1 Chapter 19
   DNA and Biotechnology

2 Outline
   - DNA Structure and Function
   - DNA Replication
   - RNA Structure and Function
     - Types of RNA
     - Gene Expression
       - Transcription
       - Translation
     - Biotechnology
     - Human Genome

3 DNA and RNA Structure and Function
   - DNA is the genetic material found principally in chromosomes.
     - In between cell divisions, chromosomes exist in long fine threads of chromatin.
     - When a cell is about to divide, chromosomes coil and condense.

4 DNA Location and Structure

5 DNA Structure and Replication
   - DNA is a sequential series of joined nucleotides.
     - Sugar (deoxyribose), phosphate, and base.
       - Adenine (A).
       - Thymine (T).
       - Cytosine (C).
       - Guanine (G).

6 DNA Structure and Replication
   - DNA is a double helix with a sugar-phosphate backbone and bases projecting between the backbones.
     - Exhibits complementary base pairing.
       - A-T.
       - G-C.

7 DNA Replication
   - Replication Steps.
     - Hydrogen bonds between strands break and the molecule unzips.
     - New nucleotides fit beside parental strand.
     - DNA polymerase joins new nucleotides.
     - Two complete molecules present, each with one old strand and one new strand.
Semi-conservative replication.

8 DNA Replication
9 Structure and Function of RNA
   - RNA is made up of nucleotides containing the sugar ribose and the base uracil in place of thymine.
     - Single stranded.
     - RNA is a helper to DNA allowing protein synthesis.

10 Types of RNA
   - Ribosomal RNA.
     - Joins with proteins made in the cytoplasm to form the subunits of ribosomes.
   - Messenger RNA.
     - Carries genetic information from DNA to the ribosomes in the cytoplasm where protein synthesis occurs.
   - Transfer RNA.
     - Transfers amino acids to the ribosomes where amino acids are joined.

11 Gene Expression
   - Structure and Function of Proteins.
     - Proteins are composed of amino acids.
     - Proteins differ because the number and order of their amino acids differ.

12 DNA Code
   - Genetic code is essentially universal.
     - Contains a triplet code.
     - Every three bases represents one amino acid.
   - Transcription.
     - Strand of mRNA forms that is complementary to a portion of DNA.
     - Triplet of mRNA is termed a codon.

13 Processing of mRNA
   - Most human genes are interrupted by introns.
     - Intragenic segments interrupt gene segments, exons.
     - During processing, introns are removed and exons are joined to form an mRNA molecule.

14 Function of Introns

15 Translation
   - Translation is the synthesis of a polypeptide under the direction of an mRNA molecule.
     - Transfer RNA molecules bring amino acids to the ribosomes.
Anticodon is triplet complementary to an mRNA codon.
- Polypeptide synthesis requires three steps.
  - Initiation.
  - Elongation.
  - Termination.

Anticodon-Codon Base Pairing

Gene Expression Review
- DNA triplet codes for a specific amino acid.
- During transcription, a segment of DNA serves as a template for mRNA.
- Messenger RNA has introns removed.
- Messenger RNA carries a sequence of codons to the ribosomes.
- Transfer RNA molecules have anticodons complementary to mRNA codons.
- Linear sequence of mRNA codons determines order amino acids are incorporated into a protein.

Regulation of Gene Expression
- Gene Regulation Mechanisms.
  - Transcriptional control.
  - Posttranscriptional control.
  - Translational control.
  - Posttranslational control.

Biotechnology
- Genetic engineering is the use of technology to alter the genomes of organisms.
- Biotechnology includes genetic engineering and other techniques to make use of natural biological systems to achieve an end desired by humans.

The Cloning of a Gene
- Recombinant DNA Technology.
  - Uses at least two different DNA sources.
    - Vector used to introduce foreign DNA into a host cell.
      - Plasmid.
  - Enzymes.
    - Restriction enzymes cleave DNA.
    - DNA ligase seals DNA into an opening created by the restriction enzyme.

Polymerase Chain Reaction
- Polymerase Chain Reaction (PCR) can create millions of copies of a DNA segment very quickly.
Can be subjected to DNA fingerprinting using restriction enzymes to cleave the DNA sample, and gel electrophoresis to separate DNA fragments.

Biotechnology Products
- Transgenic Bacteria.
  - Insulin.
  - Human Growth Hormone.
- Transgenic Plants.
  - Pest resistance.
  - Higher yields.

Biotechnology Products
- Transgenic Animals.
  - The use of transgenic farm animals to produce pharmaceuticals is currently being pursued.
  - Cloning transgenic animals.
    - Dolly (1997).

The Human Genome
- Genome is all the genetic information of an individual or species.
  - Base sequence map.
  - Shows sequences of all base pairs.
    - Completed for humans.
  - Genetic map.
    - Shows locations of genes along each chromosome.
    - Unfinished for humans.

Gene Therapy
- Gene therapy is the insertion of genetic material into human cells to treat a disorder.
  - Ex Vivo Gene Therapy.
    - Bone marrow stem cells are removed from the blood and infected with an RNA retrovirus that carries a normal gene for the enzyme.
    - Cells returned to patient.
  - In Vivo Gene Therapy.
    - Genes injected alone, or with a virus, directly into the organ, or the body.

Review
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- DNA Replication
- RNA Structure and Function
  - Types of RNA
- Gene Expression
  - Transcription
  - Translation
- Biotechnology
  - Human Genome