

Chapter 3: The Cell

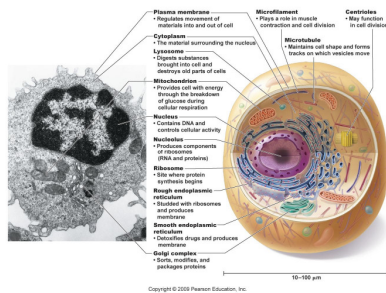
BIO 105

Cell Theory

1. A cell is the smallest unit of life.
2. Cells make up all living things.
3. New cells only arise from preexisting, living cells.

Categories of cells

- Eukaryotic cells



Categories of cells

- Prokaryotic cells

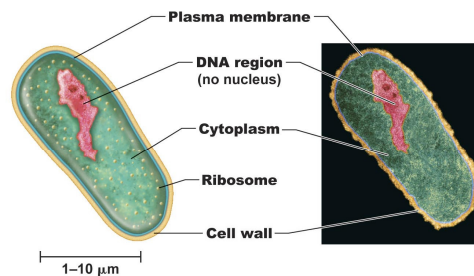


TABLE 3.1 Review of Features of Prokaryotic and Eukaryotic Cells

Feature	Prokaryotic Cells	Eukaryotic Cells
Organisms	Bacteria, Archaea	Plants, animals, fungi, protists
Size	1–10 μm across	10–100 μm across
Membrane-bound organelles	Absent	Present
DNA form	Circular	Coiled, linear strands
DNA location	Cytoplasm	Nucleus
Internal membranes	Rare	Many
Cytoskeleton	Present	Present

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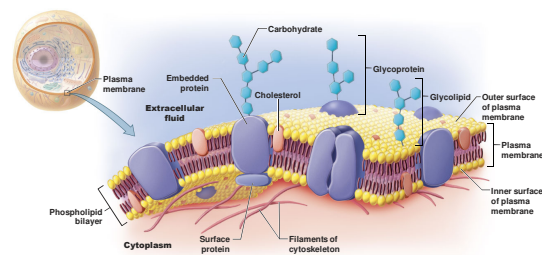
Cell structure

1. Plasma membrane
2. Nucleus
3. Cytoplasm

Plasma membrane components

- Lipids
 - Phospholipids
 - Cholesterol
- Proteins
- Carbohydrates

Fluid mosaic model



Plasma membrane functions

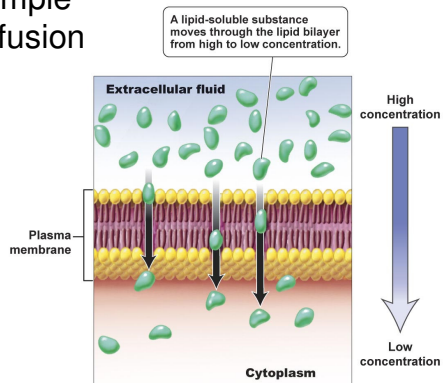
- Maintain structural integrity of the cell
- Regulate movement of substances into and out of the cell
- Provide recognition between cells
- Provide communication between cells
- Stick cells together to form tissues and organs

Membrane Transport

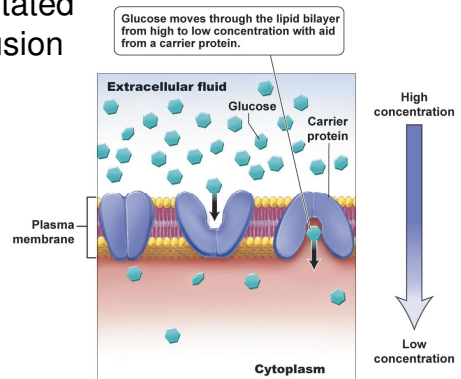
Two types of forces are instrumental in moving substances across the plasma membrane.

