10.3: Control of the Cell Cycle

Key Concepts:
- How is the cell cycle regulated?
- How are cancer cells different from other cells?
- What causes cancer?
The Cell Cycle – review of the basics:

- Genetic information in the form of DNA
- Cell cycle = process of cell division
  - The cell grows;
  - DNA is copied;
  - The contents of the nucleus are divided;
  - Cytoplasm is divided;
  - Two new cells exactly like the original cell!
Also, recall...

- one of the major characteristics of living things is the ability to **GROW**

- an adult doesn't have bigger cells, they have *more cells*

You can grow too many cells!!!
An Interesting Fact About Cell Division:

- Not all cells move through the cell cycle at the same rate
  - **Ex:** most muscle cells & nerve cells do not divide at all once they have developed
  - **Ex:** skin cells and cells lining our intestines complete the cell cycle every 24-28 hours
  - **Ex:** frog embryo cells take less than one hour!
Controls on Cell Division

- Controls can be observed in a lab
  - Cells in a petri dish containing nutrient broth (food) will grow and divide forming a thin layer
  - When the cells come into contact with each other, they **stop growing**
Controls on Cell Division continued...

- If cells from the center are removed, growth and division will continue until cells are in contact with each other once again.

- When have you witnessed this happening with your own body?
Cell Cycle Regulators

• Several scientists discovered that cells undergoing cell division (mitosis) contained a protein/enzyme

• If it was injected into a nondividing cell, the mitotic spindle would start to form
  – Called this protein **CYCLIN**
  – Scientists have since discovered a family of closely related proteins (cyclins) & dozens of other proteins that help **regulate the cell cycle**
The Cell Cycle

Cell with chromosomes in the nucleus

G1

CDK

cyclin

DNA synthesis

Chromosome duplication

G2

Mitosis

Cell division

Cell with duplicated chromosomes

Chromosome separation
Recent studies suggest...

- The portion of interphase just before DNA replication is a key control period in the cell cycle;
- There are several enzymes identified as controlling the cell cycle...
- RECALL: enzymes are proteins, and
- Proteins are coded for by DNA! So...
The Cell Cycle

Cell with chromosomes in the nucleus

G1

CDK

cyclin

S

DNA synthesis

Chromosome duplication

M

Mitosis

Chromosome separation

G2

Cell with duplicated chromosomes
A mistake (MUTATION) in the DNA (GENES) that codes for one or more of these control factors/enzymes could lead to a LOSS OF CONTROL OF THE CELL CYCLE.
UNCONTROLLED CELL GROWTH

• What would happen if cell growth wasn’t regulated so carefully?
  – CANCER!!

• Cancer cells do not respond to signals that regulate the growth of most cells.
• The result? They form masses of cells called **TUMORS** that can damage the surrounding tissues
  – Benign vs. malignant

• Cancer cells can also break off and spread throughout the body **metastasis**

**BREAST TUMOR**

**Old Mastectomy**

**Vs.**

**New Mastectomy**
A tumor grows from a single cancer cell.

Cancer cells invade neighboring tissue.

Cancer cells spread through lymph and blood vessels to other parts of the body.
Cancer is the 2\textsuperscript{nd} leading cause of death in the U.S.

- It can affect any tissue, but the most commonly affected are:
  - lung
  - colon
  - breast
  - prostate
What causes the loss of growth control?

- **Smoking tobacco**
- **Radiation exposure**
- **Viral infection**
Cancer Prevention:

- There is a clear link between healthy lifestyle and reducing the incidence of cancer;
- Diet low in fat and high in fiber; (fruits, vegetables, & grains)
- Vitamins and minerals; (A, C, E, & calcium)
- Exercise;
- Wear sunscreen
• DON’T SMOKE!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
(Seriously!! This should be a no-brainer!!)

WARNING
CIGARETTES CAUSE LUNG CANCER

85% of lung cancers are caused by smoking. 80% of lung cancer victims die within 3 years.

Health Canada
Treatments

- surgery (for benign tumors)
- radiation
- chemotherapy
Recent Research

• Many cancer cells have a defect in a gene called p53
  – The protein made from this segment of DNA normally halts the cell cycle until all chromosomes have been replicated properly (without mutations)
  – If it isn’t working, damaged DNA can replicate
  – The cell may have lost the information it needs to respond to growth control signals

• Cancer is a disease of the cell cycle
Most of the time the p53 tumor suppressor gene stops mutating cells becoming cancer; but when p53 is damaged, mutations accumulate more rapidly leading to cancer.
What is unusual about cancer cells?

a) They stop growing when they come into contact with other cells
b) They keep growing when they come into contact with other cells
c) They are regulated and respond to cyclins, which control the cell cycle
d) None of the above