**Study Guide Chapter 3 Part 1**

**Reproduction and Chromosome Transmission**

***Key Terms***

Actin- the most abundant protein in most eukaryotic cells- forms microfilaments needed in mitosis and meiosis

Anaphase- the fourth stage of M phase, as anaphase proceeds, half of the chromosomes move to one pole, and the other half move to the other pole

Asexual reproduction- a form of reproduction that does not involve the union of gametes; at the cellular level, a preexisting cell divides to produce two new cells

Autosomes- chromosomes that are not sex chromosomes

Binary fission- the physical process whereby a bacterial cell divides into two daughter cells. During this event, the two daughter cells become divided by the formation of a septum.

Bivalents- A structure in which two pairs of homologous sister chromatids have synapsed (i.e. aligned) with each other.

Cell cycle- in eukaryotic cells, a series of stages through which a cell progresses in order to divide. The phases are G for growth, S for synthesis (of the genetic material), and M for mitosis. There are two G phases- G1 and G2.

Cell plate- The structure that forms between two daughter plant cells that leads to the separation of the cells by the formation of an intervening cell wall.

Chiasma (chiasmata)- the site where crossing over occurs between two chromosomes. It resembles the Greek letter chi, X.

Chromatids- following chromosomal replication in eukaryotes, the two copies that remain attached to each other in the form of sister chromatids.

Sister chromatids

Chromatin- The association between DNA and proteins that is found within chromosomes

Chromosome theory of inheritance- a theory of Sutton and Boveri that the inheritance patterns of traits can be explained by the transmission patterns of chromosomes during gametogenesis and fertilization

Chromosomes- the structures within living cells that contain the genetic material. Genes are physically located within the structure of chromosomes. Biochemically, chromosomes contain a very long segment of DNA, which is the genetic material, and proteins, which are bound to the DNA and provide it with an organized structure.

Cleavage furrow- a constriction that causes the division of two animal cells during cytokinesis.

Condense- refers to chromosomes forming a more compact structure

Crossing over- a physical exchange of chromosome pieces that most commonly occurs during prophase of meiosis I.

Cytogenetics – field of genetics that involves the microscopic examination of chromosomes

Cytokinesis- the division of a single cell into two cells. The two nuclei produced in M phase are segregated into separate daughter cells during cytokinesis

Diakinesis- the fifth stage of prophase of meiosis I

Diploid- an organism or cell that contains two copies of each type of chromosome

Diplotene- the fourth stage of prophase of meiosis I

Eukaryotes- one of three domains of life. Their cells contain nuclei bounded by cell membranes; some are single-celled protists and yeast; more complex multicellular species include fungi, plants, and animals

Gametes- a reproductive cell (usually haploid) that can unite with another reproductive cell to create a zygote. Sperm and egg cells are types of cametes

Germ cells- the gametes- spern and egg cells

Haploid- describes the phenomenon that gametes contain half the genetic material found in somatic cells. For a species that is diploid, a haploid gamete contains a single set of chromosomes.

Homologs- one of the chromosomes in a pair of homologous chromosomes

Karyotype- a photographic representation of all the chromosomes within a cell; it reveals how many chromosomes are found within an actively dividing somatic cell

Interphase- the series of phases G1, S, and G2 during which a eukaryotic cell spends most of its life

Leptotene- the first stage of prophase of meiosis I.

Locus (loci)- the physical location of a gene within a chromosome

Meiosis- a form of nuclear division in which the sorting process results in the production of haploid cells from a diploid cell

Metaphase- the third stage of M phase. The chromosomes align along the center of the spindle apparatus, and the formation of the spindle apparatus is complete.

Metaphase plate- the plane at which chromosomes align during metaphase.

Microtubule-organizing centers- I site in a cell where microtubules begin to grow

Mitosis- a type of nuclear division into two nuclei, such that each daughter cell receives the same complement of chromosomes

Mitotic spindle (apparatus)- the structure that organizes and separates the chromosomes during M phase of the eukaryotic cell cycle.

Nucleus- a membrane-bound organelle in eukaryotic cells where the linear sets of chromosomes are found.

Oogenesis- the production of egg cells

Organelles- large specialized structures within a cell that are often surrounded by a single or double membrane.

