Life Science
Chapter 6

Cell Division

6A Genes and Cell Division

genetics: the study of heredity

gene: contain the cell's blueprints (the information needed to build the cell and cell products)
a discrete particle which passes inherited characteristics on to its offspring. (a carrier of traits)
(a segment of DNA capable of producing a specific protein, which in turn produces a specific characteristic)

The genes(blueprints) of a cell are usually stored in chromosomes (file cabinets), which are kept in the nucleus (file room).

Your genes are not floating around in you.
Each DNA strand in a nucleus actually comprises many genes.
These long strands of DNA are coated with proteins and are called chromosomes.

chromosome: a strand of DNA with attached proteins; usually found in the nucleus of cells.

"Some people find it hard to believe that the genes are capable of carrying enough information to produce all the physical traits you possess. Your DNA is tightly compressed. The entire DNA from all your cells would fit into a one-inch cube. If the entire DNA in one human cell were uncoiled and stretched out, it could form a thin string about 2 yards long. It has been estimated that the information found in the DNA of 1 human cell is equal to the information in 1,000 books containing 600 pages each. The nucleus of each of your cells is a good-sized chemical library."

The number of chromosomes in a cell is a species characteristic
human 46 fruit fly 8 goldfish 100 crayfish 200

The number of chromosomes does not determine the species.
It is the genes on the chromosomes that make the organism.

----------Quiz 6A

Cell Division

Parent cell: a cell that is ready to begin mitosis

cell division: (sometimes called binary fission) when 1 cell (parent cell) divides to produce 2 new cells (daughter cells).

The Cell Cycle
(the regular sequence of growth and division that cells undergo)

1. **interphase**: the phase of a cell's life cycle before cell division; genes are copied during this period

2. **mitosis**: the equal distribution of the parent cell's genes between the 2 new daughter cells.
3. **cytokinesis**: the division of the parent cell's cytoplasm after mitosis is finished (provides each daughter cell with cytoplasm and organelles)
   The final stage of cell division.
   Starts at about the same time as telophase.

Cell division varies in different types of cells. Some differences between plant and animal cell division are:

- takes longer in an animal cell than a plant cell
  a human liver cell takes about 22 hours
  an onion root tip cell takes 12 hours
  some bean plant cells take 19 hours
- plant cells don't have centrioles
- cytokinesis is different in plant cells – forms a division plate rather than pinching in.

Interphase - the period of time between cellular divisions (not actually a phase of mitosis)

It is important that genes duplicate (make a copy of every one of its genes) before cell division. This stage of a cell's life is called interphase. This gives each new cell a complete set of genes. The new cell will then use the information from these genes to build its own structures.

toward the end of interphase: cells duplicate all the genes and it produces 2 identical chromosomes called **sister chromatids**

After the sister chromatids are formed, the cell is ready to go through the following phases of mitosis.

Why is it important for a cell to copy its hereditary information before dividing?

PHASES OF MITOSIS

I. **Prophase** - first phase of mitosis

- nuclear membrane disappears
- chromosomes (sister chromatids) begin to coil (getting shorter and thicker)
- often appear as a fat X
- the sister chromatids are still attached by a **centromere**
- nucleolus disappears
- spindle fibers form

II. **Metaphase** - all chromosomes are lined up at the center of the spindle (the period of time when the centromeres are on the equatorial plane)

III. **Anaphase** –

- each pair of sister chromatids separates into 2 chromosomes [called **daughter chromosomes** - separated sister chromatids)]
- the daughter chromosomes move along the spindle fibers to opposite ends of the cell
- the X-shaped chromosome separates into 2 L-shaped chromosomes

IV. **Telophase** –

- it begins when the daughter chromosomes reach the end of the spindle
- nucleus begins to form
- daughter chromosomes begin to uncoil
- nucleoli reappear
- spindles disappear

The 2 cells which result from mitotic division followed by cytokinesis are called **daughter cells**.

Daughter cells are actually cells entering interphase.

* they have exactly the same genes as the mother cell.

The purpose of mitotic cell division is to insure that each new daughter cell has genes identical to those in the parent cell.

What would happen if mitosis failed to occur before cytokinesis?

----------Quiz 6B

ASEXUAL REPRODUCTION: a result of mitosis

asexual reproduction - reproduction that takes place by mitotic cell divisions (the production of a new organism without the joining of gametes)
asexual reproduction provides very little genetic variety.

