

Week 8

BIO-1305 - Biology 1 – Campbell Textbook

Hello and welcome to the weekly resources for BIO-1305 - Biology 1 – Campbell Textbook!

This week is **Week 8** of class, and typically in this week of the semester, your professors are covering the topics below. If you do not see the topics your particular section of class is learning this week, please take a look at other weekly resources listed on our website for additional topics throughout the semester.

We also invite you to look at the group tutoring chart on our website to see if this course has a group tutoring session offered this semester.

If you have any questions about these study guides, group tutoring sessions, private 30 minute tutoring appointments, the Baylor Tutoring YouTube channel, or any tutoring services we offer, please visit our website www.baylor.edu/tutoring or call our drop in center during open business hours (M-Th 9am-8pm on class days at 254-710-4135).

Keywords: Cell Signaling, The Cell Cycle, Meiosis

Topic of the Week: Cell Signaling

Cells are in *constant communication* with one another. We have talked about some cellular communication through **cell junctions**, but how do cells communicate with other cells that are all the way across the body? The answer is **long distance signaling**! This brings us to the discussion of the two main types of cell signaling:

Local signaling: up to a few cells distance

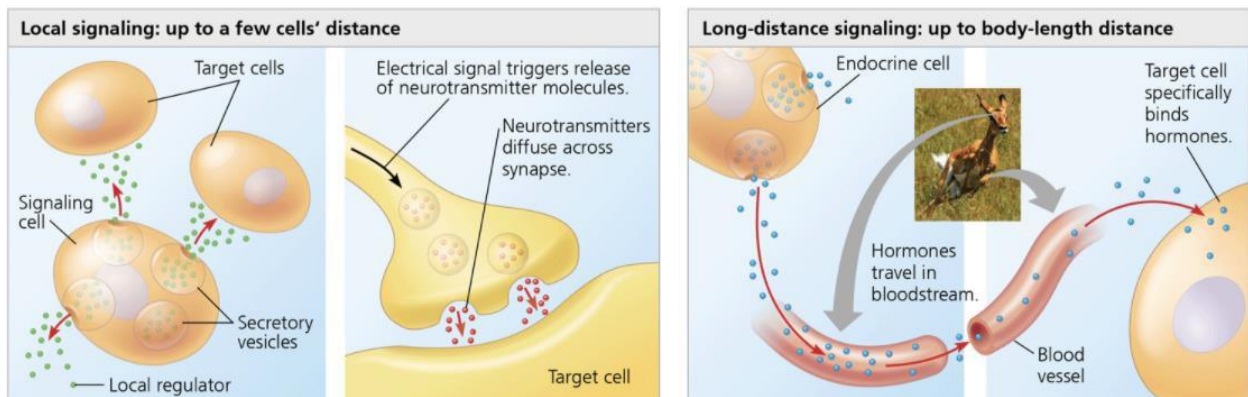
Two types:

- **Paracrine:** involves secretion of molecules such as growth factors
- **Synaptic signaling:** a neurotransmitter is released into a synapse

Long distance signaling: up to a body length distance

One type:

- **Endocrine (hormonal):** specialized cells can release **hormones** in fluids such as the blood. The hormones will travel to the target cells in this way.



There are three stages of cell signaling:

1. Signal reception

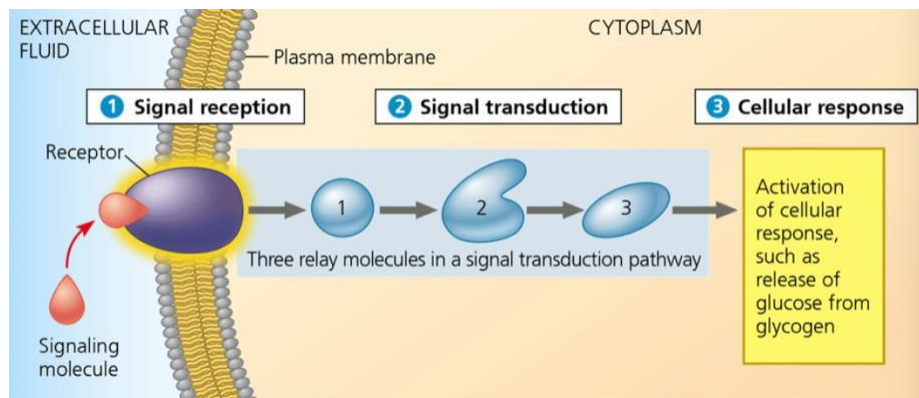
- The target cell detects a *signaling molecule* from outside of the cell
- The signal molecule binds to a *receptor protein* at the cell's surface

2. Signal transduction

- The binding of the signaling molecule causes a *conformational change* in the protein shape that starts a *chain reaction*

3. Cellular response

- A response is *triggered in the cell*. This response can be anything!



