CELLS and the CELL CYCLE

Objectives

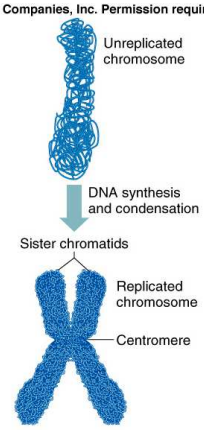
1. Describe genetic material and define its various parts.
2. Describe the stages of the cell cycle, interphase, mitosis and cytokinesis.
3. Describe how cell cycles are regulated and signal transduction.
4. Define totipotent, pluripotent, stem cell, progenitor cell.

Outline

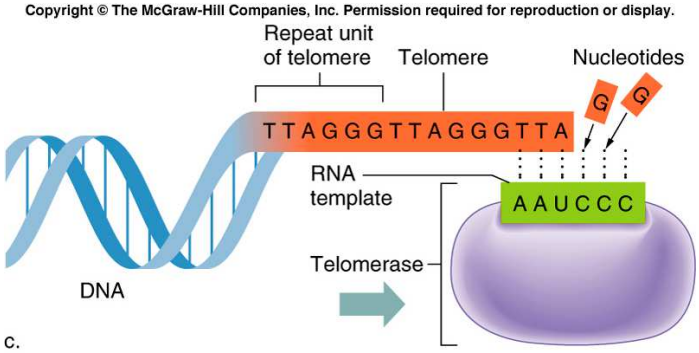
A. Genetic Material
B. Life Cycle
C. Cell Cycle
    1. Interphase
        a. G_1 – Gap 1 phase
        b. S – Synthesis phase
        c. G_2 – Gap 2 phase
    2. Mitosis (M)
        a. Prophase
        b. Metaphase
        c. Anaphase
        d. Telophase
    3. Cytokinesis
    4. Functions of Mitosis
D. Apoptosis Cycle
E. Control System
    1. Checkpoints
    2. Factors affecting Cell Cycle
    3. Signal Transduction
F. Cell Specialization
    1. Stem Cells

A. Genetic Material

- DNA
    - Complexed with protein
- Genes
    - Heritable traits
- Chromatin
- Chromosomes
- Chromatids
    - Centromere
    - Telomeres
        - Shorten during each replication
    - Telomerase



a.



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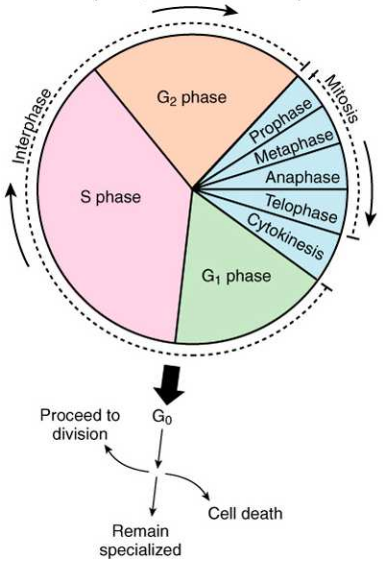
B. Life Cycle

- Sequence of life stages
- Growth
    - Apoptosis
- Reproduction

C. Cell Cycle

- Interphase
- Mitosis (M)
- Cytokinesis
    - Often coupled with mitosis



- Mother cell becomes two daughter cells
    - Exact replicas
        - Genes
        - Organelles

1. Interphase

- Metabolically active
    - Not a resting stage

- Increasing volume
- Producing materials needed for life
- Duplicating DNA

a. G_1 – Gap 1 phase

- Stage after cell division
    - Stage with most variation in length
        - Lasts minutes to months to forever
- Not committed to divide
    - Some never divide (G_0)

b. S – Synthesis phase

- DNA replicated
    - Not visible under microscope
    - Commits cell to divide
- Other materials for division produced

c. G_2 – Gap 2 phase

- Between S and M phases
- Synthesize proteins, membranes for cell division

2. Mitosis (M)

- Nuclear division
    - Produces two identical nuclei
- Short phase
- Continuous process
    - Divisions somewhat arbitrary

