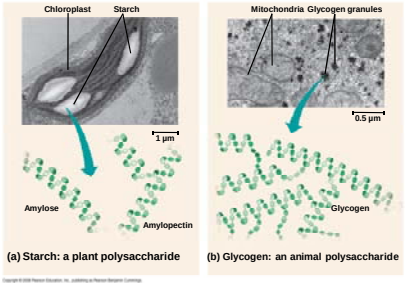
Slide 13

Polysaccharides

- Example: 3 glucose polysaccharides
  - **Glycogen**: Animal Energy Storage
  - **Starch**: Plant Storage, Animal Source
  - **Cellulose**: Plant Structure, Not a Source

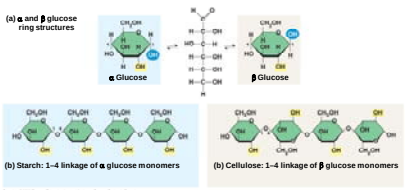
Slide 14

Fig. 5-6



Slide 15

Fig. 5-7



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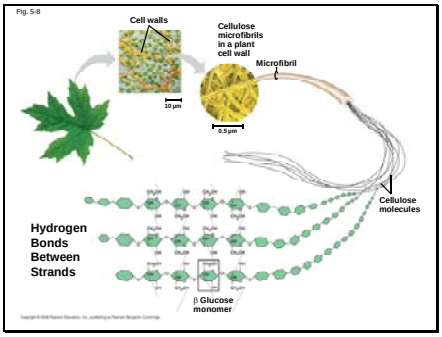
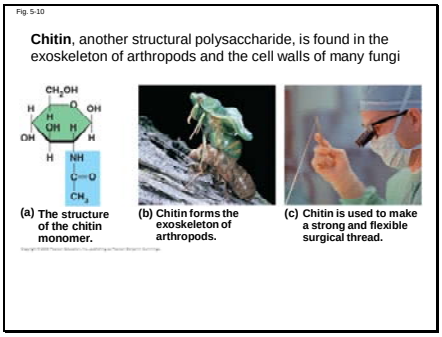


Slide 17

- Enzymes that digest starch by hydrolyzing α linkages can't hydrolyze β linkages in cellulose
- Cellulose in human food passes through the digestive tract as insoluble fiber
- Some microbes use enzymes to digest cellulose
- Many herbivores, from cows to termites, have symbiotic relationships with these microbes

Slide 18



Slide 19

Biological Lipids

- **Lipids** do not form polymers
- Hydrophobicity arises from nonpolar covalent hydrocarbons in the presence of a polar solvent
- Some lipids separate from water because water molecules form hydrogen bonds with each other and exclude them
- The most biologically important lipids are fats, phospholipids, and steroids

Slide 20

- The major function of fats is?

  _____

- What are adipose cells?

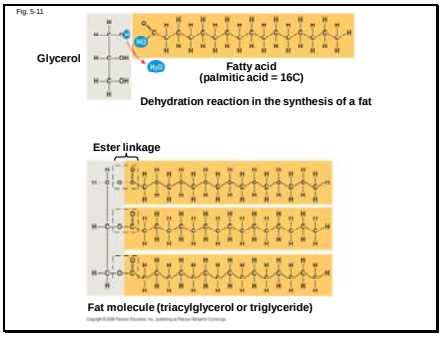
  _____

Slide 21

Fats

- **Fats** are constructed from two types of smaller molecules: glycerol and fatty acids
- Glycerol is a three-carbon alcohol with a hydroxyl group attached to each carbon
- A **fatty acid** consists of a carboxyl group attached to a long carbon skeleton

Slide 22



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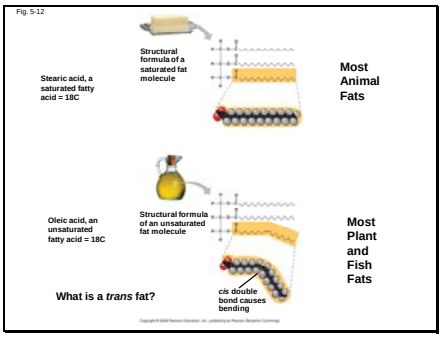