There are **several types of receptors** in the plasma membrane that are involved in cellular signaling:

- G protein-coupled receptors (GPCRs)
- Receptor tyrosine kinases
- Ligand gated ion channels

Phosphorylation and Dephosphorylation

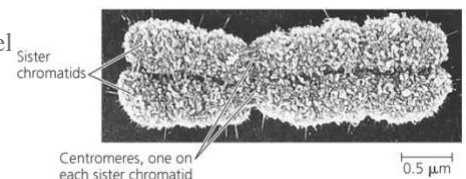
- **Protein kinase**: an enzyme that transfers phosphate groups from ATP to a protein
 - Many signal transduction pathways use these as a phosphorylation cascade
- The opposite of a protein kinase is a **protein phosphatase**, an enzyme that takes phosphate groups off of proteins

Highlight #1: The Cell Cycle Overview

Cell division is vitally important and is the reason you are who you are! Before we talk about cell division, let's talk about some *cellular features* that will play a role in the cell's life cycle.

Each one of your cells contains a copy of your **genome**, which is all of your genetic information. Your genome is packaged into *chromosomes* which have to be copied before your cells can divide. Our *somatic cells (body cells)* specifically have **46 chromosomes**, while our *gametes (reproductive cells)* have **23 chromosomes**.

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After chromosomes are copied before division, each chromosome will have two **sister chromatids** that are attached to each other.

The picture on the right shows that the sister chromatids of a single chromosome are attached at their *centromeres*.

Now we can start laying the foundation of cell division.

There are **two main phases** in a cell's division:

Mitosis: division on genetic material

Cytokinesis: division of cytoplasm

Stages of the Cell Cycle

Mitosis is part of the cell cycle, but it is actually the *shortest part* of the entire life cycle of a cell. When a cell is not dividing, it is in *interphase*, a period of growth and development. Interphase consists of several distinct phases:

G1 – growth

S – “synthesis”

G2 – more growth

As you can see, mitosis makes up only a small part of a cell's life. However, it is extremely important and consists of many stages. Your book has a very detailed picture of these steps, but for now I just listed the **main points** for each stage:

Prophase—DNA condenses, mitotic spindle begins to form

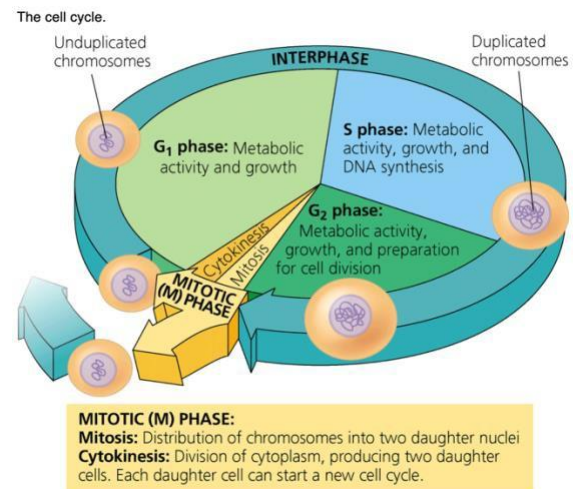
Prometaphase—nuclear envelope breaks down, kinetochore forms

Metaphase—chromosomes line up at the center

Anaphase—sister chromatids pull apart

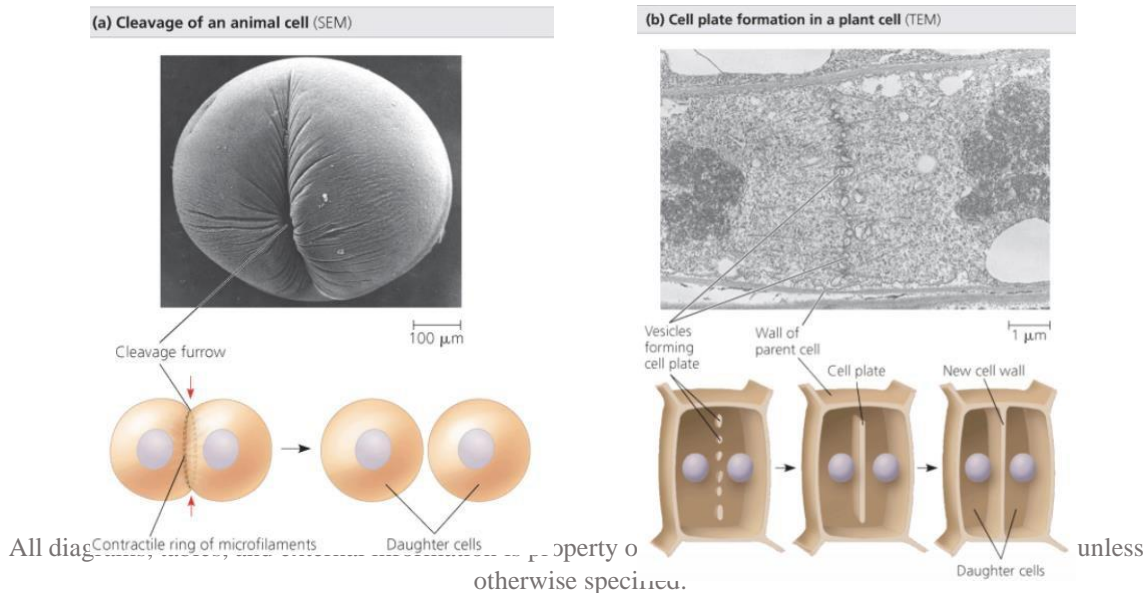
Telophase—nuclei reform, chromosomes relax

