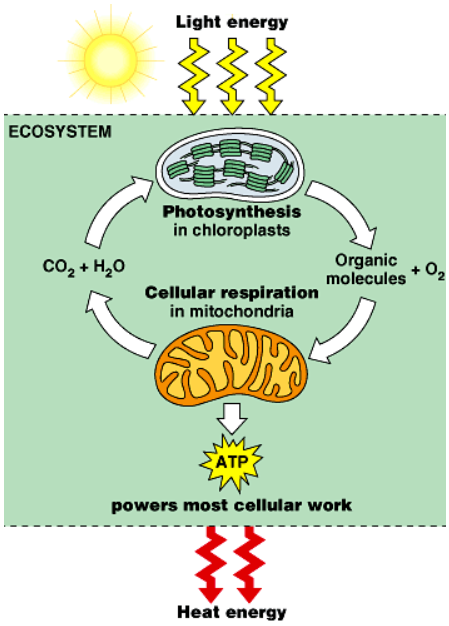
ENERGY IN CELLS

revised 12 Oct 2016
Campbell 6th: 87-96, 155-173, 7th: 160-178, Sadava: 122-135, Campbell's 9th , 163-181, 10th: 162-182



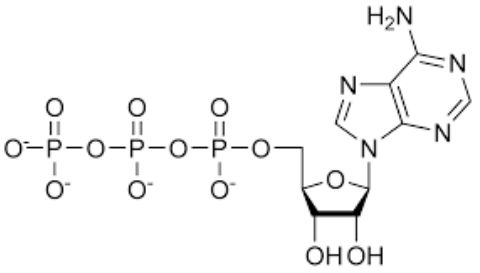
ENERGY FLOW SUPPORTS LIFE ON EARTH:
Life on earth is dependent on **solar energy**.
Photosynthesis and **respiration** are opposite sides of a yin yang diagram (p 163)
Plants: **phototrophs** ["light nourish"] make glucose and O_2, use light energy
Animals: **heterotrophs** ["other nourish"] burn glucose with O_2, give off CO_2, make ATP
Show chemical reactions, name organelles responsible.

METABOLISM sum of biochemical reactions in a cell (anabolism *and* catabolism)
oxidation + reduction = redox reactions (another yin yang)
Remember: **Oxidation** = loss hydrogen atoms or e^-; **Reduction** = gaining e^- them.
Plants reduce CO_2 using light energy absorbed, store it in glucose, energy storage molecule

ANABOLISM [" up throw"] uses energy to synthesize macromolecules
endergonic ["into, energy"], typical Rxn: **dehydration condensation**

CATABOLISM ["down throw"] degrade macromolecules, generate ATP
exergonic ["out, energy"], typical Rxn: **hydrolysis**, etc
Catabolism releases energy stored in organic compounds
Hydrogens are removed fr glucose, "burned" in a "fuel cell"
ATP is synthesized using that energy

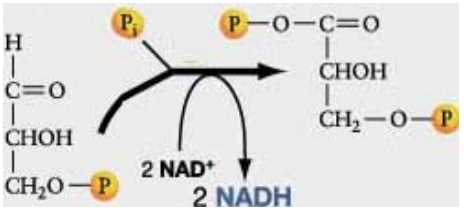
ADENOSINE TRIPHOSPHATE(LEARN): energy currency for the cell: (p. 149)
LEARN: Draw components of ATP: adenine, ribose, three PO_4s.
Energy in adjacent PO_4s due to charge repulsion, stressed bonds in inter PO_4 links
Energy released by hydrolysis of ATP: ATP + H_2O = ADP + P_i (inorganic PO_4^{-3})
Catabolism of glucose + O_2 (-686 Kcal/mol) yeilds **~36-38 ATPs** (fuzzy number)



How to extract this energy from glucose?
Dissect off hydrogen atoms for "fuel cell" in cristae of mitochondria.