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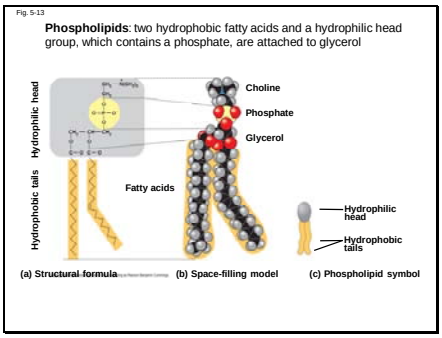

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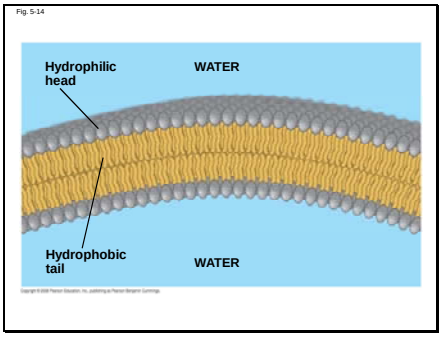

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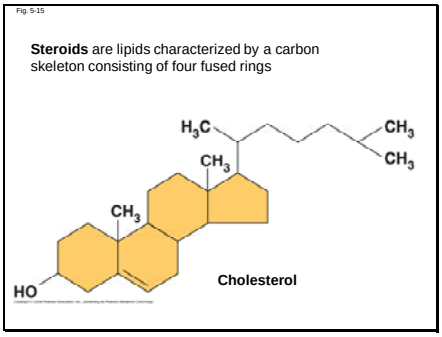

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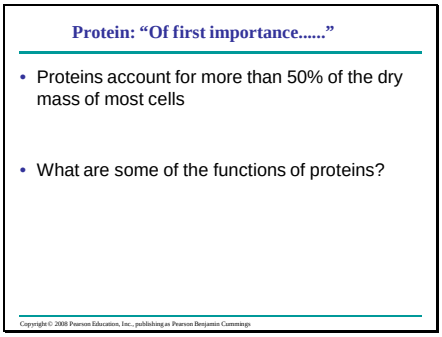


Slide 28

Table 5-1

An Overview of Protein Functions

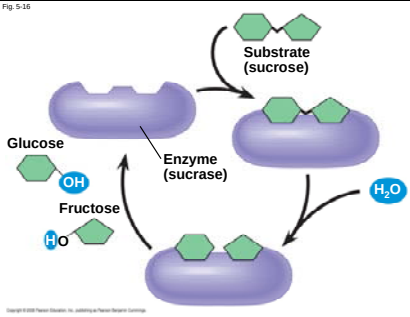
Type of Protein	Function	Examples
Enzymatic proteins	Selective acceleration of chemical reactions	Digestive enzymes
Structural proteins	Support	Silk fibers; collagen and elastin in animal connective tissues; keratin in hair, horns, feathers, and other skin appendages
Storage proteins	Storage of amino acids	Ovalbumin in egg white; casein, the protein of milk; storage proteins in plant seeds
Transport proteins	Transport of other substances	Hemoglobin, transport protein
Hormonal proteins	Coordination of an organism's activities	Insulin, a hormone secreted by the pancreas
Receptor proteins	Response of cell to chemical stimuli	Receptors in nerve cell membranes
Contractile and motor proteins	Movement	Actin and myosin in muscles, proteins in cilia and flagella
Defensive proteins	Protection against disease	Antibodies combat bacteria and viruses.

Slide 29

- **What are enzymes**?

Slide 30

Fig. 5-16



Slide 31

Protein Monomers and Polymers

- Protein monomers are _____
- Monomers are linked by _____
- The polymers are _____
- The order of monomers is the polymer's

  _____

Slide 32

Protein Monomers and Polymers

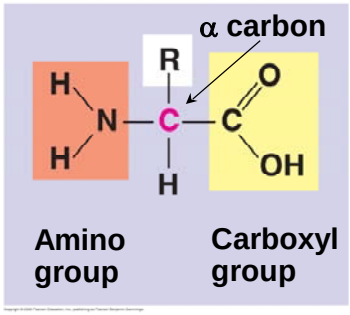
- How many amino acids do we use? _____
- What key functional groups do they have?

