Metabolism

Sum of all chemical reactions ina living thing/system

Laws of Thermodynamics

#1	You can convert energy from one form to another (Ex. Carbohydrate is converted into ATP)
#2	No transfer energy is a 10% efficient process (Ex. Converting carbohydrate to ATP is only 64% efficient)

Entrophy

Measurement of randomness/disorder

Increase entrophy	Increase order = energy increases
Decrease entrophy	Increase disorder = energy decreases

Gibb's Free Energy (G)

- Gives the potential of a system or a rxt tp do useful work
- G = H - (TS)
- H= Enthalpy (total energy)
- T = Temperature (in kelvin)
- S = Entropy
- When kelvin is 0, atoms do not move
- What the equation tells you:

1) Spontaneous system if G is negative, catabolic reaction (Ex. Cellular respiration)
2) Non-Spontaneous system if G is positive, anabolic reaction (Ex. Photosynthesis)

G

Negative G	Positive G
Decrease energy	Increase energy
Increase entropy	Decrease entropy
Decrease temperature	Increase temperature
Spontaneous system	Non-Spontaneous System
Lose energy	Convert energy
Catabolic reaction (Cellular respiration)	Anabolic reaction (Photosynthesis)

ATP

Energy is released in ATP when a phosphate is broken off

Metabolic Reactions

Catabolism	Exergonic reaction (energy is released or lost), breaks down organic compounds, example: glycolysis
Anabolism	Endergonic reaction (energy is added), organic compounds are synthesized, example: photosynthesis
Oxidation (Exergonic)	Molecule loses an electron, H is formed
Reduction (Endergonic)	Molecule gains an electron (H)
Coupled Reaction	An exergonic reaction provides the energy for an endergonic reaction

Metabolic Reactions (cont)

Electron Carriers	NAD+/NADH, FADH+/FADH
Chemiosmosis	Movement of ions across a semipermeable membrane, examples: ETC
Phosphorylation	Adding a phosphate molecule
Oxidative Phosphorylation	Happens in the ETC, phosphate is added to ADP to form ATP
Photophosphotylation	Happens in photosynthesis, ATP is formed
Substrate Phosphorylation	Adds a phosphate, can still make ATP, occurs in glycolysis & krebs cycle

Cellular Respiration

Aerobic Respiration	Needs oxygen, consists of: glycolysis, krebs cycle, and the electron transport chain
Anaerobic Respiration	Oxygen is toxic, consists of: glycolysis, fermentation (lactic acid + alcoholic)
Glycolysis	In cytosol, oldest process
Krebs Cycle	In matrix of mitochondria
Electron Transport Chain	In cristae of mitochondria

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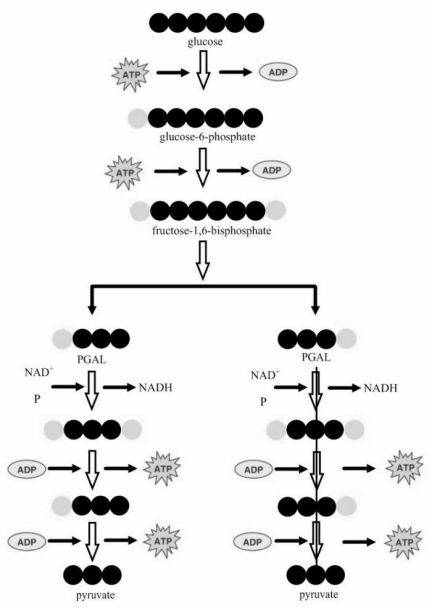
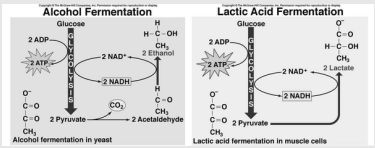
Glycolysis