Cytokinesis—cytoplasm divides and two daughter cells are formed



Looking closer at *cytokinesis*...

When a cell enters cytokinesis, a **cleavage furrow** forms and essentially “pinches” the cell into two. Specifically in plants, a **cell plate forms** and grows until it fuses with the cell membrane.



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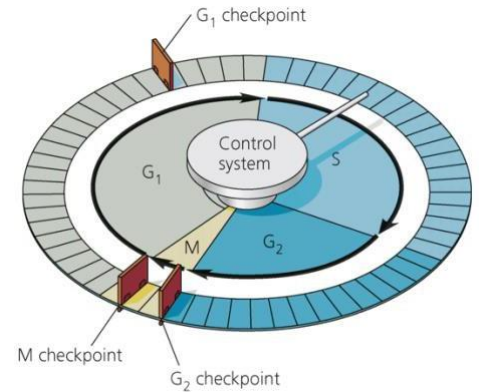
Cell Cycle Control System

So how does a cell know what to do in the cell cycle? The life of a cell is directed by a **control system** in which specific molecules activate the cycle and push the cell through it. The control center consists of several **checkpoints** that decide whether or not a cell is prepared to divide.

The molecules that regulate this control system:

Protein kinases and cyclins

The *concentrations* of these molecules within the cell determines how the cell proceeds through the cycle.



Highlight #2: Meiosis and Sexual Life Cycles

Now that we know the basics of cell division, we can start talking about **genetics**! Here are some basic terms to have down before moving forward:

Genes: hereditary units

Locus: a gene's location on the chromosome

Homologous chromosomes: a pair of chromosomes where one comes from mom and one comes from dad

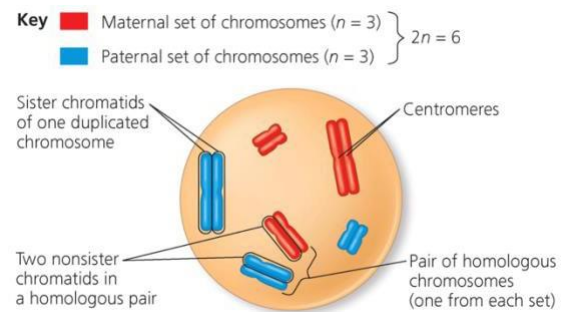
Sex chromosomes: chromosomes that determine sex

Autosomes: all other chromosomes besides sex chromosomes

Our body cells are **diploid cells**, meaning they have *two sets* of chromosomes—one from our mother and one from our father. In other words, our cells that have 46 chromosomes have 23 from our mom and 23 from our dad. This is an important concept to understand before moving on in genetics.

Haploid cells contain only *one set* of chromosomes.