1. Passive
2. Active

Simple Diffusion

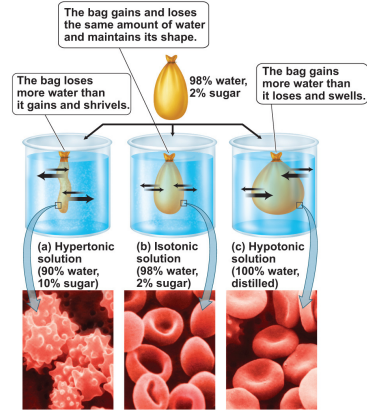
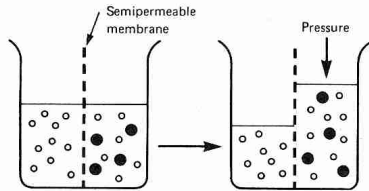


Facilitated Diffusion

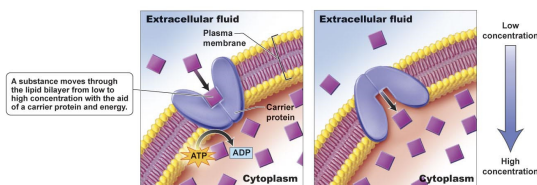


Osmosis

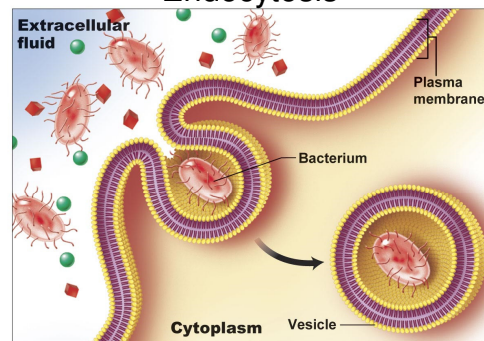
Osmosis – movement of solvent (i.e. H_2O) molecules from an area of high to lower concentration



Active Transport



Endocytosis



(a) Phagocytosis ("cell eating") occurs when cells engulf bacteria or other large particles.

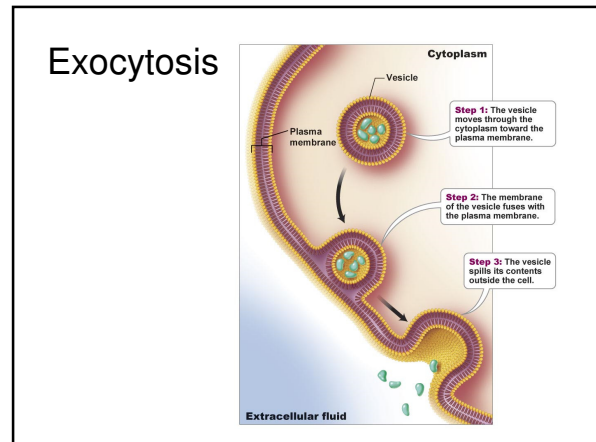
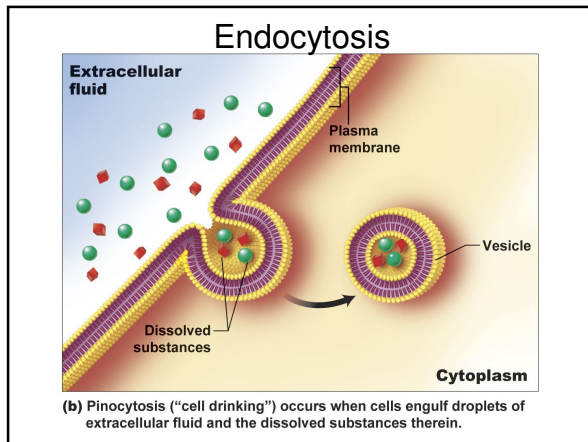
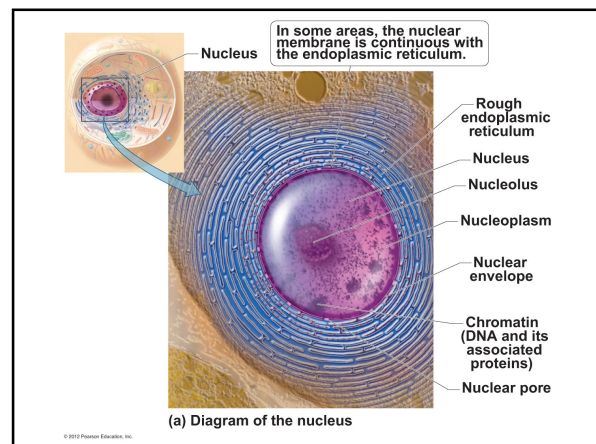
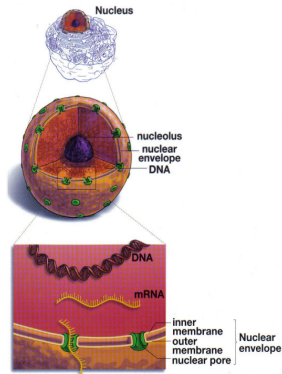