a. Prophase

- Chromatin condenses
    - Chromosome – two chromatids
- Nuclear membrane, nucleolus vanish
- Mitotic spindle forms
    - Made of microtubules
    - Anchored at ends by centrioles

b. Metaphase

- Spindle attaches to centromere
- Chromosomes pulled into line
    - Equatorial plate

c. Anaphase

- Centromeres divide
    - Chromatids separate
        - Each now called a chromosome
- Fibers pull chromosomes to poles
- Spindle stretches cell

d. Telophase

- Chromosomes arrive at poles
    - Unwind into chromatin
- Spindle disappears
- Nuclear membrane, nucleoli reappear

3. Cytokinesis

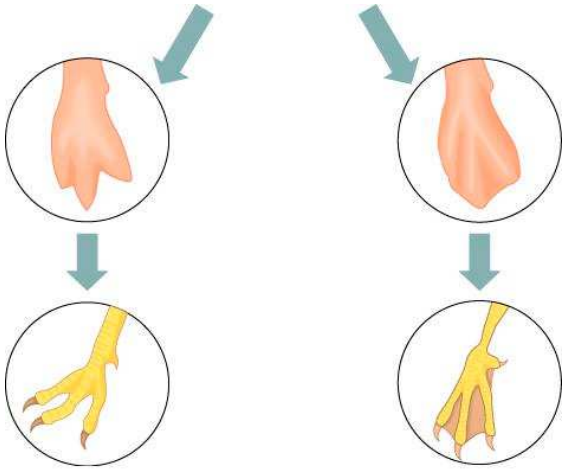
- Generally occurs with telophase
- Animals
    - Furrow forms in middle
        - Pinches cells apart
- Division is usually equal

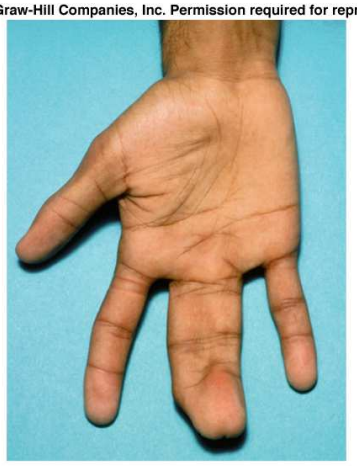
4. Functions of Mitosis

- Growth
    - Multiplication of somatic cells
- Cell Replacement
- Asexual Reproduction