Pachytene- the third stage of prophase of meiosis I

Prometaphase- the second phase of M phase. During this phase, the nuclear membrane vesiculates, and the mitotic spindle is completely formed

Prophase- the first stage of M phase; the chromosomes have already replicated and begin to condense; the mitotic spindle starts to form

Prokaryotes- another name for bacteria and archaea. The term refers to the fact that their chromosomes are not contained within a separate nucleus of the cell

Somatic cell- any cell of the body except for germ-line cells that give rise to gametes

Spindle pole- during cell division in eukaryotes, one of two sites in the cell where microtubules originate

Synapsis- the event in which homologous chromosomes recognize each other and then align themselves along their entire lengths

Synaptonemal complex- a complex of proteins that promote the interconnection between homologous chromosomes during meiosis

Telophase- the fifth stage of M phase, the chromosomes have reached their respective poles and decondense

Testcross- an experimental cross between a recessive individual and an individual whose genotype the experimenter wishes to determine

Tetrad- the association among four sister chromatids during meiosis

X-linked alleles (genes)- genes or alleles that are physically located within the X chromosome

X-linked inheritance- an inheritance pattern in certain species that involves genes that are located only on the X chromosome

Zygotene- the second stage of prophase of meiosis I

***Chapter Outline***

*3.1 General Features of Chromosomes*

1. Define the term chromosome: a chromosome is the structure within living cells that contain the genetic material. Genes are physically located within the structure of chromosomes. Biochemically, chromosomes contain a very long segment of DNA, which is the genetic material, and proteins, which are bound to the DNA and provide it with an organized structure.

2. Outline key differences between prokaryotic and eukaryotic cells.

Prokaryotic: no membrane bound nucleus or organelles, usually simpler organisms; single celled organisms

Eukaryotic: membrane bound nucleus and organelles; usually more complicated multicellular organisms.

3. Compare and contrast the similarities and differences between homologous chromosomes.

Homologous chromosomes have the same genes but have a variety of alleles to express the genotype. Both have the gene for color, but they might express it differently.

*3.2 Cellular Division*

1. Describe the process of binary fission in bacteria.

Follows DNA replication; 2 daughter cells become separate by the formation of a septum. Each cell receives a copy of the chromosomal genetic material; the daughter cells are usually genetically identical because they contain exact copies of the genetic material from the mother cell.

2. List and outline the phases of the eukaryotic cell cycle.

The division produces two daughter cell that have the same number and types of chromosomes as the original mother cell. G1, G2, and S are known as interphase. Cells may remain in G0 (just before S) for long periods of time or forever (not progressing through the cell cycle); G1 -> S -> G2

G: Gap:

G1: A cell may prepare to divide; may accumulate molecular change that cause it to progress through the rest of the cell cycle (**restriction point**- when reached the cell is committed on a pathway that leads to replication)

G2: The cell accumulates the materials necessary for nuclear and cell division; then progresses into the M phase.

S: Synthesis: Chromosomes are replicated (after replication the two copies are called **chromatids**- joined at the **centromere**); when completed a cell has twice as many chromatids as chromosomes in the G1 phase

M: Mitosis: When mitosis occurs; the primary purose of mitosis is to distribute the replicated chromosomes

1.Asexual reproduction involves the division of a preexisting cell to form two new cells. This process is common in bacteria and some eukaryotic species (yeast, amoeba)

2. This type of cell division is necessary for the formation of multicellular organisms from fertilized egg.

Eukaryotic Cells Progress Through a Cell Cycle to Produce Genetically Identical Daughter Cells

1. Eukaryotic cells undergo a cell cycle (Figure 3.5) that consists of several   
distinct phases.

a. G1 (gap phase), S phase, G2 (gap phase) and M (mitosis).

b. G1, G2, and S phases are collectively called interphase.

c. Some cells remain in G0 phase (just prior to S phase) for extended periods of time, thus arresting cell division.

2. Understand what is happening in each phase and structures involved

*3.3 Mitosis and Cytokinesis*

1. Describe the structure and function of the mitotic spindle.

The mitotic spindle is involved in the organization and sorting of chromosomes during mitosis. It is formed from microtubule-organizing centers which are structures found in eukaryotic cells from which microtubules grow. Formed from two MTOC’s called centrosomes located at spindle poles. A pair of centrioles at right angles to each other is found within each centrosome of animal cells.

Aster microtubules: emanate outward from the centrosome toward the plasma membrane- positioning of the spindle apparatus within the cell and later in the process of cell division

Polar microtubules: project toward the region where the chromosomes will be found during mitosis- the region between the two spindle poles. Polar tubules that overlap play a role in the separation of the two poles.