Table 3.2 Review of Mechanisms of Transport across the Plasma Membrane	
Mechanism	Description
Simple diffusion	Random movement from region of higher concentration to region of lower concentration
Facilitated diffusion	Movement from region of higher concentration to region of lower concentration with the aid of a carrier or channel protein
Osmosis	Movement of water from region of higher water concentration (lower solute concentration) to region of lower water concentration (higher solute concentration)
Active transport	Movement, often from region of lower concentration to region of higher concentration, with the aid of a carrier protein and energy, usually from ATP
Endocytosis	Process by which materials are engulfed by the plasma membrane and drawn into the cell in a vesicle
Exocytosis	Process by which a membrane-bound vesicle from inside the cell fuses with the plasma membrane and spills contents outside the cell



Nucleus

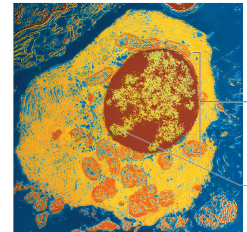
- Nuclear envelope
- Nuclear pores
- Nucleolus
- Genetic material



Genetic material

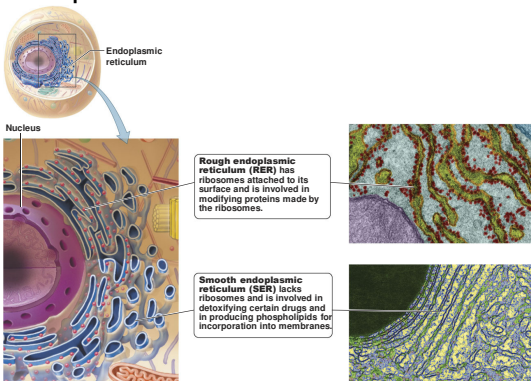


(a) Individual chromosomes are visible during cell division, when they shorten and condense.

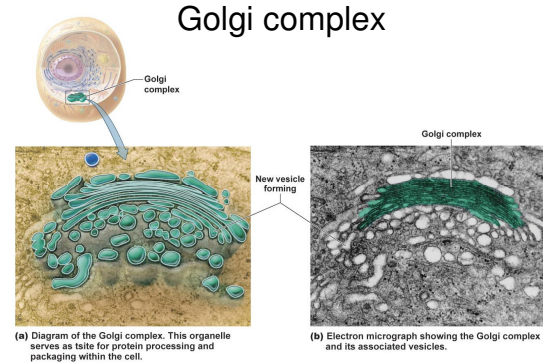


(b) At all other times, the genetic material is dispersed and called chromatin.

Endoplasmic Reticulum & Ribosomes



Golgi complex



(a) Diagram of the Golgi complex. This organelle serves as a site for protein processing and packaging within the cell.

(b) Electron micrograph showing the Golgi complex and its associated vesicles.