D. Apoptosis Cycle

- Programmed cell death

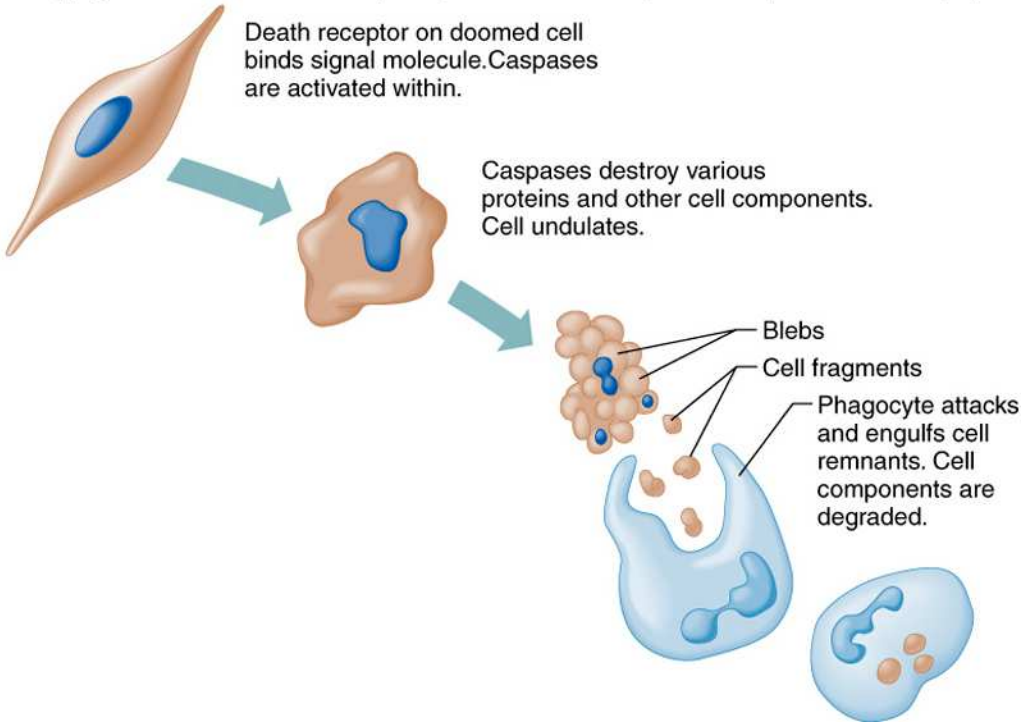




b.

- Capsases activated
  - Destroy DNA repair enzymes
  - Cut DNA
  - Dismantle cytoskeleton
    - Condense chromatin

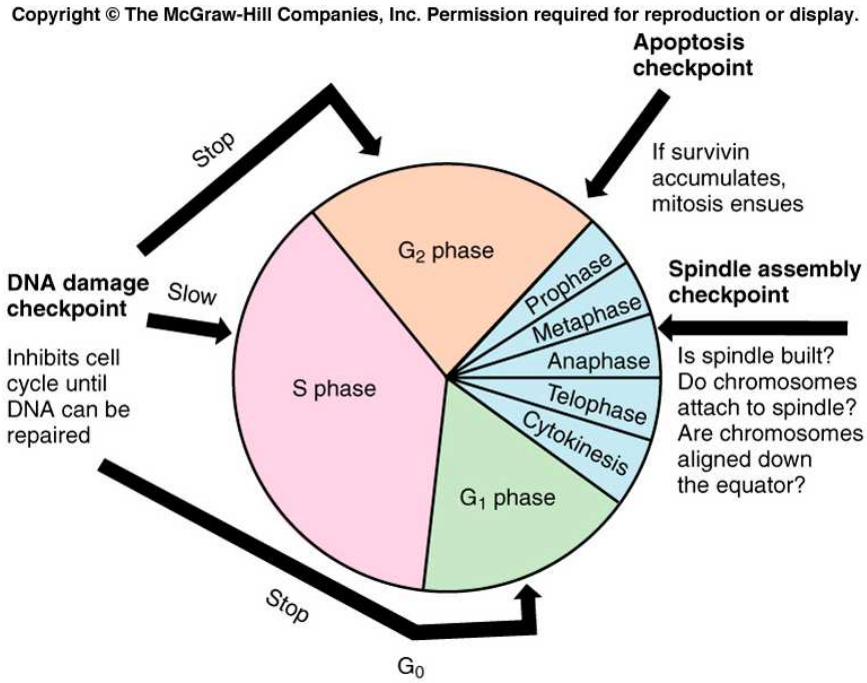
- Mitochondria, other organelles destroyed
- Cell adhesion proteins removed
- Phospholipids signal macrophages
  - Cell phagocytized



E. Control System

- How do cells know when to divide?
    - Too often – tumor
    - Not often enough – death

1. Checkpoints



- DNA damage checkpoint (G_1, G_2)
    - Damage to DNA repaired
    - Signals entrance into S or G_0
- Apoptosis checkpoint (G_2)
    - Just before mitosis
    - Survivan signals mitosis to begin
        - Overrides apoptosis signals

