Introduction

The living must exchange materials with the nonliving.

How does this happen? Cell transport

Two major types of cell transport:

- **Passive Transport**
  - Cellular energy not expended
  - Goes with the concentration gradient

- **Active Transport**
  - Cellular energy expended
  - Goes against the concentration gradient
Passive Transport

Characteristics:
- No energy is required
- Substances move from areas of higher to lower concentrations (downhill)
- Usually an equilibrium is reached and NET diffusion stops, but particle movement continues.

Diffusion

Diffusion – Spreading/scattering of molecules from a greater concentration to a lesser concentration.
Types of Diffusion: Dialysis

- Dialysis
  - Diffusion of small solutes through a selectively permeable membrane,
  - Results in separation of small solutes from large solutes
- Examples
Types of Diffusion: Osmosis

- Osmosis
  - Diffusion of water from a greater concentration to a lesser concentration
  - Water moves across a semipermeable membrane (selective permeability)

Illustration of Osmosis

Osmosis (Osmometer)

3% zoutoplossing stopt met stijgen als de druk van de waterkolom gelijk is aan de osmotische druk.
Osmosis

Osmotic potential - The pressure that is required to stop the osmotic movement of water into a solution. It is a measure of osmotic potential of a solution.

Isotonic - iso = "same"; tonic = "pressure"; Same number of solutes.

Hypotonic - hypo = "below"; Less solutes and higher water potential.

Hypertonic - hyper = "above"; More solutes and less water potential.

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(a) Animal cell

Hypertonic:
In hypertonic solutions, more water moved out than moved in. The cell loses water and shrinks, a process called plasmolysis.

Isotonic:
In isotonic solutions, the movement of water into and out of the cell is equal.

Hypotonic:
In hypotonic solutions, more water moved in than moved out. The animal cell gains water and expands, finally bursting. The plant cell just becomes flaccid.
Other Types of Passive Transport

Facilitated diffusion

- Carrier assisted transport - Another molecule is necessary for transport of certain substances across the plasma membrane’s phospholipid bilayer.
- E.g. Glucose
Filtration

- Hydrostatic pressure
- Movement through a membrane
- Passive

Active Transport

- Cellular energy is expended
- Cell pumps - Go against the concentration gradient.
  - Ex. Sodium-potassium pump -- Na\(^+\) is kept lower in the cell and K\(^+\) is kept higher.
Sodium-Potassium Pump

1. Outside of cell

2. ATP

3. Phosphate

Sodium-Potassium Pump

4. Phosphate released

5. Phosphate released

6. Phosphate released
Active Transport

- **Endocytosis**: Vesicles or vacuoles fuse with cell membranes.
  - **Endocytosis** – moves substances INTO the cell.
  - **Phagocytosis** - “cell eating,” cell takes in large substances
    - E.g. white blood cell (macrophage or neutrophil) "eating" a bacterium.
  - **Pinocytosis** - “cell drinking,” cell takes in small particles (liquids other than water).
  - **Exocytosis** – Moves substances OUT of the cell.
    - E.g. secretion

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**Exocytosis, Phagocytosis, and Pinocytosis**

![Exocytosis](image1)

- (a) Exocytosis

![Phagocytosis](image2)

- (b) Phagocytosis

![Pinocytosis](image3)

- (c) Pinocytosis

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3 Processes
- Glycolysis
- Krebs Cycle
- Electron Transport Chain

Cell Respiration

Proteins → Amino acids → Glucose → Glycolysis → Pyruvic acid → krebs cycle → Electron Transport Chain → ATPs

Carbohydrates → Sugars → Glycerol → Fatty acids → Krebs Cycle → Oxidative phosphorylation → ATPs

Lipids → Glycerol → Krebs Cycle → Oxidative phosphorylation → ATPs
Cell Life Cycle – 2 Major Events

Cell Growth (INTERPHASE)

- **Mitosis**
  - parent cell
  - prophase
  - chromosomes align at the equatorial (metaphase) plate
  - metaphase (centromeres divide)
  - sister chromatids separate during anaphase, becoming daughter chromosomes
  - two daughter cells

Cell Reproduction (MITOSIS & MEIOSIS)

Chromosomes

DNA molecule

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Protein Synthesis

DNA Replication

- One parent strand of DNA is replicated into two daughter strands.
- This is what allows cells to reproduce themselves.
- The cellular DNA must have a mechanism to be transmitted from one generation to the next.
PROTEIN SYNTHESIS

Central Dogma

DNA → mRNA → Proteins

• Transcription – same language: nitrogen bases
• Translation – new language: amino acids

Cell Growth-Interphase

- Cell builds new molecules & increases in size.
- Cell matures.
- Divided into 3 phases
  - G1 – Protein synthesis
    • Transcription
    • Translation
  - S – DNA Replication
  - G2 - More protein synthesis

EUKARYOTIC CELL CYCLE

G1 (Gap 1)
G2 (Gap 2)

S phase (DNA synthesis)
M (mitosis)

Cells that cease division
Cell Cycle

- Includes the sequence of cell growth and division.

- Interphase
  - G1
  - S
  - G2

- Mitosis

MITOSIS-Nucleus Division

- Reproduction of body cells
- 1 Parent cell (diploid) → 2 Daughter cells (diploid)
- 4 Phases
  - Prophase
  - Metaphase
  - Anaphase
  - Telophase
Prophase

“Before” phase

Longest phase.

Nuclear envelope breaks down.

Chromosomes shorten and thicken, becoming visible.

- NOTE: Chromosomes consist of 2 chromatids joined by a centromere.
- 46 chromosomes, composed of 92 chromatids.

Spindle starts to form.

Centrioles can been seen moving apart.

 Metaphase

The 46 chromatid pairs move to the equator of the cell.

When they are aligned, this is the end of metaphase.
Anaphase
- Most rapid phase.
- Chromatid pairs move apart.
  - 46 daughter chromosomes (formerly chromatids) go to one side of the cell.
  - 46 daughter chromosomes (formerly chromatids) go to the OTHER side of the cell.
- Centromeres move first and “drag” the arms.

Telophase
- End phase
- Chromosomes have reached the opposite poles.
- Chromosomes elongate and disappear from view.
- Spindle fibers break down.
- Nuclear envelope reforms.
- Cytokinesis occurs.
Cytokinesis-Cell Division

- Doesn’t always happen.
- Begins with telophase.
- Cleavage occurs at the midline of the spindle.

Meiosis

- Reproduction of Sex Cells (Gametes)
  - Diploid (with chromosomes copied) → Haploid gametes
- Phases
  - Meiosis I
    - Number of chromosomes is halved, centromeres do not split.
    - 1 Diploid Parent cell (46 chromosomes) → 2 Haploid Daughter Cells (23 chromosomes)
  - Meiosis II
    - Centromeres split, chromatids separate.
    - 2 Haploid Daughter Cells → 4 Haploid Daughter cells
Meiosis

http://www.micro.utexas.edu/courses/levin/bio304/genetics/celldiv.html

Meiosis I
- Prophase
- Metaphase
- Anaphase

Meiosis II
- Metaphase
- Anaphase, Telophase & Cell Division

MEIOSIS

Telophase & Cell Division