

PowerLecture:

Chapter 14

From DNA to Protein

Section 14.0: Weblinks and InfoTrac

See the latest Weblinks and InfoTrac articles for this chapter online

Impacts, Issues: Ricin and Your Ribosomes

- Ricin – comes from the castor oil plant
- Inactivates ribosomes, the protein-building machinery of all cells

Impacts, Issues Video

Section 14.1: Weblinks and InfoTrac

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Marvelous Mussel Adhesive

- Mussel binds itself to rocks with threads coated with the protein byssus
- Gene for byssus has been put into yeast
- Yeast synthesize the protein based on the instructions in the mussel DNA

Steps from DNA to Proteins

Same two steps produce all proteins:

1) DNA is transcribed to form RNA

- Occurs in the nucleus
- RNA moves into cytoplasm

2) RNA is translated to form polypeptide chains, which fold to form proteins

Three Classes of RNAs

- Messenger RNA
  - Carries protein-building instruction
- Ribosomal RNA
  - Major component of ribosomes
- Transfer RNA
  - Delivers amino acids to ribosomes

A Nucleotide Subunit of RNA

DNA and RNA

Uracil-thymine comparison

Transcription & DNA Replication

- Like DNA replication
  - Nucleotides added in 5' to 3' direction
- Unlike DNA replication
  - Only small stretch is template
  - RNA polymerase catalyzes nucleotide addition

- Product is a single strand of RNA

#### Promoter

- A base sequence in the DNA that signals the start of a gene
- For transcription to occur, RNA polymerase must first bind to a promoter

#### Transcript Modification

#### Pre-mRNA transcript processing

#### Transcript Modification

#### Gene transcription details

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#### Genetic Code

- Set of 64 base triplets
- Codons
- 61 specify amino acids
- 3 stop translation

#### Genetic Code

#### Genetic code

#### Genetic Code

#### Structure of tRNA

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#### tRNA Structure

#### Ribosomes

#### Structure of a ribosome

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#### Three Stages of Translation

#### Initiation

#### Elongation

#### Termination

#### Initiation

- Initiator tRNA binds to small ribosomal subunit
- Small subunit/tRNA complex attaches to mRNA and moves along it to an AUG “start” codon
- Large ribosomal subunit joins complex

## Binding Sites

### Elongation

- mRNA passes through ribosomal subunits
- tRNAs deliver amino acids to the ribosomal binding site in the order specified by the mRNA
- Peptide bonds form between the amino acids and the polypeptide chain grows

### Elongation

### Termination

- Stop codon into place
- No tRNA with anticodon
- Release factors bind to the ribosome
- mRNA and polypeptide are released

## What Happens to the New Polypeptides?

- Some just enter the cytoplasm
- Many enter the endoplasmic reticulum and move through the cytomembrane system where they are modified

## Translation

### Translation

### Overview

## Protein Synthesis

### Protein synthesis summary

Section 14.5: Weblinks and InfoTrac

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Videos: CNN

Ask your Thomson Sales Representative for these volumes on CD or VHS

- Environmental Science, 2002, Vol. 5, *Chernobyl* (2:56)
- Environmental Science, 2002, Vol. 5, *Nuclear Power Plant Safety* (2:03)
- Environmental Science, 2004, Vol. 7, *Nuclear Fallout* (2:01)

## Gene Mutations

Base-Pair Substitutions

Insertions

Deletions

Base-Pair Substitution

Base-Pair Substitution

**Base-pair substitution**

Frameshift Mutations

- Insertion
  - Extra base added into gene region

- Deletion
  - Base removed from gene region
- Both shift the reading frame
- Result in many wrong amino acids

### **Frameshift Mutations**

#### **Frameshift mutation**

### **Transposons**

- DNA segments that move spontaneously about the genome
- When they insert into a gene region, they usually inactivate that gene

### **Transposons**

- Barbara McClintock

- Nonuniform coloration of kernels in strains of indian corn

### **Mutation Rates**

- Each gene has a characteristic mutation rate
- Average rate for eukaryotes is between  $10^{-4}$  and  $10^{-6}$  per gene per generation
- Only mutations that arise in germ cells can be passed on to next generation

### **Mutagens**

- Ionizing radiation (X rays)
- Nonionizing radiation (UV)
- Natural and synthetic chemicals

### **Ionizing Radiation**