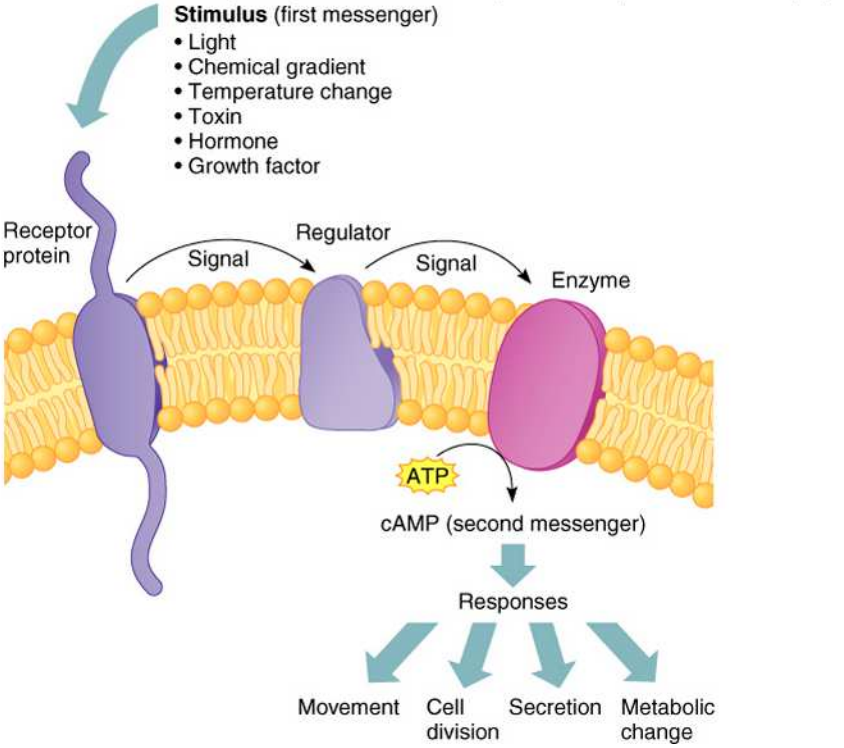
- Spindle assembly checkpoint (M)
    - Just before anaphase

2. Factors affecting Cell Cycle

- Anchorage dependence
- Density-dependent inhibition
    - Contact inhibition
- External Signals
    - Hormones
    - Growth Factors
        - Continue cell cycle
- Internal Signals
    - Cyclins and Kinases
        - Activate mitosis
        - Cyclin degraded during mitosis
    - Capsases
        - Activate apoptosis

2. Signal Transduction

- Receptor
    - Receives primary messenger
- Regulator
- Enzyme
    - Secondary Messenger