HYDROGEN CARRIERS: pick up e^- from oxidized glucose:
hydrogen carriers "truck" it to the mitochondrion electron transport "fuel cell"
https://www.youtube.com/watch?v=Kb-4uuCYLvE

hi energy	**NAD^+**	Nicotinamide adenine dinucleotide	(niacin = vitamin B3) (p 165)
lower energy	**FAD**	Flavin adenine dinucleotide	(riboflavin = vitamin B2)

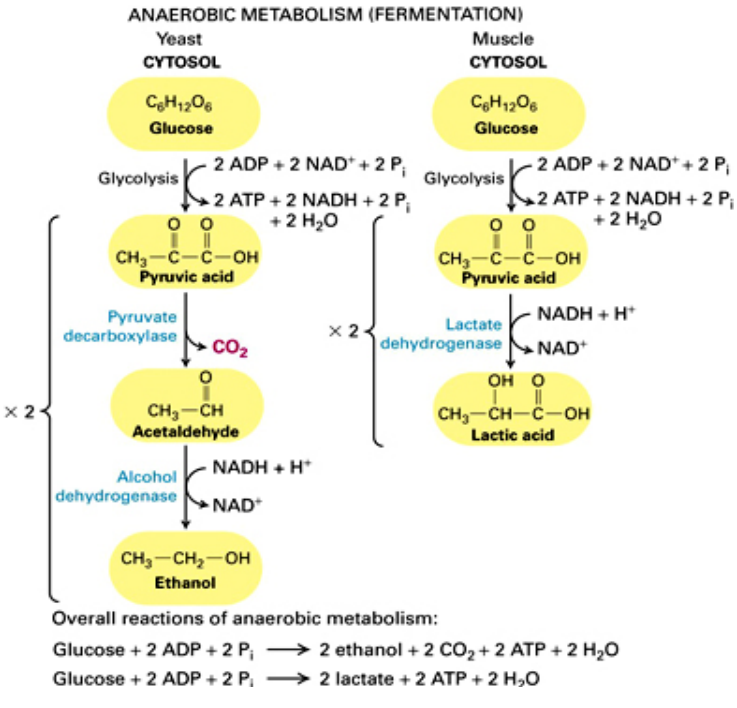


Overview: (p 167)

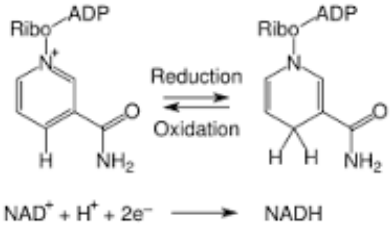
GLYCOLYSIS occurs in cytoplasm, makes 2 ATP fr each glucose (p 168-169)
learn: glucose, glu-1-PO_4, Fructose-1-PO_4, Fruct. 1,3bisPO_4, glyceraldehyde-3-PO_4, pyruvate
emphasize **oxidation** of glyceraldehyde-3-PO4, creating **NADH**
Videos of the ten steps of glycolysis:
3D: https://www.youtube.com/watch?v=mmACA_eVLTE
2D: http://www.youtube.com/watch?v=DJrA64rBhSk

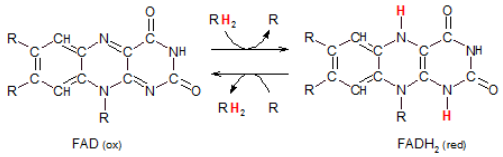
FERMENTATION, after yeild of 2 ATP, regenerates NAD^+. Definition:

