Aim: What is the structure and function of nucleic acids?

Section E: Nucleic Acids - Informational Polymers

1. **Nucleic acids store and transmit hereditary information**
2. **A nucleic acid strand is a polymer of nucleotides**
3. **Inheritance is based on replication of the DNA double helix**
4. **We can use DNA and proteins as tape measures of evolution**

Introduction

- The amino acid sequence of a polypeptide is programmed by a **gene**.
- A gene consists of regions of DNA, a polymer of **nucleic acids**.
- DNA (and their genes) is passed by the mechanisms of inheritance.

1. Nucleic acids store and transmit hereditary information

- There are two types of nucleic acids: **ribonucleic acid (RNA)** and **deoxyribonucleic acid (DNA)**.
- DNA provides direction for its own replication.
- DNA also directs RNA synthesis and, through RNA, controls protein synthesis.

- The flow of genetic information is from DNA -> RNA -> protein.
  - Protein synthesis occurs in cellular structures called ribosomes.
  - In eukaryotes, DNA is located in the nucleus, but most ribosomes are in the cytoplasm with mRNA as an intermediary.

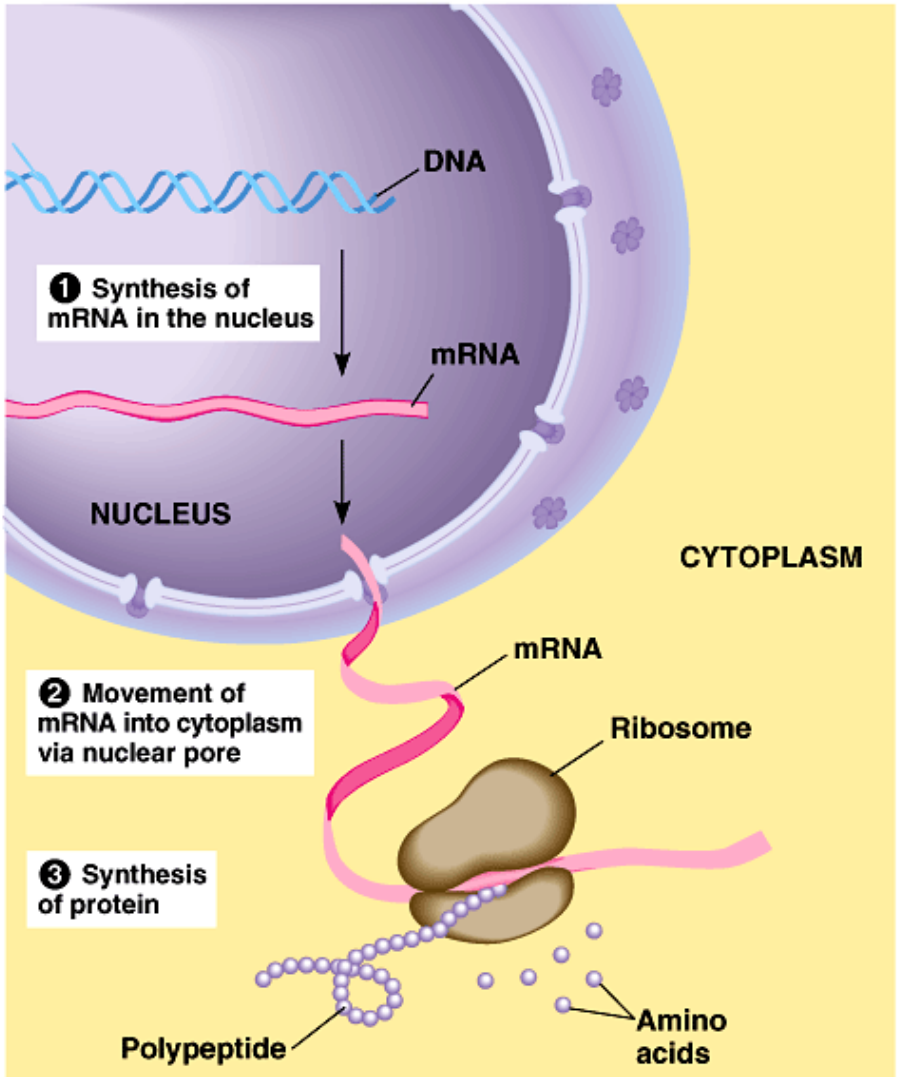

Fig. 5.28

2. A nucleic acid strand is a polymer of nucleotides

- Nucleic acids are polymers of monomers called **nucleotides.**
- Each nucleotide consists of three parts: a nitrogen base, a pentose sugar, and a phosphate group.

