The Cell Cycle and Cancer

RNA is synthesized from DNA in the nucleus.
- mRNA (messenger) is created as a copy of the gene.

Genetic Code
- Each three-base sequence on DNA (triplet) is represented by a codon on mRNA.
  - One gene → one mRNA strand → one polypeptide product.

Translation
- Converts base sequence of nucleic acids into the amino acid sequence of proteins.
  - Involves mRNA, tRNA, and rRNA.
  - Occurs at the ribosome in the cytoplasm.

Protein synthesis involves the following steps:
1. Transcription: DNA is transcribed into RNA in the nucleus.
2. RNA Processing: Pre-mRNA is edited and modified.
3. Translation: mRNA is translated into a polypeptide at ribosomes in the cytoplasm.

Figure 3.36: Table of the Genetic Code

<table>
<thead>
<tr>
<th>mRNA Codon</th>
<th>Amino Acid</th>
</tr>
</thead>
<tbody>
<tr>
<td>UUU, UUC, UUA, UUG</td>
<td>Leu</td>
</tr>
<tr>
<td>UAU, UAC</td>
<td>Ile</td>
</tr>
<tr>
<td>GCU, GCC, GCA, GCG</td>
<td>Ala</td>
</tr>
<tr>
<td>AGU, AGC</td>
<td>Ser</td>
</tr>
<tr>
<td>UAA, UAG, UGA</td>
<td>Stop</td>
</tr>
<tr>
<td>AUG</td>
<td>Met</td>
</tr>
</tbody>
</table>
Functions of Cell Division

- Growth
- Replacement
- Repair
- Reproduction

The Cell Cycle

- An illustration of the life cycle of a cell
- Consists of four major phases
  - G1 phase
  - S phase
  - G2 phase
  - M phase

Interphase (preparation for cell division)

The Cell Cycle Summary

- Interphase
  - G1
    - Prepare for division
  - S
    - DNA replication
  - G2
    - Last minute preparation before division begins
- M phase
  - Mitosis
    - Separation of replicated DNA
  - Cytokinesis
    - Splitting of the cell
Preparing for Cell Division

- DNA replication
  - Takes place during S (synthesis) phase of cell cycle
  - Occurs in the nucleus

DNA Replication

- End result is two complete sets of DNA
- Assures appropriate chromosome number in daughter cells

46 → S → 92 → G2 → M → 46

The Process of Cell Division

- Includes two distinct events
  1. Mitosis—division of chromatin
     - Prophase
     - Metaphase
     - Anaphase
     - Telophase
  2. Cytokinesis—division of cytoplasm by cleavage furrow

The Process of Cell Division

- Mitotic (M) phase of the cell cycle
  - Essential for body growth and tissue repair
    - Does not occur in most mature cells of nervous tissue, skeletal muscle, and cardiac muscle
  - We will come back to cancer...
The Process of Cell Division

- **Problems during mitosis**
  - May or may not be fatal
  - Examples
    - Non-disjunction
      - Down syndrome
      - X and Y chromosomes

Cytokinesis

- **“Cell movement”**
- Cells actually divide
- Follows nuclear division

Cytokinesis

- Begins during late anaphase
- Ring of actin microfilaments contract to form a cleavage furrow
- Two daughter cells are pinched apart
  - Each contains a nucleus identical to the original

Cancer

- Second most common cause of death in U.S.
  - Actually just became the most common in Kansas
- Prostate cancer
  - Estimated 247,730 men will be diagnosed
- Breast cancer
  - 12.2% women will be diagnosed
Cancer

- Damage control exists in the cell cycle of normal cells
  - Example: proto-oncogenes, tumor suppressor genes (P53)
- Controls do not function properly in cancer cells
- Results in uncontrolled cell division
  - Absence of or defective regulatory proteins
  - Cancer cells compete with and "crowd out" normal cells

- Genes coding for "checkpoint" proteins
  - Mutation of genes results in uncontrolled cell division
  - Anything that can alter these genes can "trigger" cancer

- Cancer cells form tumors
  - Masses of abnormal cells within otherwise normal tissue
    - Benign tumor
      - Cells are encapsulated and remain at original site
    - Malignant tumor
      - Invades surrounding tissue and may metastasize
Cancer

- **Classification – REMEMBER THESE FOR ALL 5 TERMS**
  1. Carcinoma
  2. Sarcoma
  3. Myeloma
  4. Lymphoma
  5. Leukemia
  - Abnormal white blood cells

- **Symptoms vary with type**
  - Unusual bleeding or discharge
  - A lump that does not go away
  - A sore that does not heal within two weeks
  - A change in bowel or bladder habits
  - Persistent hoarseness or cough
  - Indigestion or difficulty swallowing
  - Change in a wart or mole

Cancer

- **Causes**
  - Carcinogens
  - Oncogenic viruses
    - Examples: Human Papilloma Virus (HPV – can infect cervical cells)
      - Epstein Barr virus (can infect B-cells and lead to lymphoma)
      - Hepatitis B virus (can infect liver cells)
  - Hereditary factors