  _____
- They differ due to _____
- A **protein** consists of how many polypeptides?

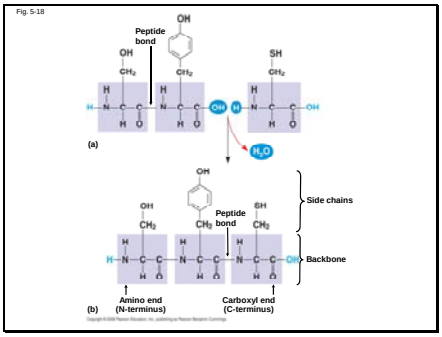
  _____
- What are the polypeptides called when there is more than one? _____

Slide 33

Fig. 5-UN1



Slide 34



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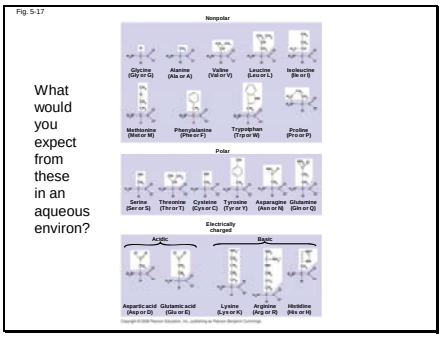

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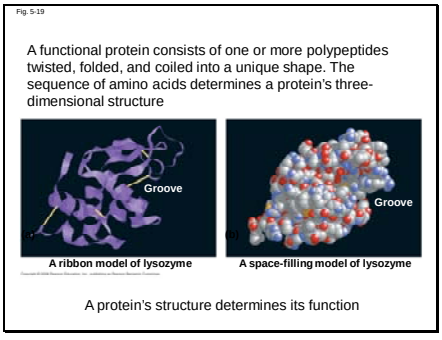
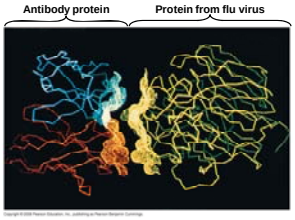


Slide 37

Fig. 5-20



Slide 38

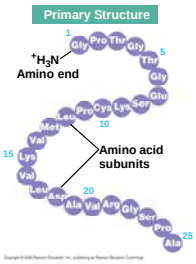
Four Levels of Protein Structure

- The primary structure of a protein is _____
- Secondary structure consists of _____
- Tertiary structure is _____
- Quaternary structure is _____

Slide 39

Fig. 5-21a

Primary structure, the sequence of amino acids in a protein, is like the order of letters in a long word

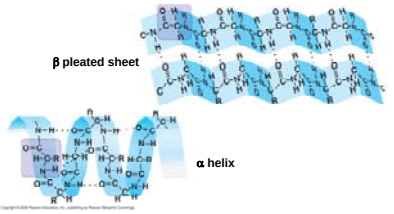


Primary structure is determined by inherited genetic information

Slide 40

Fig. 5-21c

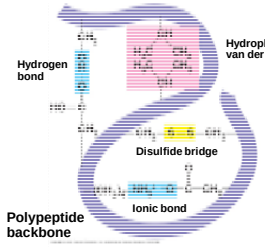
The coils and folds of **secondary structure** result from hydrogen bonds between repeating constituents of the polypeptide backbone



Slide 41

Fig. 5-21f

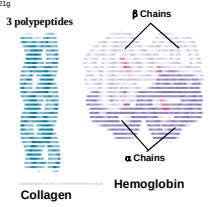
Tertiary structure is determined by interactions between R groups, rather than interactions between backbone constituents



Strong covalent bonds called **disulfide bridges** may reinforce the protein's structure

Slide 42

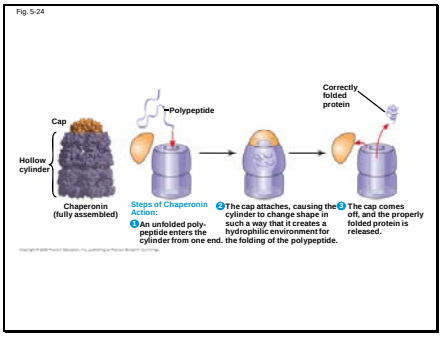
Fig. 5-21g



Quaternary structure results when two or more polypeptide chains form one macromolecule