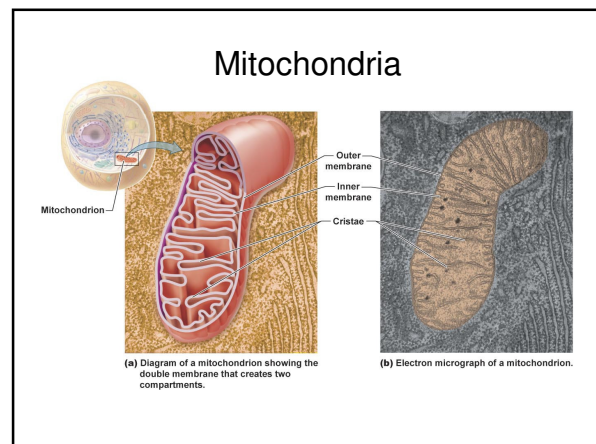
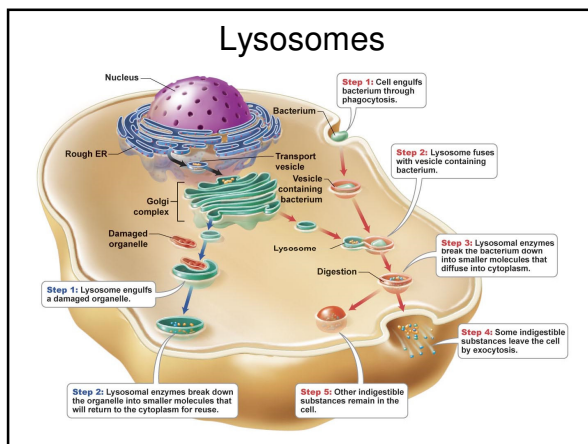
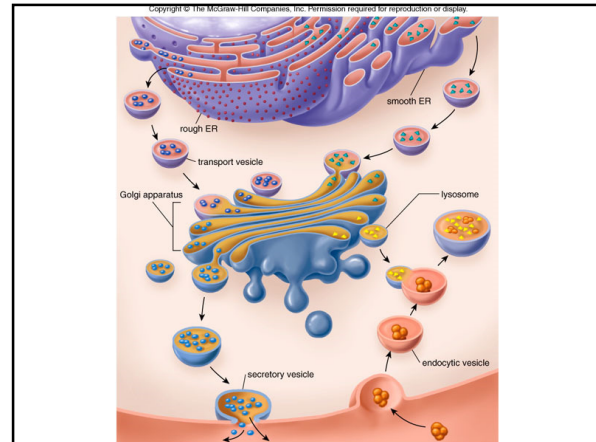
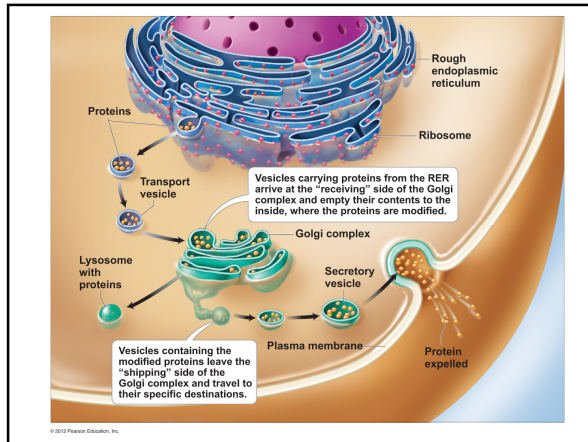


TABLE 3.3 Review of Major Organelles and Their Functions

Organelle	Function
Nucleus	Contains almost all the genetic information and influences cellular structure and function
Rough endoplasmic reticulum (RER)	Studded with ribosomes (sites where the synthesis of proteins begins); produces membrane
Smooth endoplasmic reticulum (SER)	Detoxifies drugs; produces membrane
Golgi complex	Sorts, modifies, and packages products of RER
Lysosomes	Digest substances imported from outside the cell; destroy old or defective cell parts
Mitochondria	Provide cell with energy through the breakdown of glucose during cellular respiration

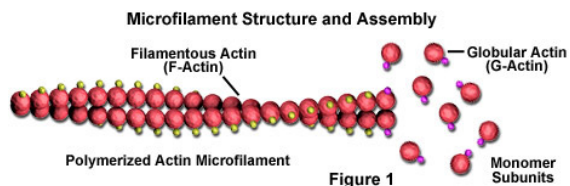
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Cytoskeleton

