Chapter 5
Cancer:
DNA Synthesis, Mitosis, and Meiosis
5.1 What Is Cancer?

- **Cell division** is the process through which a cell copies itself.

- **Cancer** begins when a cell divides when it should not.

- Unregulated cell division leads to a **tumor**
  - A mass of cells with no apparent function in the body.
What Is Cancer?

• **Benign** tumors do not invade surrounding tissue

• **Malignant** tumors invade surrounding structures:
  – are cancer

• Cells from Malignant tumors can break away and start new cancers elsewhere
  – through the process of **metastasis**
  – Benign tumors **cannot** metastasize
What Is Cancer?

• Cancer cells differ from normal cells:
  – Divide when they should not
  – Invade surrounding tissue
  – Move to other locations in the body
What Is Cancer?

- Normal cell division
- Unregulated cell division

**Tumor**
- **Malignant** if tumor invades surrounding tissue (cancerous)
- **Benign** if tumor has no effect on surrounding tissue (non-cancerous)
- **Metastatic** if individual cells break away and start a new tumor elsewhere (cancerous)

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What Is Cancer?

• Cancer travels through the body by way of the lymphatic and circulatory systems
  – Lymphatic vessels
  – Blood vessels

• The **lymphatic vessels** collect fluids lost from Blood vessels

• **Lymph nodes** are structures that filter the lost fluids
  – Lost fluid is called lymph
What Is Cancer?

- All tissues that undergo cell division
- such as ovarian tissue
- are susceptible to cancer
How Can Ovarian Cancer Kill You?

Lymphatic system
- Lymph ducts empty into veins
- Lymph nodes purify lymph

Ovary
How Can Ovarian Cancer Kill You?

• Ovarian tumor cells metastasize into the lymph
  – Some get stuck in lymph nodes
  – Some travel to the bloodstream

• They can travel all over the body in the bloodstream

• Set up camp in vital organs
  – The function of the organs are disrupted by ovarian cell tumors

• Cause multi-organ failure and death
Why is ovarian cancer so deadly?

• Rarely causes symptoms until tumor is quite large
• No good “early detection” test
  – CA125 tumor marker bloodtest
    • Does not catch half of the early stage ovarian cancers
    • Does catch 90% of advanced
    • False positive tests from endometriosis, fibroids, pelvic inflammatory disease, pregnancy
• Usually metastasizes before detected
  – 70% of cases
  – Stage 2, 3, and 4
• Usually highly aggressive cancer cells
  – Grades 2 and 3
• Overall “5 year survival rate” is (live at least 5 years from diagnosis)
  – Stage 1 = 87%
  – Stage 2 = 59%
  – Stage 3 = 27%
  – Stage 4 = 11.5\%  
  (Rosenthal and Jacobs, 1998)
Cancer cells travel in lymph and blood

Malignant tumor in ovary

Cancer cells traveling through lymph ducts

Cancer cells traveling through blood vessels

Metastatic cancer in another tissue
5.2 Cell Division Overview

• Cell division produces new cells in order to:
  – Heal wounds
  – Replace damaged cells
  – For growth

  – Also for reproduction
Cell Division Overview

Asexual reproduction:
• Make exact copies
• Does not need two parents
• Single celled organisms, like amoebas, carry out asexual reproduction
Amoeba
Cell Division Overview

• Before dividing, a copy of **DNA** (deoxyribonucleic acid) must first be made

• DNA is located within the nucleus and carries **genes** – instructions for building the proteins that cells require
Cell Division Overview

• DNA is organized into structures called **chromosomes** which can carry hundreds of genes along their length
• The number of in each cell depends on the organism: humans have 46
Cell Division Overview

- DNA starts out in a string-like, uncondensed form…

Uncondensed DNA
Cell Division Overview

• Before cell division begins:
  – DNA is condensed into short, linear chromosomes
Cell Division Overview

• A chromosome is replicated during cell division
  – the copy carries the same genes

• Each chromosome is copied
  – the copy is called a sister chromatid

• The sister chromatid
  – is connected to the original DNA by a centromere
Cell Division Overview

DNA condensed into chromosomes

Centromere
Sister chromatids
Chromosomes

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DNA Structure

- DNA is a double stranded molecule made of
  - two single strands of nucleotides that are bonded together

- The DNA molecule looks a lot like
  - a twisted rope ladder
DNA structure

• The “rungs” of the molecule are the bases:
  – A (adenine)
  – T (thymine)
  – G (guanine)
  – C (cytosine)

• The bases across the “ladder” are connected in a specific way:
  – A always bonds with T
  – C always bonds with G

• This is complementary base pairing
Each strand is a chain of nucleotides.
Cell Division Overview

James Watson and Francis Crick:
• Determined the structure of the DNA molecule
• Published in *Nature* in 1953
• Based on Rosalind Franklin’s experiments
Why do we care about DNA structure?

• Because the structure of DNA allows life as we know it to exist

• Because complementary base pairing allows
  – new cells to be made with exactly the same DNA as the original cell
    • If you can’t do this, you will die!
    • A brain cell makes another brain cell, not a liver cell in your head

• Because complementary base pairing allows
  – DNA to make an exactly correct RNA
  – that then can make an exactly correct protein
    • People need to make insulin, stomach digestive enzymes, etc
    • If you can’t do this, you will die!

• Because it is Nerdy fun…