

Chapter 14

Cellular Reproduction

Biology 3201

Introduction

- One of the important life functions of living things is their ability to reproduce.
- Reproduction depends on the cell.
- Cells reproduce in order to make identical copies of themselves.
- In order to understand human reproduction, we must first look at how cells reproduce.

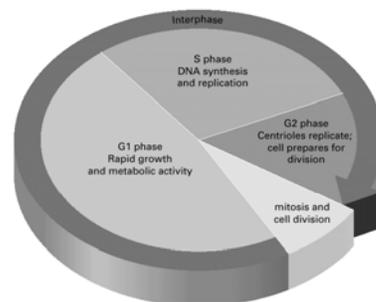
14.1

How Body Cells Reproduce

- Cells reproduce through a continuous sequence of growth and division called the cell cycle
- There are two main phases:
 1. Growth Phase
 2. Division Phase
- The growth stage, also called interphase, is a stage in which the cell produces new molecules

Interphase

- Three Parts of Interphase:
 1. G1 (gap 1)Phase
 2. S Phase
 - DNA made and copied
 3. G2 (gap 2)Phase



Division Phase

- Two Processes involved in cell division
 1. Mitosis (pronounced “my-toe-sis”)
 - Division of the nucleus (including DNA)
 2. Cytokinesis
 - Division of the cytoplasm
- Overall length of the cell cycle varies depending on the species and where it is living
 - See pg. 461 Figure 14.3

Function of Mitosis

- Cells which go through the process of mitosis divide to produce two new cells
- This allows an organism to:
 - Grow
 - Regenerate (repair) damaged tissues or body parts
 - Replace malfunctioning cells
 - Replace dead cells

Mitosis...

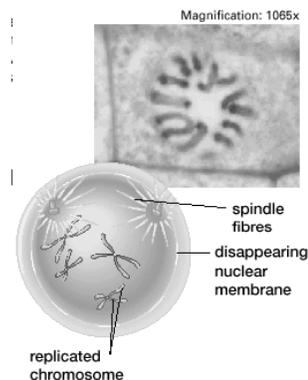
- Occurs in an organism's somatic (body) cells, not sex cells
- New cells are identical copies of the parent cell
- Maintains the number of chromosomes from cell to cell (ie. 46 in humans)
- Each parent cell divides producing two new daughter cells that are genetically identical to the parent cell

Stages of Mitosis

- Mitosis is divided into four phases:
 1. Prophase
 2. Metaphase
 3. Anaphase
 4. Telophase
 - Upon completion of mitosis the daughter cells enter interphase before the cycle repeats itself
- Each of these phases is unique and is characterized by a particular arrangement of the chromosomes within the cell and by the appearance and disappearance of certain cell structures.

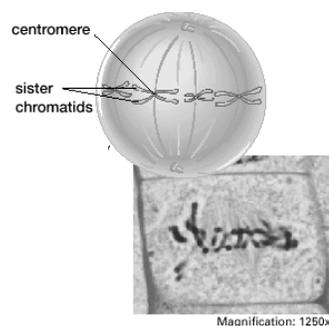
1. Prophase

- In this phase, chromatin in the cell's nucleus forms thick, condensed structures called chromosomes.
- A chromosome is made up of two sister chromatids which are held together by a structure called a centromere
- Each sister chromatid contains an identical copy of the genetic information or DNA.
- Other events which occur during this stage are:
 1. The nuclear membrane and the nucleolus disappear.
 2. The centrioles migrate to opposite poles of the cell.
 3. Spindle fibers start to form from each centriole.
- The cell is now ready to enter the second stage of mitosis called metaphase.



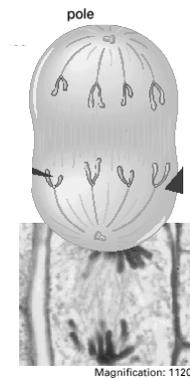
2. Metaphase

- The spindle fibers attach to the centromere of the chromosomes and pull the chromosomes to the center or equator of the cell.
- Spindle fibers from each cell pole then attach to the sister chromatids.
- The cell is now ready to enter the third stage of mitosis called anaphase.