- It is hard to predict a protein's structure from its primary structure
- Most proteins go through several states on the way to stable structure
- Chaperonins are proteins that assist the proper folding of other proteins

Slide 43

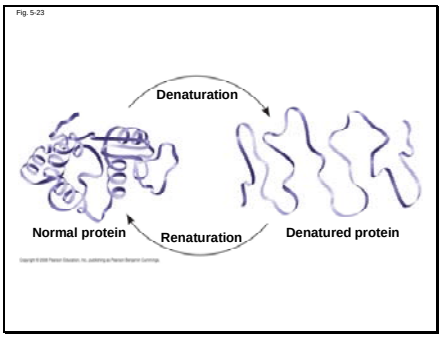


Slide 44

What Determines Protein Structure?

- In addition to primary structure, physical and chemical conditions can affect structure
- Alterations in pH, salt concentration, temperature, or other environmental factors can cause a protein to unravel
- This loss of a protein's native structure is called **denaturation**
- A denatured protein is biologically inactive

Slide 45



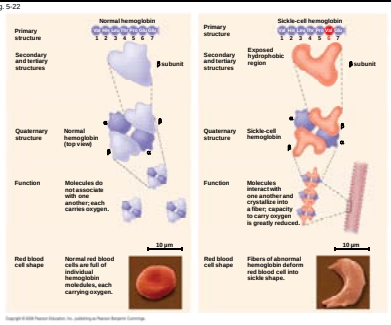
Slide 46

Sickle-Cell Disease: A Change in Primary Structure

- A slight change in primary structure can affect a protein's structure and ability to function
- Sickle-cell disease, an inherited blood disorder, results from a single amino acid substitution in the protein hemoglobin

Slide 47

Fig. 5-22



Slide 48

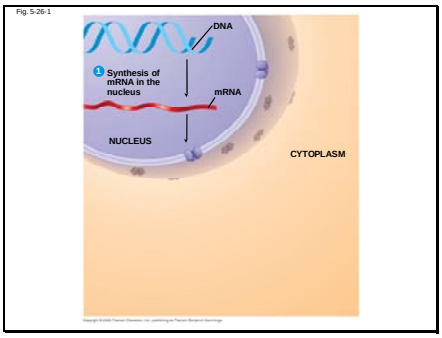
The primary amino acid sequence of a polypeptide is the source of its structure and function but what is the source of that sequence?

Slide 49

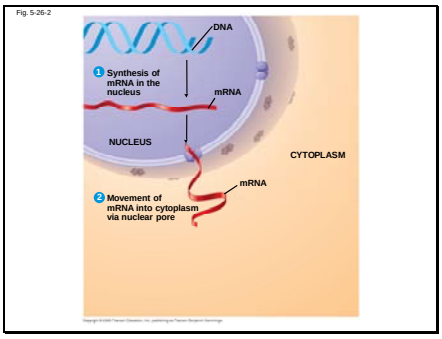
Nucleic Acids

- What are the two types of nucleic acids?
- What is replication?
- What is transcription?
- What are ribosomes?

Slide 50



Slide 51



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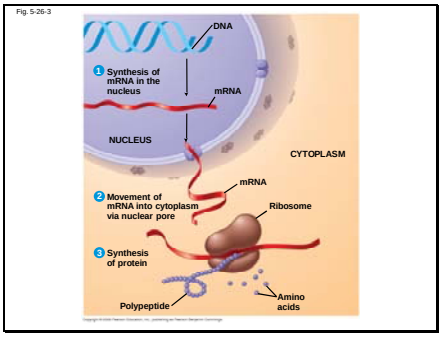


Slide 53

The Structure of Nucleic Acids

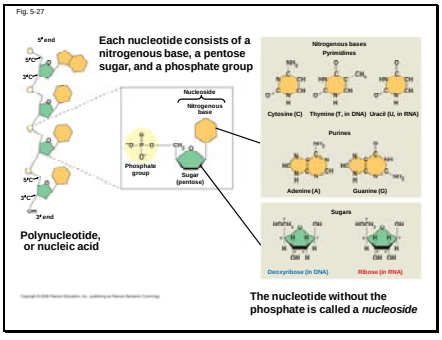
- What are the nucleic acids monomers called?

_____

- What are the nucleic acid polymers called?

