AP BIOLOGY
CELLULAR ENERGETICS
ACTIVITY #2

NAME__ Notes ______

DATE__________HOUR______

CELLULAR RESPIRATION

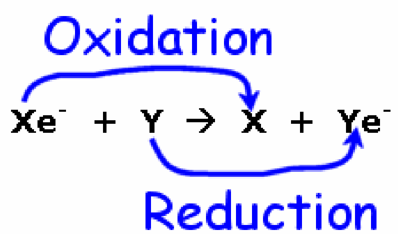
SUMMARY EQUATION

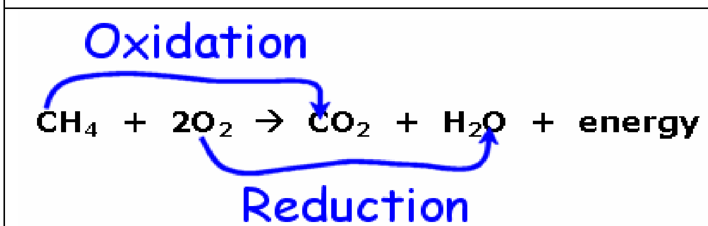
$$C_6H_{12}O_6 + O_2 \rightarrow 6CO_2 + 6H_2O + \text{energy (ATP)}$$

STEPWISE REDOX REACTION

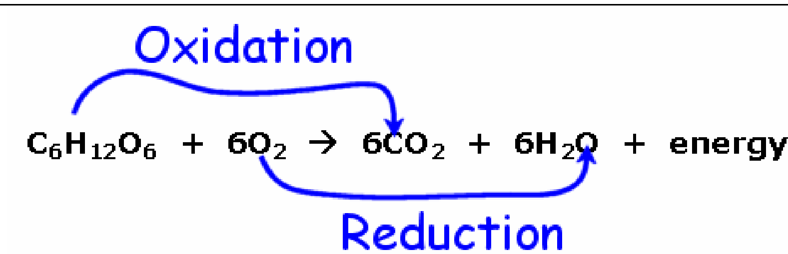
Oxidation: partial or complete loss of electrons

Reduction: partial or complete gain of electrons





C partial loss of e-
O partial gain of e-



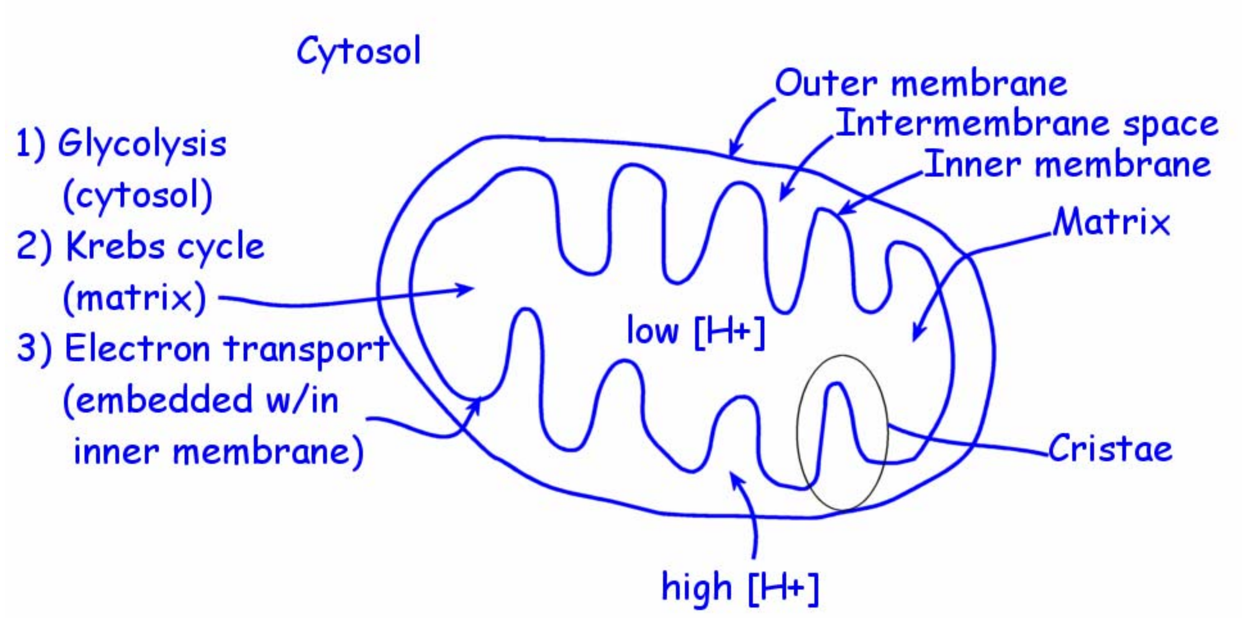
Role of NAD+

▪ Coenzyme ▪ e- acceptor ▪ Traps high energy e- from glucose	Dehydrogenases ▪ Remove 2 H (2e- & 2H+) from substrate ▪ Delivers 2e- & 1H+ to NAD+ ▪ NAD+ + 2e- + 1H+ → NADH