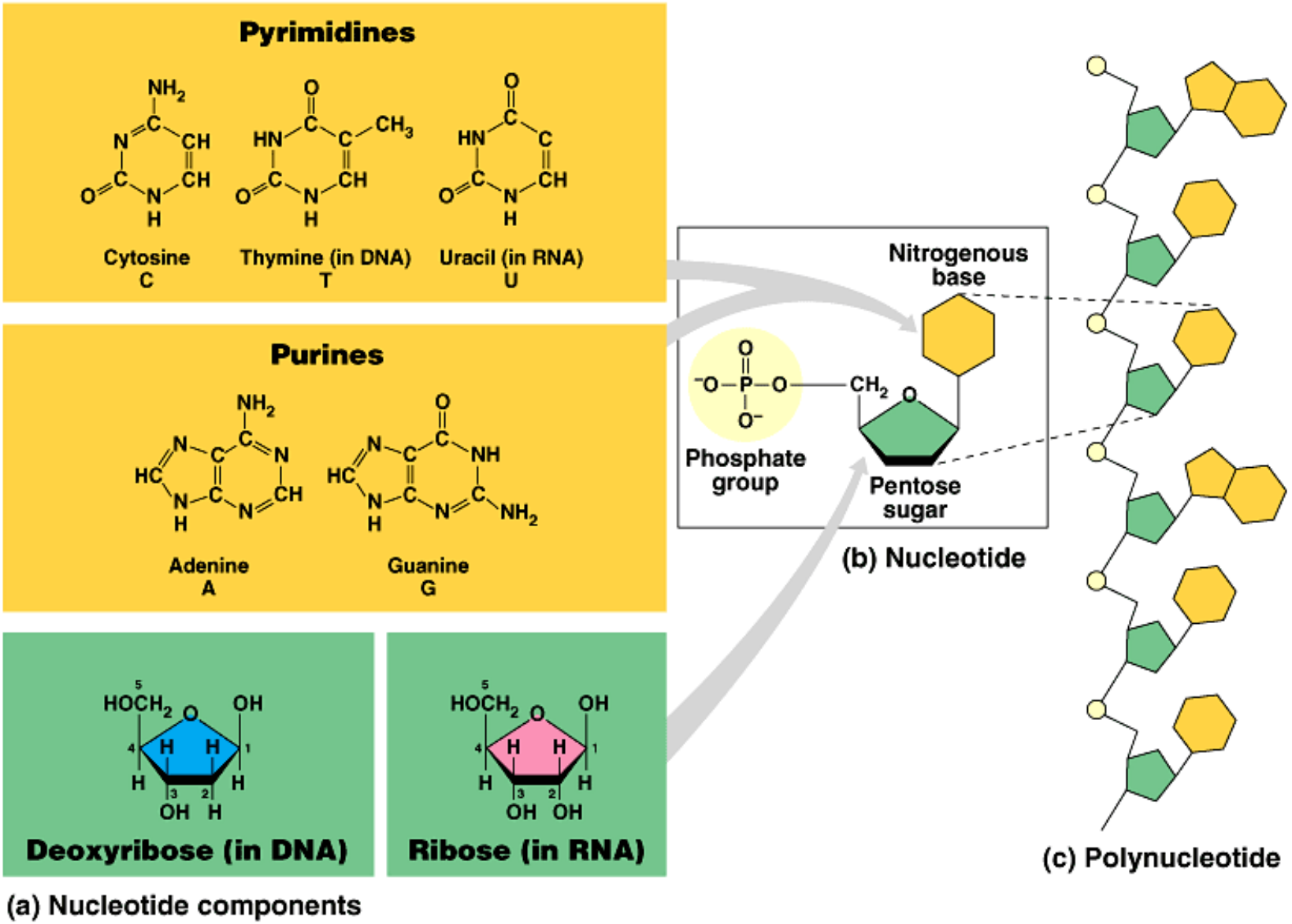

Fig. 5.29

- The nitrogen bases, rings of carbon and nitrogen, come in two types: purines and pyrimidines.
  - Pyrimidines have a single six-membered ring.
  - The three different pyrimidines, cytosine (C), thymine (T), and uracil (U) differ in atoms attached to the ring.
  - Purine have a six-membered ring joined to a five-membered ring.
  - The two purines are adenine (A) and guanine (G).

- The pentose joined to the nitrogen base is **ribose** in nucleotides of RNA and **deoxyribose** in DNA.
  - The only difference between the sugars is the lack of an oxygen atom on carbon two in deoxyribose.
- The addition of a phosphate group creates a nucleoside monophosphate or nucleotide.