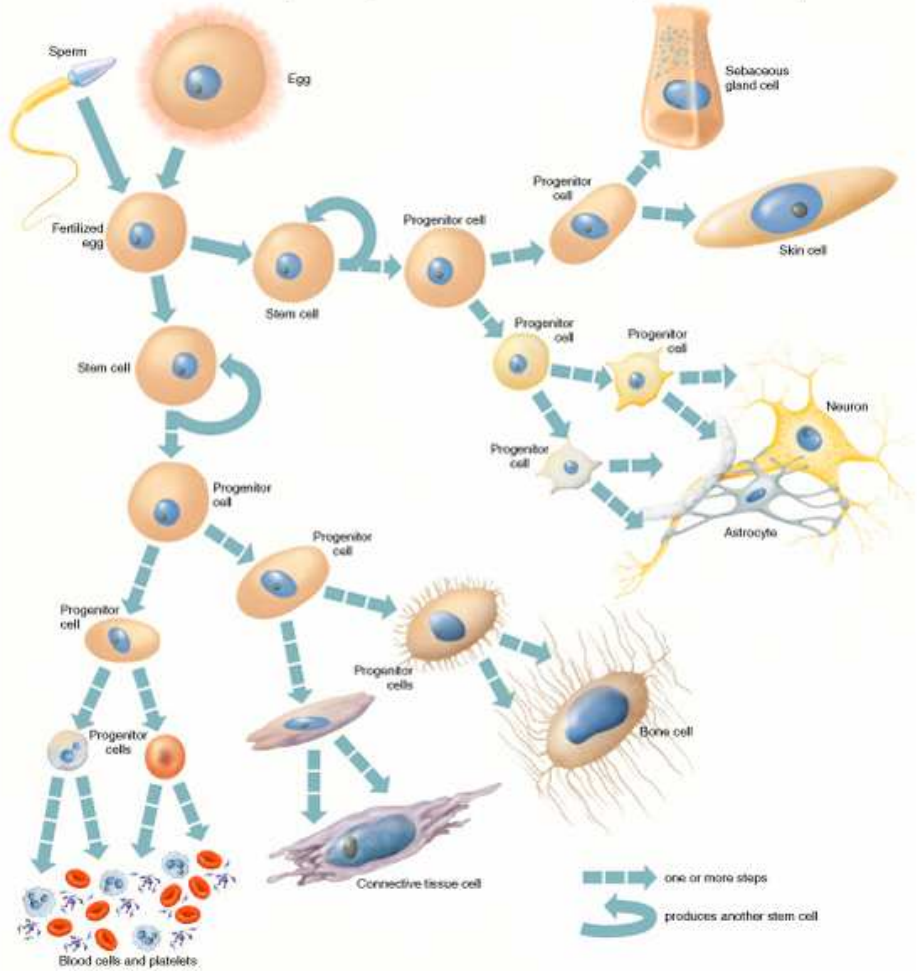
E. Cell Specialization

- Totipotent

- Pluripotent

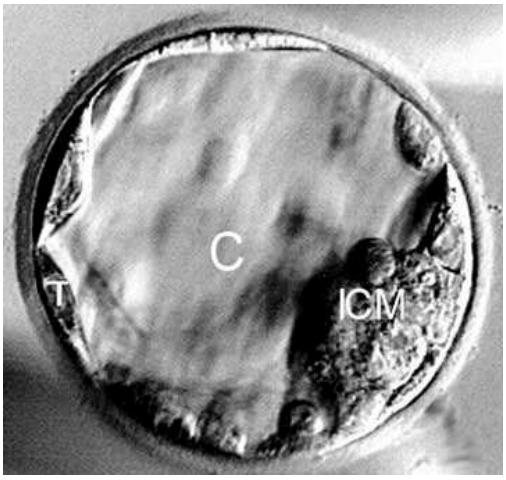
    - Stem cells

    - Progenitor cells

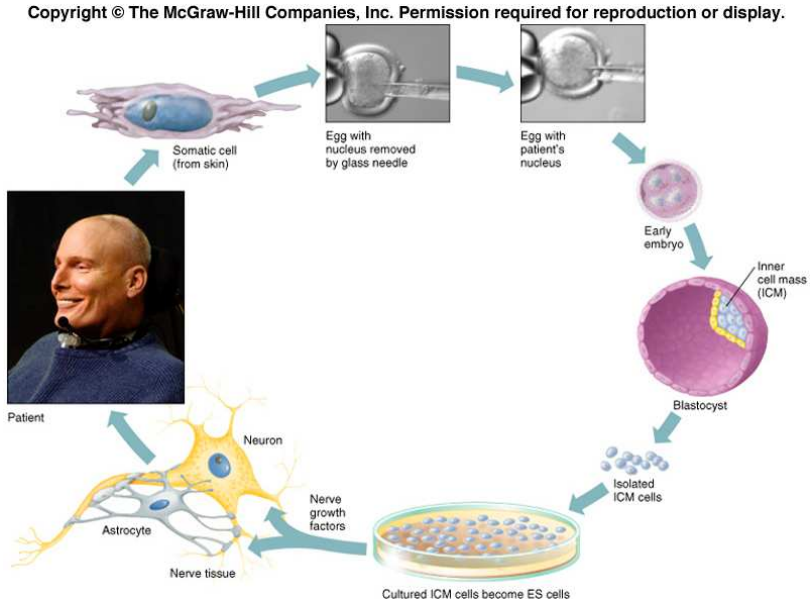


1. Stem Cells

- Embryonic stem cells
    - From inner cell mass of blastocyst



    - *in vitro* fertilization
    - somatic cell nuclear transfer



- Adult Stem Cells
    - Present in case of injury