Phosphorylation

Substrate Level	Oxidative
▪ ATP produced ▪ ADP + P_i → ATP ▪ Direct transfer of P_i from intermediate compound to ADP	▪ ATP produced ▪ ADP + P_i → ATP ▪ Exergonic slide of e- used to create H+ gradient; KE of H+ moving down conc. gradient used to add P_i to ADP

Structure of Mitochondrion

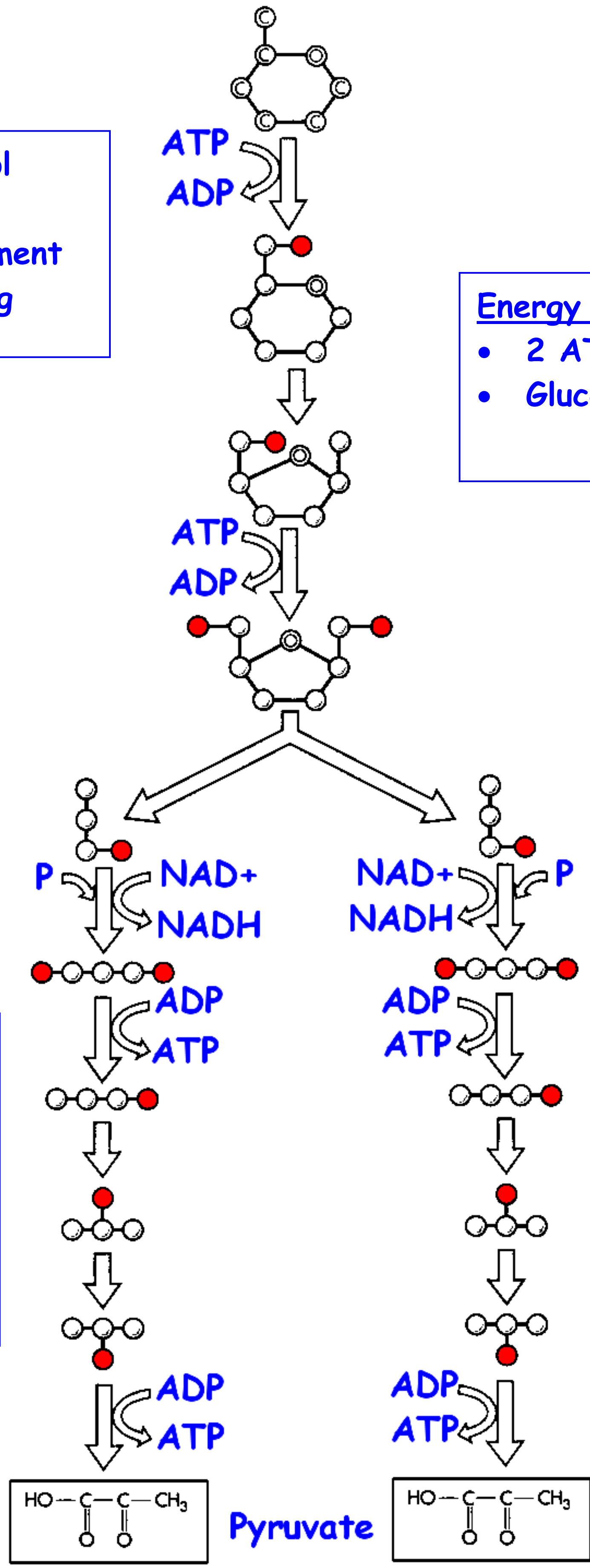


GYCOLYSIS

Location = cytosol

Divisions

- Energy investment
- Energy yielding



Energy investment

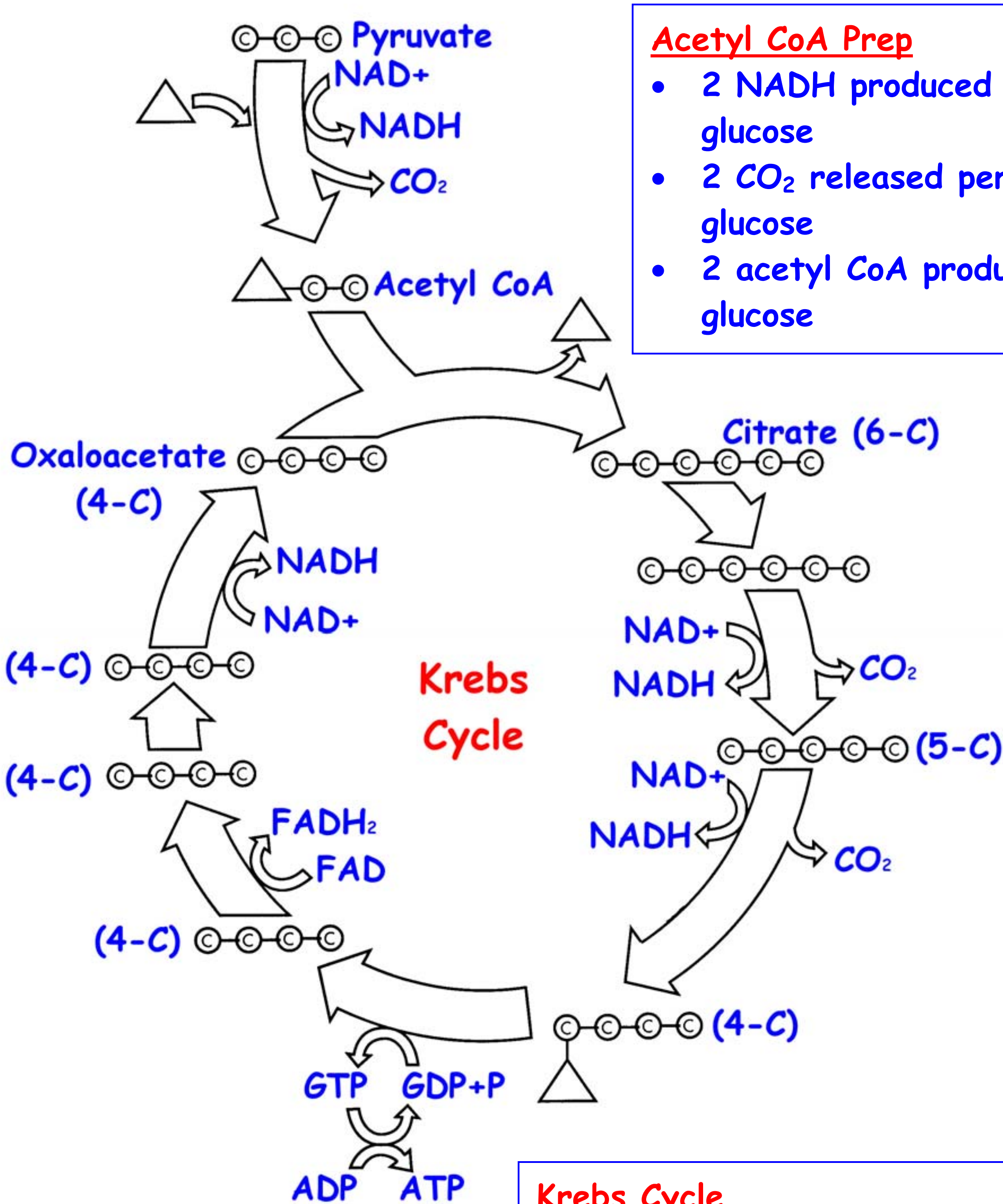
- 2 ATP used
- Glucose split

Energy yielding

- 2 NADH produced
- 4 ATP produced