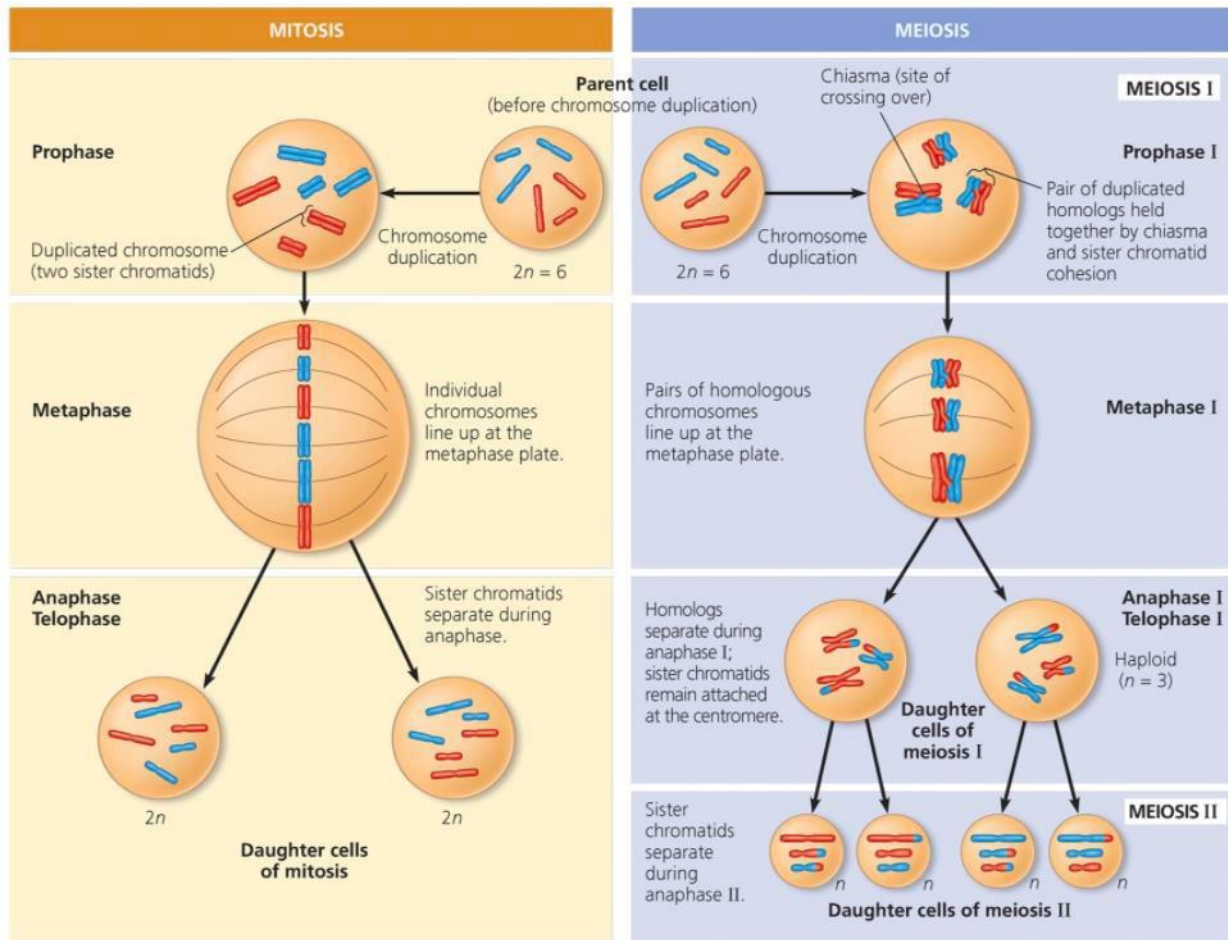
Gametes (egg and sperm cells) are haploid because when they meet at fertilization, their sets combine to make a **diploid zygote**. So, how do gametes come to have just one set of chromosomes? This happens through **meiosis**! Meiosis is very similar to mitosis in several ways, but there are some key differences:



Meiosis consists of *two cell divisions*, **meiosis I and meiosis II**. Each of these divisions contains steps prophase, metaphase, anaphase, telophase, and cytokinesis. Notice that meiosis does not have a prometaphase. Your book also has a very detailed picture of each stage of meiosis that I highly recommend you look at.

Highlight #2: Meiosis vs. Mitosis

This helpful image shows the main differences between mitosis and meiosis:



Three things occur in meiosis I that make it unique from mitosis:

- Synapsis and crossing over
- Homologous pairs align at metaphase plate
- Homologs separate

One last key thing to note about meiosis is the way that it generates *genetic variation*. There is a concept that is extremely important to understand if you plan to take a genetics class later on:

Independent assortment of chromosomes – during meiosis I, homologous chromosomes line up at the metaphase plate. Homologs arrange themselves **randomly!** In the image above, notice in metaphase I that the red and blue pairs of chromosomes do not all link up on the same side. This generates *variation* in the chromosome composition of the daughter cells at the end of the process.

CHECK YOUR LEARNING

1. What are the main differences in mitosis vs. meiosis?
2. What is the difference between a locus and a gene?

THINGS YOU MAY STRUGGLE WITH

1. Remember that meiosis has two phases! And remember that the goal is to have genetically different daughter cells.
2. Remember that sister chromatids become chromosomes during anaphase II. The number of chromosomes doubles at this point in the cycle!

Thanks for checking out these weekly resources!

Don't forget to check out our website for group tutoring times, video tutorials and lots of other resources:
www.baylor.edu/tutoring! Answers to *Check your Learning* questions are below!

Answers:

1. These things occur: Synapsis and crossing over, Homologous pairs align at metaphase plate, Homologs separate
2. Genes: hereditary units . Locus: a gene's location on the chromosome

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