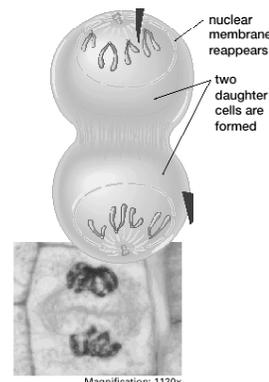
3. Anaphase

- In this stage the centromere splits apart and the sister chromatids are pulled to opposite poles of the cell by the spindle fibers.
- The cell is now ready to enter the fourth stage of mitosis called telophase.



4. Telophase

- This is the last phase of mitosis.
- The chromatids reach the opposite poles of the cell.
- The chromatids, now called chromosomes, begin to unwind and form into chromatin again.
- The spindle fibers break down and disappear.
- The nucleolus reappears.
- A nuclear membrane forms around the chromatin.
- The cell is now ready to divide into two new cells, a process called cytokinesis.



Cytokinesis

- Once the cell has completed the four stages of mitosis, the cell now separates its cytoplasm and forms two new daughter cells.
- After cytokinesis is completed, two new daughter are formed which are identical to the parent cell.
- At this point cell division is complete.

Mitosis Lab

- Read Page 466 – 467 for next class
- Complete the entire lab activity
 - Pre-lab, Prediction
 - Complete procedure (in your lab write-up make page references only)
 - Post Lab, Conclude and Apply,
 - Exploring Further (# 5 only)
- Lab should be type-written, diagrams should be on plain white paper
- DUE DATE: TBA

Mutations Affecting Cell Division

- A mutation is a permanent change to the DNA which makes up a gene. This causes the gene to either function improperly or not at all.
- There are a number of causes of mutation:
 - Chemical compounds
 - Radiation
 - Viruses
 - Mistakes during DNA replication
- Once a mutation occurs in a cell any division of this cell will pass the mutation on to the newly formed daughter cells.
- Most mutations in somatic cells are not serious because the mutated cell can easily be replaced by a new normal cell.
- If a mutation occurs in a gene which controls cell division the cell may divide rapidly and uncontrollably. This will produce a mass of cells which create a tumor or cancer.
- Genes which cause cancer when they become mutated are called oncogenes.

Radiation Therapy & Chemotherapy

- Radiation therapy involves using beams of radiation such as X-rays or gamma rays to treat the affected part of the body.
- This damages the chromosomes of the cancerous cell, this makes it unable to grow or divide.
- Although some healthy tissue is damaged along with the cancerous tissue, the healthy tissue is usually able to heal itself.
- This form is used to treat tumors of the skin, breast, larynx and cervix.
- Chemotherapy involves the use of chemicals or drugs to treat the cancerous tissue.
- It can be used with radiation therapy or on its own.
- This type of therapy is used to treat cancers which spread through the entire body such as leukemia

Side Effects of Cancer Treatments

- These treatments have several side effects:
 - Skin inflammation
 - Fatigue
 - Hair loss
 - Sterility
 - Nausea
 - Diarrhea
- Although there are side effects, many people will still undergo treatment since if they are not treated they are at greater risk of dying from the cancer itself.
- The ultimate goal of cancer research is to find a treatment which affects the cancer cells, but leaves the healthy tissue unharmed.

14.2 How Reproductive cells are Produced The Function of Meiosis (“my-oh-sis”)

- Meiosis is a special type of cell division which occurs in reproductive organs.
- Meiosis produces the sex cells which are called gametes.
 - In males the gametes are sperm cells
 - In females the gametes are the egg cells.
- Gamete cells are called haploid cells.
 - This means that they contain only half the number of chromosomes as a normal body cell.
 - Haploid cells are represented by the letter n.
- Somatic cells are called diploid cells.
 - This means they contain the normal number of chromosomes.
 - Diploid cells are represented by 2n.
- A normal body cell in humans contains 46 chromosomes. A sperm or an egg will contain only 23 chromosomes.
- Meiosis is referred to as reduction - division.
 - The first part of meiosis reduces the chromosome number from diploid to haploid so that the gametes which are produced will only contain 23 chromosomes.
 - Of these 23, 22 are autosomes (body chromosomes) and one is a sex chromosome (X or Y). A female has two X chromosomes (XX) and a male has an X and a Y chromosome (XY).

Phases of Meiosis

- The phases of meiosis are very similar to the phases of mitosis. However, meiosis involves two sequences of phases.

- The sequence of phases for meiosis
 - Interphase
 - Prophase I, Metaphase I, Anaphase I, Telophase I
 - Prophase II, Metaphase II, Anaphase II, Telophase II

Interphase

- The chromosomes replicate during this phase.