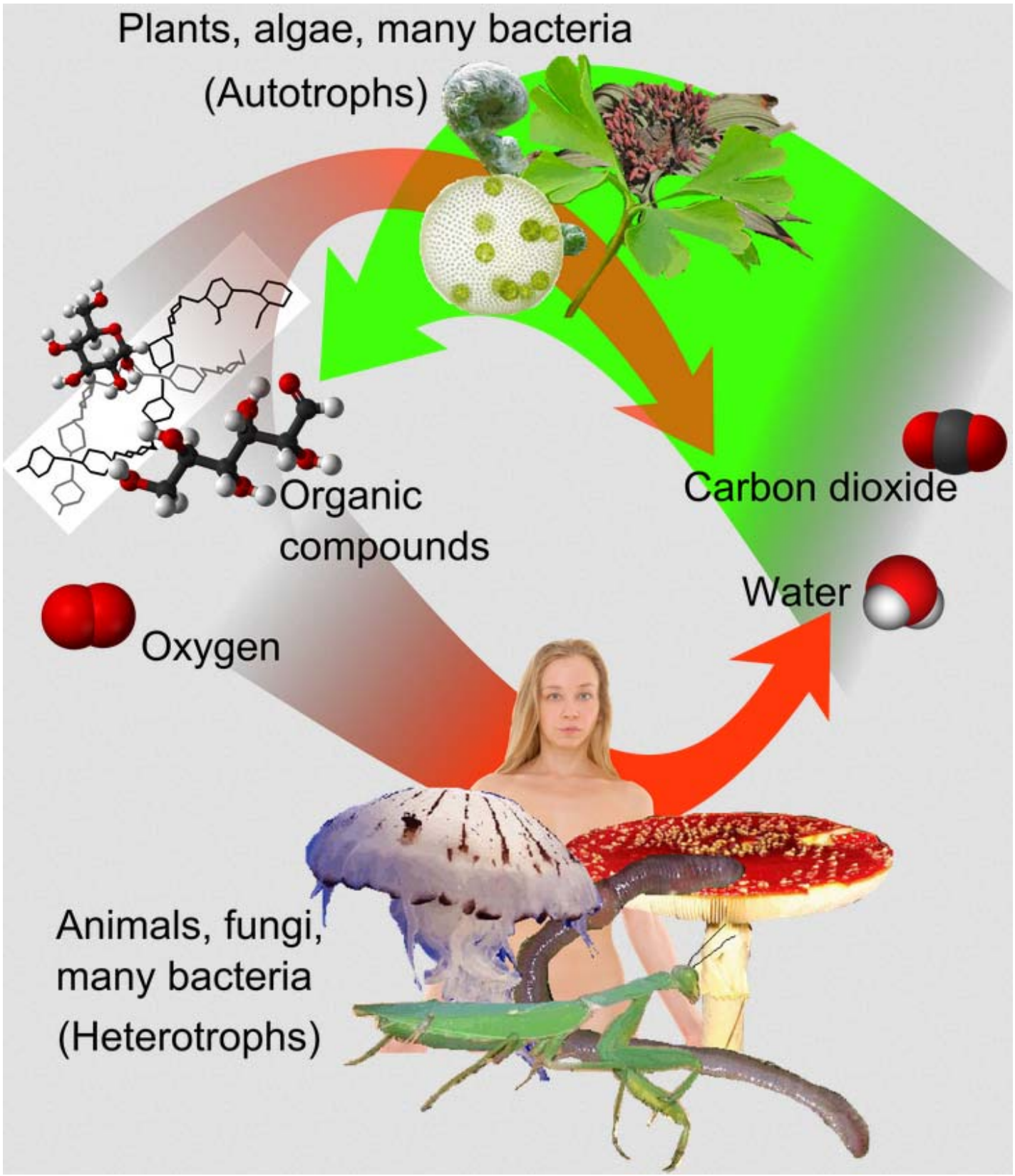
"Catabolism of glucose in which the terminal H acceptor is *organic*."
Purpose: **regenerate NAD^+**, *required* for glycolysis
(unloads H from NADH, occurs in cytoplasm)
show lactic acid formation (muscle, yogurt)
alcoholic fermentation (yeast)



RESPIRATION (p170-177) Get about 34 ATP per glucose.
"Catabolism of glucose in which the terminal H acceptor is *inorganic*."
Overall purpose: "oxidative phosphorylation"
i.e., glucose is oxidized, and the released energy phosphorylates ADP


Ribo
ADP
Reduction
Oxidation
NAD+ + H+ + 2e− → NADH


FAD (ox)
FADH2 (red)


Plants, algae, many bacteria
(Autotrophs)
Organic compounds
Carbon dioxide
Water
Oxygen
Animals, fungi, many bacteria
(Heterotrophs)