- Microfilaments
- Microtubules
- Intermediate filaments

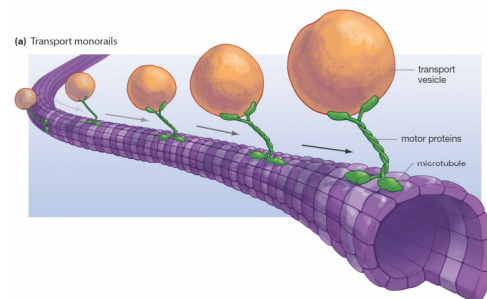
Cytoskeleton

Microfilaments – main contractile elements of the cytoskeleton

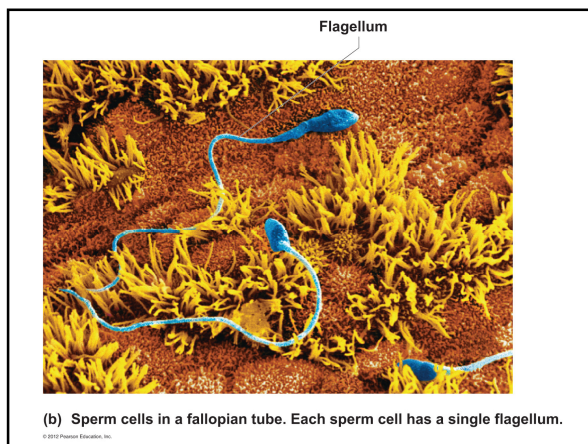
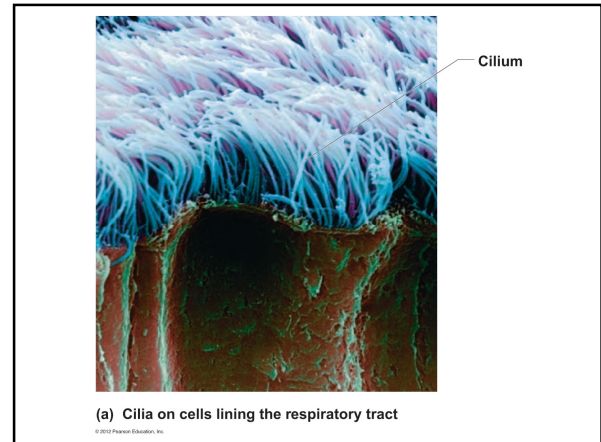
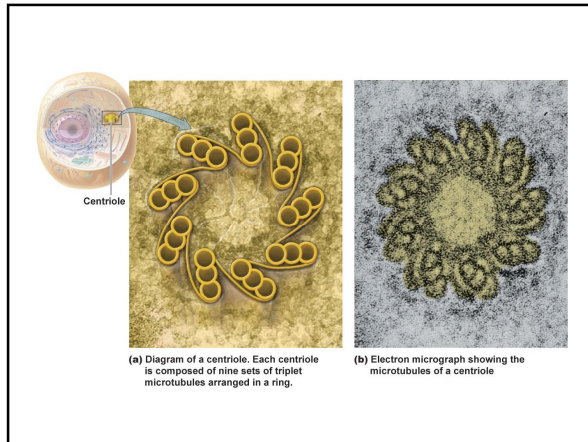


Important for muscle contraction & cell division

Cytoskeleton - microtubules



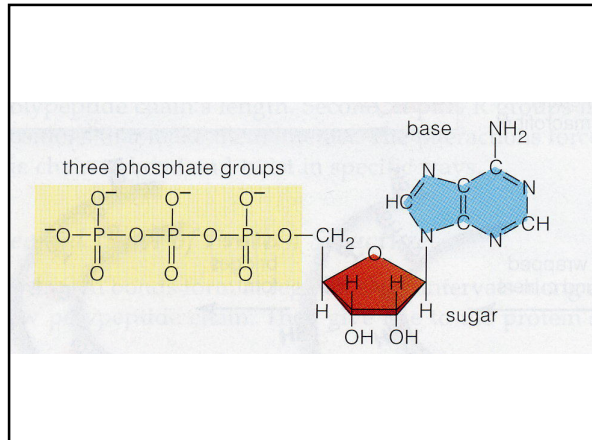
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Cell Metabolism

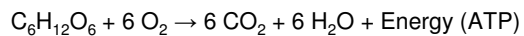
What is metabolism?

- Sum of all the chemical reactions occurring in the body
- Catabolism + anabolism
- Catabolism of glucose, amino acids, and fatty acids produces ATP