- Each chromosome is made up of two sister chromatids joined at the center by a centromere.



Quick Terminology Reminder

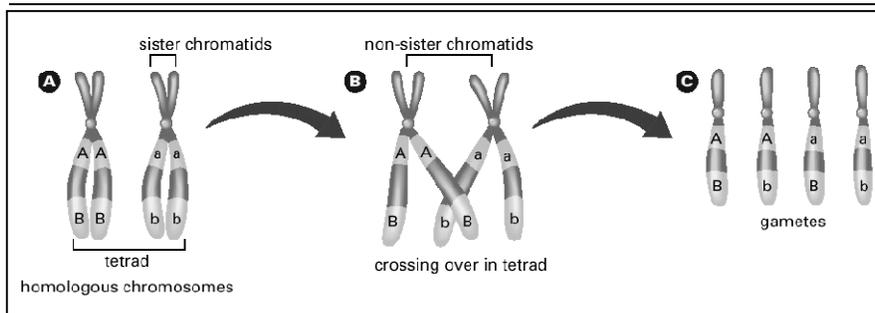
- Chromatin
 - DNA in its typical uncondensed form during interphase
- Chromatids
 - Chromatin condenses forming chromatids
- Chromosomes
 - Two sister chromatids held together by a centromere

Prophase I

- Pairs of chromosomes group together.
 - The pairs are called homologous chromosomes.
- Two pairs group together and we call this a tetrad.
 - A tetrad is a group of four chromosomes.
- Crossing over may occur, where chromosomes exchange genetic information



Crossing Over

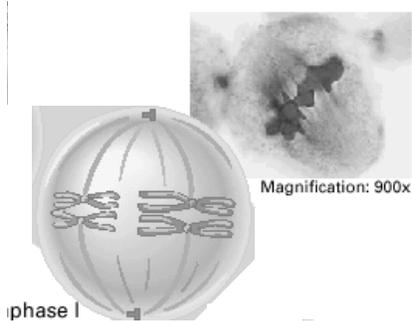


Homologous chromosomes.

Crossing over and the exchange of genetic information between homologous chromosomes.

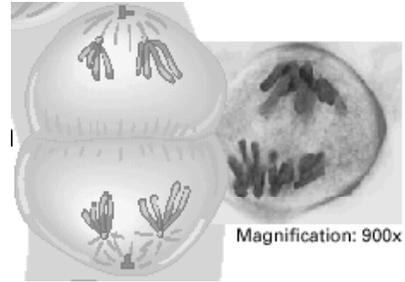
Metaphase I

- The tetrads line up across the equator of the cell.
- Spindle fibers attach to the centromere of each pair of chromosomes.



Anaphase I

- Pairs of homologous chromosomes are pulled to opposite poles of the cell by the spindle fibers.



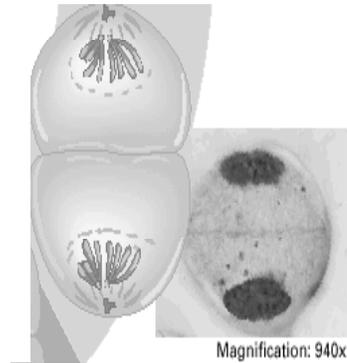
Some Meiosis Humour

GENE THERAPY



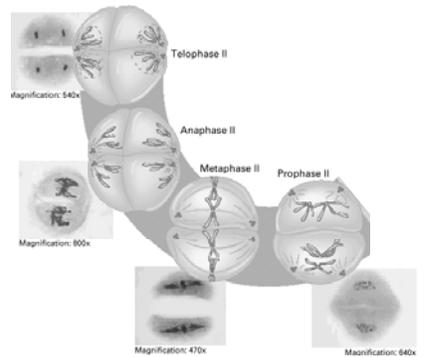
Telophase I

- Telophase I does not occur in all cells.
- If telophase I does not occur, the cell moves into the second part of meiosis which we call meiosis II.
- If telophase I does occur the following events take place:
 1. Chromosomes uncoil to form chromatin.
 2. Spindle fibers disappear.
 3. The cytoplasm divides.
 4. The nuclear membrane forms around each group of chromosomes and two cells are formed.