- Polynucleotides are synthesized by connecting the sugars of one nucleotide to the phosphate of the next with a phosphodiester link.
- This creates a repeating backbone of sugar-phosphate units with the nitrogen bases as appendages.

3. Inheritance is based on replication of the DNA double helix

- An RNA molecule is single polynucleotide chain.
- DNA molecules have two polynucleotide strands that spiral around an imaginary axis to form a **double helix.**
  - The double helix was first proposed as the structure of DNA in 1953 by James Watson and Francis Crick.

- The sugar-phosphate backbones of the two polynucleotides are on the outside of the helix.
- Pairs of nitrogenous bases, one from each strand, connect the polynucleotide chains with hydrogen bonds.
- Most DNA molecules have thousands to millions of base pairs.

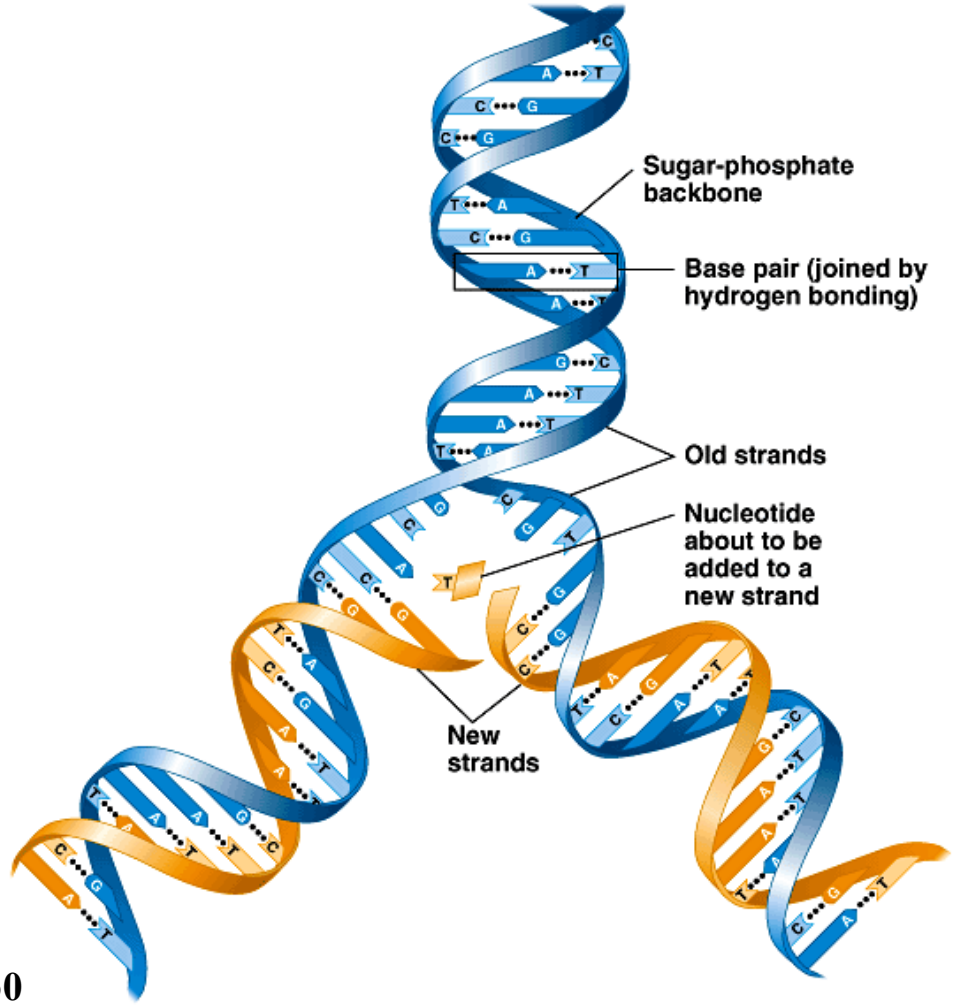

Fig. 5.30

- Because of their shapes, only some bases are compatible with each other.
  - Adenine (A) always pairs with thymine (T) and guanine (G) with cytosine (C).
- With these base-pairing rules, if we know the sequence of bases on one strand, we know the sequence on the opposite strand.
- The two strands are *complementary*.

Table 5.2 Polypeptide Sequence as Evidence for Evolutionary Relationships

Species	Number of Amino Acid Differences in the β Chain of Hemoglobin, Compared to Human Hemoglobin (Total Chain Length = 146 Amino Acids)
Human	0
Gorilla	1
Gibbon	2
Rhesus monkey	8
Mouse	27
Frog	67