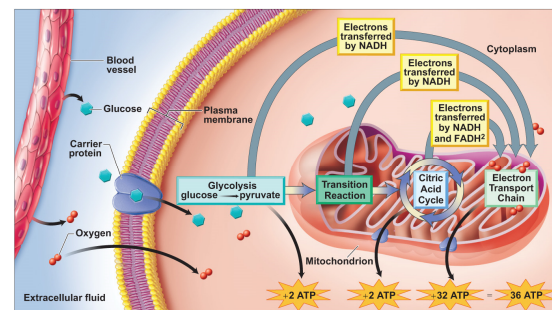
Methods of ATP production

1. Cellular respiration (aerobic)



2. Fermentation (anaerobic)

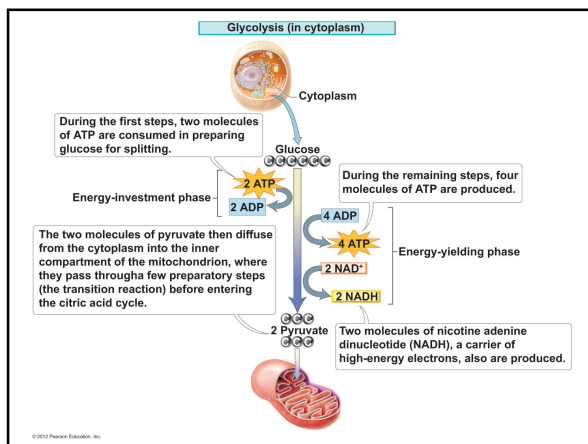
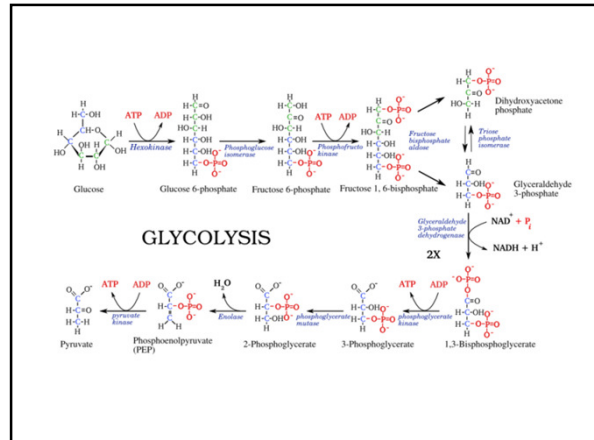
Cellular Respiration



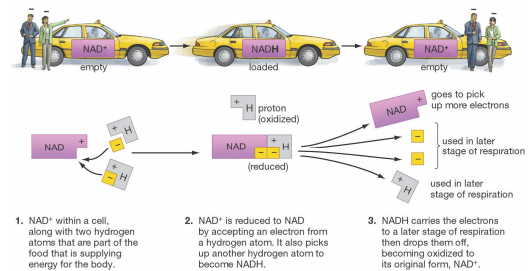
Glycolysis (overview)

Occurs in the cytoplasm of the cell

Involves the breakdown of a six-carbon molecule (glucose) into two three-carbon molecules (pyruvate)



NAD⁺ & FAD are electron carriers



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Glycolysis (summary)

Start: one molecule of glucose

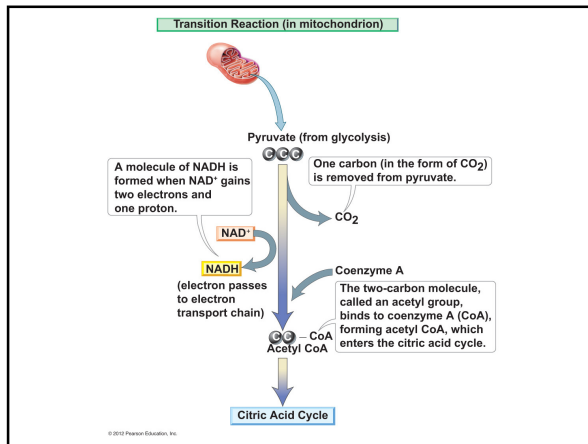
Net yield:

2 pyruvate molecules
2 ATP
2 NADH

Transition Reaction (overview)

Occurs in the mitochondria

Involves the breakdown of the two pyruvate molecules into two molecules of acetyl CoA



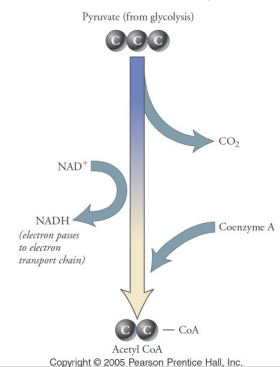
Transition Reaction summary

For one molecule of glucose:

Start: 2 pyruvates

Net yield:

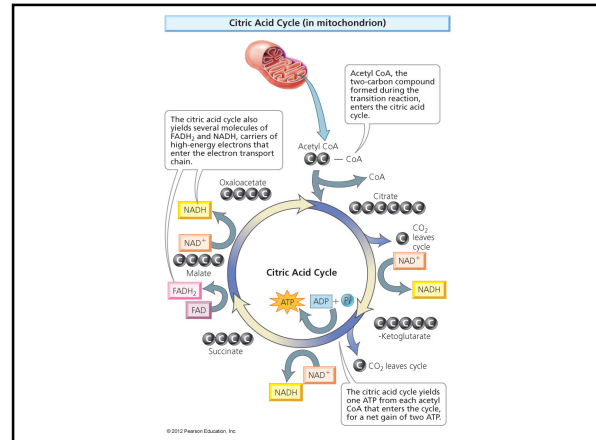
2 Acetyl CoA
2 CO_2
2 NADH



Citric Acid Cycle (overview)

Occurs in the mitochondria

Involves further processing of Acetyl CoA molecules produced at the end of the Transition Reaction.



