Introduction to the Cell Cycle

Learning Objectives

1. Differentiate between asexual and sexual reproduction in terms of the genetic information passed on to offspring, the mechanisms employed by different organisms, and the adaptive advantage(s) of having one or both types of reproduction.
2. Compare the general structure of prokaryotic and eukaryotic chromosomes.
3. Compare the structure of a sister chromatid in a duplicated chromosome, and the same chromosome before duplication. Explain why sister chromatids appear just prior to cell division.
4. Describe the significant events that take place during each phase of a somatic cell life cycle (including interphase).
5. Describe the significant events that take place in the production of gametes via meiosis.
6. Be able to differentiate between corresponding phases in meiosis I and meiosis II.
7. Explain how cytokinesis is different for animal cells and plant cells.
8. Explain why there are different mechanisms of cell division for somatic cells vs. sex cells.
9. Describe the significance of tetrad formation during meiosis, related to the genetic make-up of the daughter cells.
10. List and describe the factors that influence the rate of cell division.
11. List and describe the mechanisms which increase genetic diversity in a population, related to sexual reproduction.

DNA

- DNA is the genetic material in all organisms
- The units of genetic information are genes
- A cell’s DNA controls which ________ are made, and in this way controls most of the cell’s activity
- The structure of DNA molecules enables exact copies to be made

How is the function of the cell in the center different from the other cells in this picture?
Evidence for DNA as the Genetic Material

Bacterial Transformation: The Griffith Experiment

Evidence from Bacteriophages “Bacteria eaters”

- How have bacteriophages been utilized as an alternative to antibiotics?
- Similarly, how are bacteriophages being used to control food-borne illness?
  (Look up LISTEX)

Structure of DNA

- How can a molecule that has only 4 “words” convey instructions for making the wide variety of proteins?
- Adenine, Guanine, Thymine, Cytosine
- Why is e.g. the amount of A always the same as the amount of T, in all species?
  A=T and G=C

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DNA Replication

DNA Structure Helps Explain How It Duplicates

- DNA is two nucleotide strands held together by hydrogen bonds
- Hydrogen bonds between two strands are easily broken
- Each single strand then serves as template for new strand

Where do the nucleotides to build new DNA come from?

Cell Reproduction

- a characteristic of all living things
- for maintenance of the species
- for growth and repair

How is binary fission similar to mitosis in eukaryotic cells?

How is it different?

Control over Cell Division

- Limits on cell size
  - transport, membrane strength, control over cytoplasm, metabolic demands
- Availability of nutrients and accumulation of metabolic wastes
- Growth factors or other chemical messages bound to membrane receptors
- Contact inhibition prevents cells from reproducing too rapidly in a confined space
- Cell attachment is necessary for cell division to occur

Discuss these requirements in the context of healing a cut on your hand.
Cell Division: the basics

- Two types of nuclear division
  - Mitosis
  - Meiosis

- Before cytokinesis, replicated chromosomes must be distributed precisely into two new nuclei (in daughter cells)
  - Mitosis produces two nuclei that contain the same genetic information as the original nucleus (clones)
  - Meiosis produces new nuclei with only half the number of chromosomes

Do all human cells divide at the same rate? Explain.

Human Hand

- In the adult human, the normal rate of cell division is @ 25 million per second
- @ 2.3 million blood cells/sec
- This is out of @ 75 trillion cells
- So, only @ 0.003% of all cells

Eukaryotic Chromosomes

- In the somatic (body) cells of most plants and animals, chromosomes exist in homologous pairs (diploid = 2N)
- Homologous chromosomes are similar in shape and information
  - contain the same genes, but not necessarily the same form of the genes

What is chromatin and where would you find it?
What are alternate forms of a gene called?
Cell Cycle

- 4 distinct periods

What does the cell spend most of its life doing?

Do you think DNA synthesis is an “expensive” process? Why or why not?

Mitosis is a continuous process described in 5 phases:

Mitosis Overview

- Creates an exact copy of an existing cell.

Describe this chromosome. ______ phase

What is this?

Describe this chromosome. S phase, of ______ phase

How is it similar/different now?
Mitosis: cell anatomy

p. 66, 67, 129

Differentiate between centromeres and centrioles.

Microtubules

“equator” of the cell

Nuclear envelope

Centrioles

Early Mitosis

Write down the changes you see as the cell transitions into mitosis.

How many pairs of chromosomes (of the 23 pairs in human cells) are shown?

Circle each pair of homologous chromosomes.

Late Mitosis

Write down the changes you see as the cell transitions into mitosis.

How many pairs of chromosomes (of the 23 pairs in human cells) are shown?

Circle each pair of homologous chromosomes.
Do plant and animal cells differ in how they undergo cytokinesis?

- In animals, a contractile cytoskeletal ring "pinches off" sister cells.

Does cytokinesis require the cell to expend energy (ATP)?

Plants: cytokinesis

- cell wall materials are laid down between cells forming a cell plate.

Which of these shows cytokinesis in animals?...in plants?