FORMS OF ASEXUAL REPRODUCTION:

1. **fission** - the division of cells into 2 approximately equal parts (example: ameba)
2. **fragmentation** - a form of reproduction caused by the breaking of a colonial organism by a physical disturbance (fungus- Spirogyra)
3. **budding** - a type of asexual reproduction in which portions separate from the parent to form a new individual (yeast; sponges)
4. **regeneration** - the ability to replace missing structure; in some organisms, serves as a method of reproduction (planarian, hydra, starfish)
5. **spore** - a cell with a hard protective covering (mold, moss, fungus)
   - the protects from unfavorable conditions (cold, dry)
   - some are carried by wind
   - some have a whip-like structure to swim through water
   - a single spore develops into a new organism

SEXUAL REPRODUCTION

sexual reproduction - the joining of haploid gametes to form a diploid zygote, which develops into a new individual
- each offspring receives genes from both its parents - genetic variety
- most organisms have 2 genes for every trait
- genes are parts of chromosomes
- most genes come in pairs

Normal human cells have	23 pairs of chromosomes	(46)
honeybee	16 pairs	(32)
crayfish	100 pairs	(100)
rabbit	22 pairs	(44)
watermelon	11 pairs	(22)
corn	10 pairs	(20)

Diploid - having 1 pair of each type of chromosome in an organism (2n) (having 2 of every kind of chromosome)

MEIOSIS, GAMETES, AND FERTILIZATION

Meiosis - the process whereby 1 diploid cell form haploid cells (gametes)
(a dividing process during which the # of chromosomes is cut by 1/2 in each resulting cell - reduction division)

Haploid – having only one of each type of chromosome; a cell that has only 1 chromosome of every pair
(n)

Gamete - a haploid cell that contains only 1 of each type of chromosome found in an organism (a reproductive cell)

In order to form a haploid cell (gamete)- meiosis occurs.
In most organisms meiosis produces 1 of 2 types of gametes:

(1) **Ova** (singular-ovum) - female gametes
usually larger than the male gamete and does not have the power to move itself

(2) **Sperm** - male gametes
usually smaller than ova, but they have some means of moving themselves

Fertilization - the formation of a zygote from the union of 2 gametes

Zygote - a diploid cell formed by the union of 2 gametes

----------Quiz 6C

6B How Genes Function

Read page 84

Four main points:

- Nucleotides (symbols in the language) are arranged into codons (letters)
- Codons (letters in the language are arranged into genes (words)
- Genes (words in the language) are the instructions for making proteins
- During reproduction a complete copy is made of all genes and is given to each new organism

An organism's ability to manufacture proteins enables it to carry on its life processes.

Since what a cell can or cannot do depends upon enzymes, cells are controlled by enzymes, which are proteins.

protein - a substance made of long chains of amino acids

enzymes - the organic catalysts that control chemical reactions in living things

20 different **amino acids** ("building blocks" of proteins)
variation in the arrangement and number of amino acids make up different proteins

DNA is Coded Messages

DNA - Deoxyribonucleic acid

1952 Rosalind Franklin used an X-ray method to photograph DNA molecules

1953 James d. Watson and Francis H.C. Crick - model for the structure of DNA

looks like a twisted ladder
DNA - made up of nucleotides (4 different kinds of nucleotides)
nucleotide - the basic structured unit of DNA and RNA

nucleotides include:
1) sugar - deoxyribose (form sides of the ladder)
2) phosphate
3) base: adenine, thymine, guanine, cytosine (form the rungs (each rung is made of 2 bases))

A-T C-G

genes are sections of DNA (there are several hundred to several thousand genes on a single chromosome)
replication - the process of forming 2 DNA molecules from 1 original DNA molecule

RNA Helps to Decode the Messages

When a cell needs a certain protein, the DNA code (gene) for that protein makes RNA.

RNA- ribonucleic acid

How does RNA differ from DNA?
1) RNA has a single chain of nucleotides
2) base thymine is replaced by Uracil

transcription- the process of forming messenger RNA from DNA

Protein Synthesis

takes place in the ribosome

protein synthesis- the manufacturing of protein inside a cell
messenger RNA (m-RNA): the RNA molecule that transports a coded message from the nucleus to the cytoplasm.
transfer RNA (t-RNA): the RNA molecule that transfers amino acids to the messenger RNA
ribosomal RNA (r-RNA): decodes messenger RNA

----------Quiz 6D