Citric Acid Cycle (summary)

For one molecule of glucose:

Start: 2 Acetyl CoA

Net yield:

2 ATP
6 NADH
2 FADH_2
4 CO_2

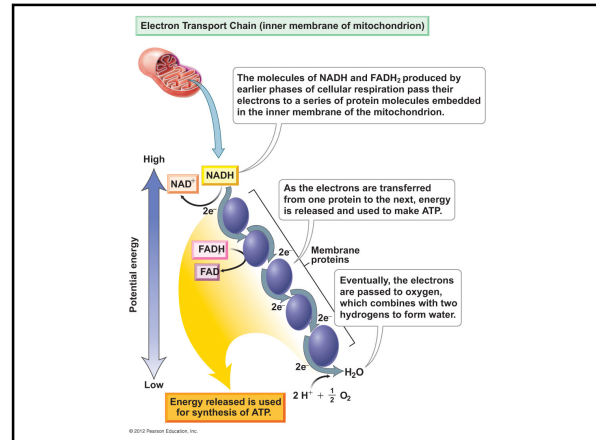
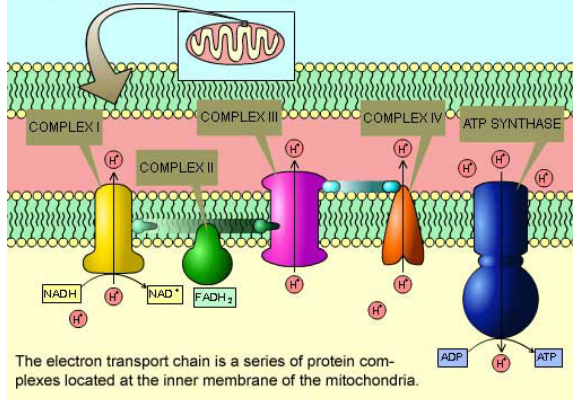
Electron Transport Chain

Takes place within mitochondria

Utilizes the electrons picked up by NAD and FAD to make ATP

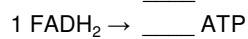
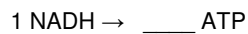
Electron transport chain is a series of 5 proteins located along the inner mitochondrial membrane

Figure J-13: Electron Transport Chain



Electron Transport Chain (summary)

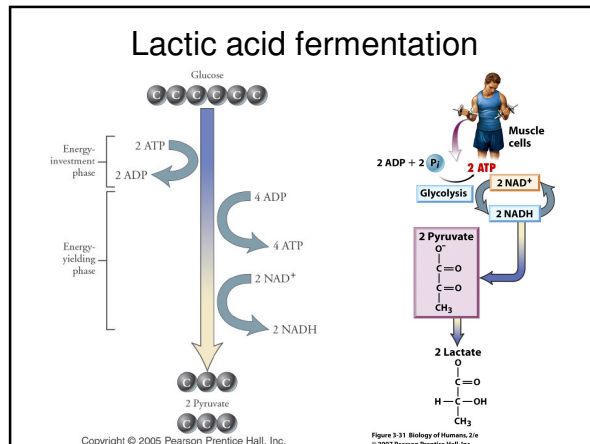
The ETC produces ____ ATP



So, how many ATP can be produced from a single molecule of glucose (under aerobic conditions)?

Phase	Location	Description	Main Products
Glycolysis	Cytoplasm	Several-step process by which glucose is split into 2 pyruvate	2 pyruvate 2 ATP 2 NADH
Transition reaction	Mitochondria	One CO ₂ is removed from each pyruvate; the resulting molecules bind to CoA, forming 2 acetyl CoA	2 acetyl CoA 2 NADH
Citric acid cycle	Mitochondria	Cyclic series of eight chemical reactions by which acetyl CoA is broken down	2 ATP 2 FADH ₂ 6 NADH
Electron transport chain	Mitochondria	Electrons from NADH and FADH ₂ are passed from one protein to the next, releasing energy for ATP synthesis	32 ATP H ₂ O

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What is the net yield of high energy products from fermentation?