Fermentation



Problems with Glycolysis

Pyruvate is Toxic	Solved with krebs cycle and/or fermentation
NAD+ is in Short Supply	Lack of NAD+ = process is not complete, solution is fermentation and/or the ETC

Cost Analysis of Glycolysis

Overall Gains	Net Gains
4 ATP	2 ATP
2 NADH	2 NADH (= 4 ATP)

Krebs Cycle

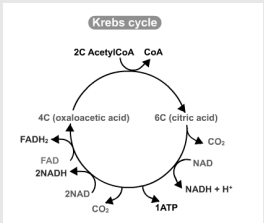
Purpose	Get rid of pyruvate from glycolysis

Rules

1) For every carbon to carbon bond that is broken, carbon dioxide is released and NADH is reduced

2) For any rearrangement of the carbon chain molecule, the substrate order is as follows: NADH -> ATP -> FADH -> NADH

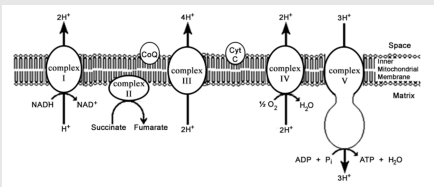
Krebs Cycle



Net Gains

Glycolysis	Krebs Cycle
2 ATP	2 ATP
2 NADH	8 NADH
	2 FADH

Electron Transport Chain



Gains from 1 Glucose

Process	Net Gains	Net Gains in ATP
Glycolysis	2 ATP	2 ATP
	2 NADH	4 ATP
Krebs	2 ATP	2 ATP
	8 NADH	24 ATP
	2 FADH	4 ATP
Total		36 ATP

Photosynthesis

- In chloroplast
- Anabolism (Small molecules become big), endergonic reaction (energy is added)
- Process of using light to split water, which provides ATP and NADH to fix carbon dioxide to 5 carbon RuBP to make 3 PGA (Phosoglyceral Aldehyde)

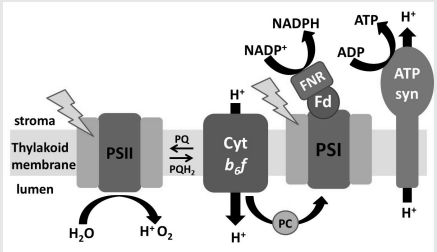
Two Reactions

Light Rxt	Occurs in thylakoid (individual pancakes of the chloroplast), needs water & sunlight, proces ATP and NADH
Dark Rxt/Calvin Cycle	In the stroma, needs ATP, NADH, and water, produces 3 PGA (Phosoglyceral Aldehyde)

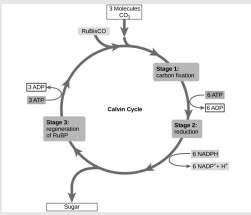
Reactions

Reaction	Reactants	Products	Location
Light Reaction	Light, water, ADP, NADP+	Energy, oxygen, hydrogen, ATP, NADPH	Thylakoid
Dark Reaction, Calvin Cycle, C3	Carbon dioxide, ATP, NADPH	3 PGA, ADP, NADP+	Stroma

Light Reaction



Calvin Cycle



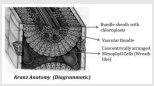
Photorespiration

- Peroxisomes & mitochondria rearrange and split a two carbon compound from the chlorpolast to release carbon dioxide
- Uses ATP

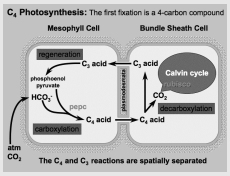
C4 Pathway

- In grassplants
- Occurs in mesophyll cells above the bundle sheath cells lining vascular tissues
- Photorespiration: Oxygen is added, causes carbon dioxide to be released to the bundle sheath, needs PEP (Phosphoenolpyruvate Acid)

Vascular Tissue



C4 Pathway



Cost Analysis

C3	18 ATP, 12 NADH
C4	...a lot of ATP
CAM	6-8 more ATP