_____

Slide 54



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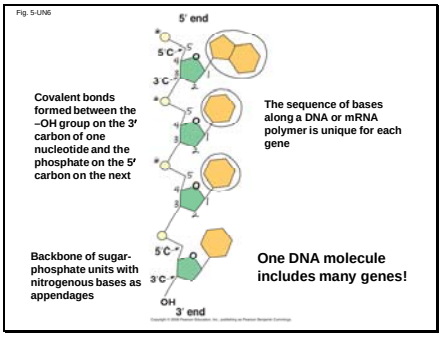
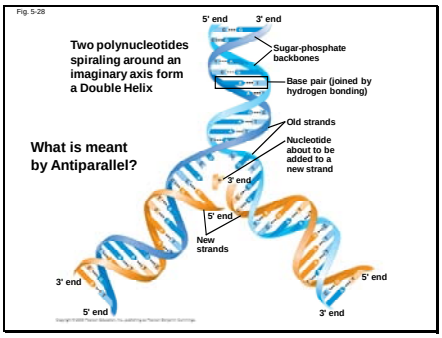


Slide 56



Slide 57

What DNA bases can pair up?

_____ and _____

_____ and _____

Slide 58

What DNA and RNA bases can pair up?

DNA RNA

_____ and _____

_____ and _____

Slide 59

DNA and Proteins as Tape Measures of Evolution

- The linear sequences of nucleotides in DNA molecules are passed from parents to offspring
- Two closely related species are more similar in DNA than are more distantly related species
- Molecular biology can be used to assess evolutionary kinship

Slide 60

What have we learned so far?

The Molecules of Life

- 1. List the four major classes of macromolecules.
- 2. Distinguish between monomers and polymers.
- 3. Draw diagrams to illustrate condensation and hydrolysis reactions.

Slide 61

What have we learned so far?

Carbohydrates Serve as Fuel and Building Material

- 1. Distinguish between monosaccharides, disaccharides, and polysaccharides.
- 2. Describe the formation of a glycosidic linkage.
- 3. Compare and contrast the structures, functions, and locations of starch, glycogen, cellulose and chitin.

Slide 62

What have we learned so far?

- **Lipids are a Diverse Group of Hydrophobic Molecules**
- 1. Describe the building-block molecules, structure, and biological importance of fats, phospholipids, and steroids. Discuss the primary functions of each type of lipid.
- 2. Identify an ester linkage and describe how it is formed.
- 3. Distinguish between saturated and unsaturated fats.
- 4. Describe the process that results in the production of *trans* fat molecules.
- 5. Discuss the role of saturated fats and trans fats in the potential development of atherosclerosis.

Slide 63

What have we learned so far?

Proteins have Many Structures, Resulting in a Wide Range of Functions

- 1. Distinguish between a protein and a polypeptide.
- 2. Explain how a peptide bond forms between two amino acids.
- 3. Name the two ends of a protein and explain the reason for their names.
- 4. List and describe the four major components of an amino acid. Explain how amino acids may be grouped according to the physical and chemical properties of the R group.

Slide 64

What have we learned so far?

5. Explain what determines protein structure and why it is important.
6. Explain how the primary structure of a protein is determined.
7. Name two types of secondary protein structure. Explain the role of hydrogen bonds in maintaining secondary structure. 22. Explain how weak interactions and disulfide bridges contribute to tertiary protein structure.
8. List three conditions under which proteins may be denatured.
9. Explain how chaperonins may assist in proper folding of proteins.
10. Explain how a single nucleotide change in the beta-globin gene can lead to sickle cell anemia disease.

Slide 65

What have we learned so far?

Nucleic Acids Store and Transmit Hereditary Information

1. List the major components of a nucleotide, and describe how these monomers are linked to form a nucleic acid. Name the type of bond that holds two nucleotides together.
2. Distinguish between:
   a. pyrimidine and purine
   b. nucleotide and nucleoside
   c. ribose and deoxyribose
   d. 5' end and 3' end of a nucleotide
3. Briefly describe the three-dimensional structure of DNA.

Slide 66

What have we learned so far?

4. Compare and contrast DNA and RNA.
5. Explain how DNA or protein comparisons may allow us to assess evolutionary relationships between species.
6. Briefly discuss the flow of genetic information (from DNA to RNA to protein).