Kinetochore microtubules: have attachments to a kinetochore.

Allows cells to organize and separate chromosomes so each daughter cell receives the same complement of chromosomes.

2. List and describe the phases of mitosis.

Prophase: The chromosomes have already replicated joined as sister chromatids. The nuclear membrane begins to dissociate and the nucleolus becomes less visible. Chromatids become condensed into more compact structures that are readily visible by light microscopy. 2 centrosomes move apart and the mitotic spindle begins to form.

Prometaphase: The centrosomes move to opposite ends of the cell and demarcate 2 spindle poles. The nuclear membrane is completely disrupted. Microtubules “happen” to make contact with a kinetochore and become attached. The kinetochore on a pair of sister chromatids is attached to kinetochore microtubules from opposite poles; sister chromatids are seen to undergo jerky movements as they are tugged back and forth. Mitotic spindle is completely formed.

Metaphase: The pairs of sister chromatids align themselves along a plane called the metaphase plate. Each pair of chromatids is attached to both poles by kinetochore microtubules; Organized into a single row along the metaphase plate.

Anaphase: The connected that is responsible for holding the pairs of chromatids together is broken. The chromosomes move toward the pole to which they are attached- the kinetochore microtubules shorten. The poles move farther apart due to elongation of polar microtubules.

Telophase: The chromosomes reach their respective poles and decondense. Nuclear membrane re-forms to produce 2 separate nuclei.

Cytokinesis: Two nuclei and all organelles are segregated into two separate daughter cells. A contractile ring assemples at the cytoplasmic surface; the ring shorts constricting the plasma membrane to form a **cleavage furrow**.

*3.4 Meiosis*

1. List and describe the phases of meiosis.

Meiosis I:

Prophase I:

Lepotene: The replicated chromosomes begin to condense and become visible with a microscobe

Zygotene: Involves a recognition process known as synapsis

**Synapsis**: the homologous chromosomes recognize each other and begin to align themselves; this involves the formation of a **synaptonemal complex** that forms between the homologous chromosomes

Pachytene: The homologs have become completely aligned; associated chromatids are known as **bivalents** (contains two pairs of sister chromatids, also known as a **tetrad**- composed of four chromatids (monads)); **crossing over** occurs- a physical exchange of chromosome pieces

The connection that results from crossing over is a **chiasmata**.

Diplotene: The synaptonemal complex has largely disappeared; bivalent pulls apart slowly

Diakinesis: the synaptonemal complex completely disappears

Prometaphase I: The pindle apparatus is complete and the chromatids are attached via kintechores.

Metaphase I: The bivalents are organized along the metaphase plate; one pair of sister chromatids is linked to one of the poles, and the homologous pair is linked to the opposite pole

Anaphase I: The two pairs of sister chromatids within a bivalent separate from each other; the connection that holds sister chromatids together does not break. Each joined pair of chromatids migrates to one pole and the homologous pair of chromatids moves to the opposite pole.

Telophase I: The sister chromatids have reached their respectivepoles; decondensation occurs in most species. Nuclear membrane reforms to produce two separate nuclei. End result is two cells with less chromatids; a reduction division. The original diploid cell had its chromosomes in homologous pairs, but the two cells produced at the end of meiosis I are considered to be haploid.

Meiosis II: Similar to mitosis; just different numbers

Outcome of meiosis is 4 daughter cells genetically varying from the mother cells

2. Compare and contrast the key differences between mitosis and meiosis.

Like mitosis, meiosis begins after a cell has progressed through the G1, S, and G2 phases of the cell cycle. 2 successive divisions rather than 1. The chromosomes are replicated in S phase to produce pairs of sister chromatids.

Look at table in book

Other:

Chromosome: the structure within living cells that contain the genetic material. Genes are physically located within the structure of chromosomes. Biochemically, chromosomes contain a very long segment of DNA, which is the genetic material, and proteins, which are bound to the DNA and provide it with an organized structure.

Chromatids: after replication, two copies of the chromosomes are called chromatids

Centromere: a section of DNA where the chromatids are joined

Sister chromatids (dyad): the joined chromatids (the pair)

Monad: A single chromatid within a dyad; or an unreplicated chromosome

Kinetochore: a group of proteins that are bound to the centromere to help hold the sister chromatids together and play a role in chromosome sorting

DRAW OUT MITOSIS AND MEIOSIS