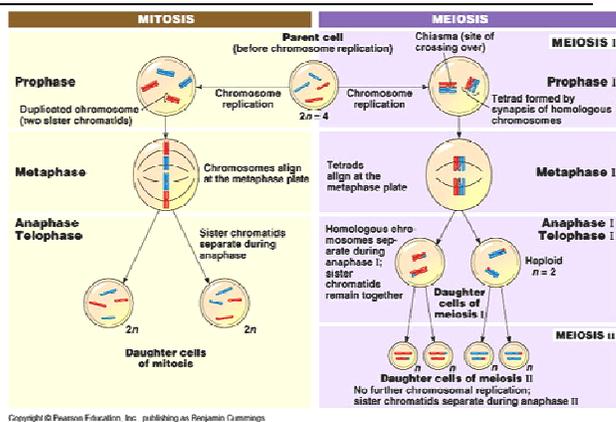
Meiosis II

- The stages of meiosis II are identical to mitosis
- At the end of meiosis II, four cells are produced. These four daughter cells will develop into gametes in animals and either gametes or spores in plants.
- See Fig. 14.14 on pg 472



Meiosis vs. Mitosis

- Figure 14.17 is a summary of the major events involved in both meiosis and mitosis.
- The final product of mitosis is two daughter cells which are genetically identical to the parent cell.
- The final product of meiosis is four daughter cells which are genetically unique or different from the parent cell.



Gamete formation

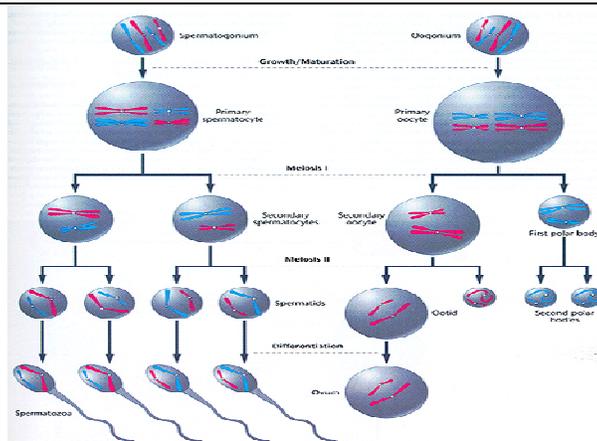
- The purpose of meiosis is to produce gametes or sex cells
- The production of gametes by meiosis is called gametogenesis
 - gameto = sex cell
 - genesis = creation
- In males, the gamete sperm is produced and this is called spermatogenesis
 - spermato = sperm
 - genesis = creation
- In females, the gamete egg is produced and this is called oogenesis
 - oo = eggs (or oocyte)
 - genesis = creation

Spermatogenesis vs. Oogenesis

- In males, meiosis occurs in the male reproductive organ called the testes.
- The process starts with a diploid cell called the spermatogonium.
- The spermatogonium goes through the stages of meiosis I and meiosis II and the final product is four haploid sperm cells.
- Each sperm contains two parts:
 - a head and tail.
- Some species produce sperm continually (humans) while other species only produce sperm during breeding season (migratory birds).
- In females, meiosis occurs in the female reproductive organs called the ovaries.
- The process starts with a diploid cell called the oogonium.
- The oogonium goes through the stages of meiosis I and meiosis II and the final product is four haploid cells, but only one cell survives. We call this cell the ovum or egg.
- The production of eggs or ova in human females continues from the start of puberty until menopause which will occur between the ages of 40 and 50.
- There are a number of differences between the sperm and eggs which are produced by meiosis.

See Table 14.2, P. 478

Gametogenesis



Cell Division Technologies

Animal Cloning

- In animal cloning, an egg from a surrogate mother is used. The nucleus of the egg is removed and a diploid nucleus from a somatic cell of an animal is placed in the empty egg cell. The new egg cell is then implanted inside the surrogate mother's uterus. The cell will divide and develop into an embryo which will produce an animal that is an exact copy of the animal which donated the somatic cell nucleus

Stem Cell Research

- Stem cell research involves the use of specialized cells called stem cells which are taken from a week old embryo and are used to grow other types of cells in adults

Stem Cell Research STSE Reading

- Read the STSE reading assignment
- Answer the following questions
 - Understanding Concepts: 1 – 8
 - Extensions:
 - Choose ONE (1) topic from the list to research
 - Write one page answering the questions in the topic
 - List your sources (Website name and address)
- DUE DATE: TBA

Chapter 14 Test

- NO TEST ON CHAPTER 14

- End-of-Chapter Assignment
 - Page 481
 - Questions: 1 – 14, 21 – 24

- Be short and concise with your answers