- 2 pyruvate produced

KREBS CYCLE

Location = matrix of mitochondria



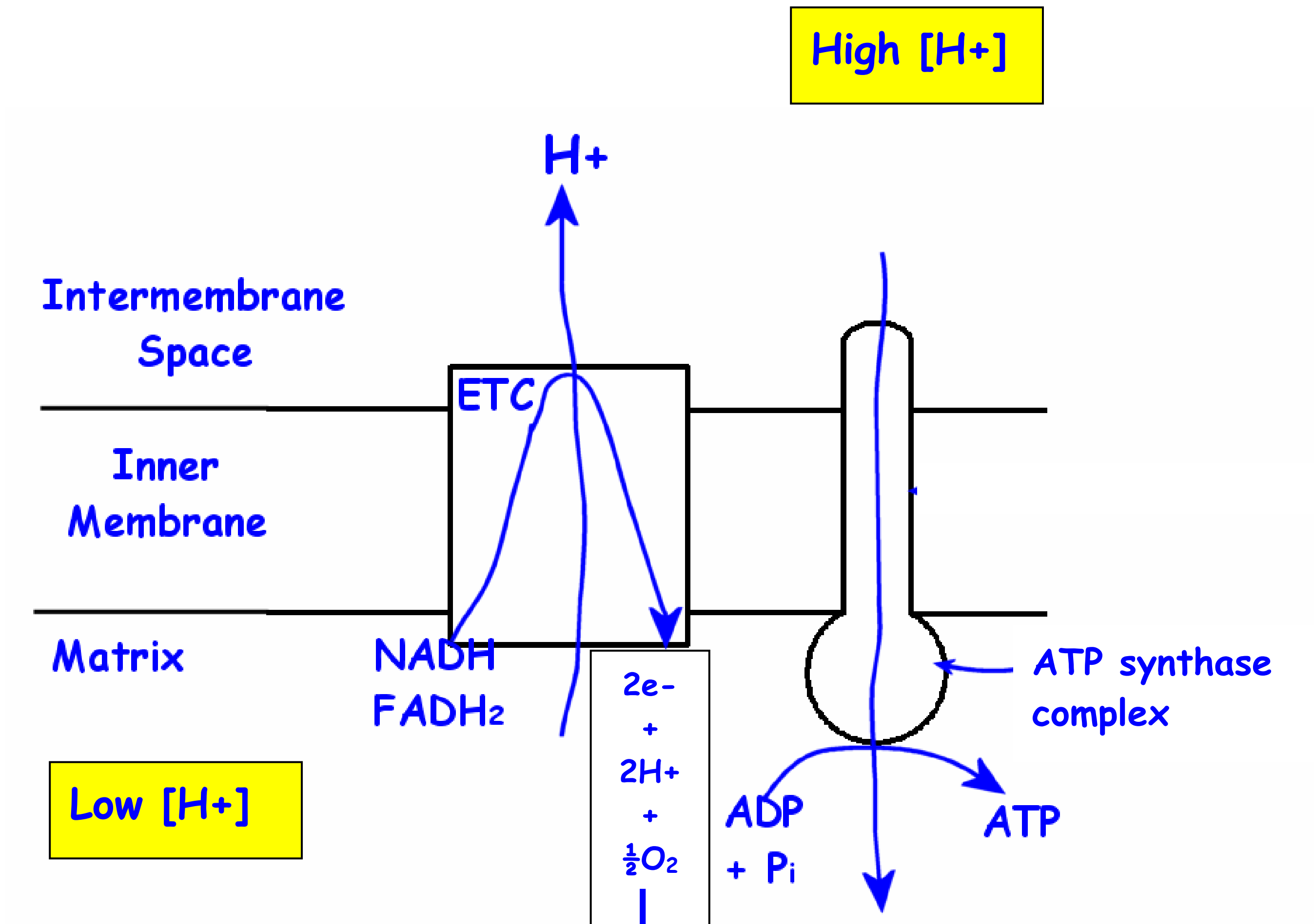
Acetyl CoA Prep

- 2 NADH produced per glucose
- 2 CO_2 released per glucose
- 2 acetyl CoA produced per glucose

Krebs Cycle

- Acetyl group added to oxaloacetate to make citrate
- 4 CO_2 released per glucose
- 6 NADH produced per glucose
- 2 $FADH_2$ produced per glucose
- Oxaloacetate regenerated

Electron Transport & Oxidative Phosphorylation



1. ETC accepts e- from NADH & $FADH_2$
2. e- passes to molecules in ETC
3. When some ETC molecules accept e- must also accept H+
4. H+ released to opposite side of membrane when e- passed to next molecule; creates high [H+] conc. in intermembrane space
5. 2 e- + 2H+ + $\frac{1}{2}O_2 \rightarrow H_2O$
   Oxygen terminal e- acceptor

6. ATP synthase complex allows H+ to move down conc. gradient
7. KE of H+ to add P_i to ADP forming ATP

Red = path of e-
Green = H+

ELECTRON TRANSPORT & OXIDATIVE PHOSPHORYLATION

Complex 1 (yellow)

- NADH donates e- to complex 1
- When complex 1 accepts e- must also accept H+
- H+ released into intermembrane space when e- released

Ubiquinone

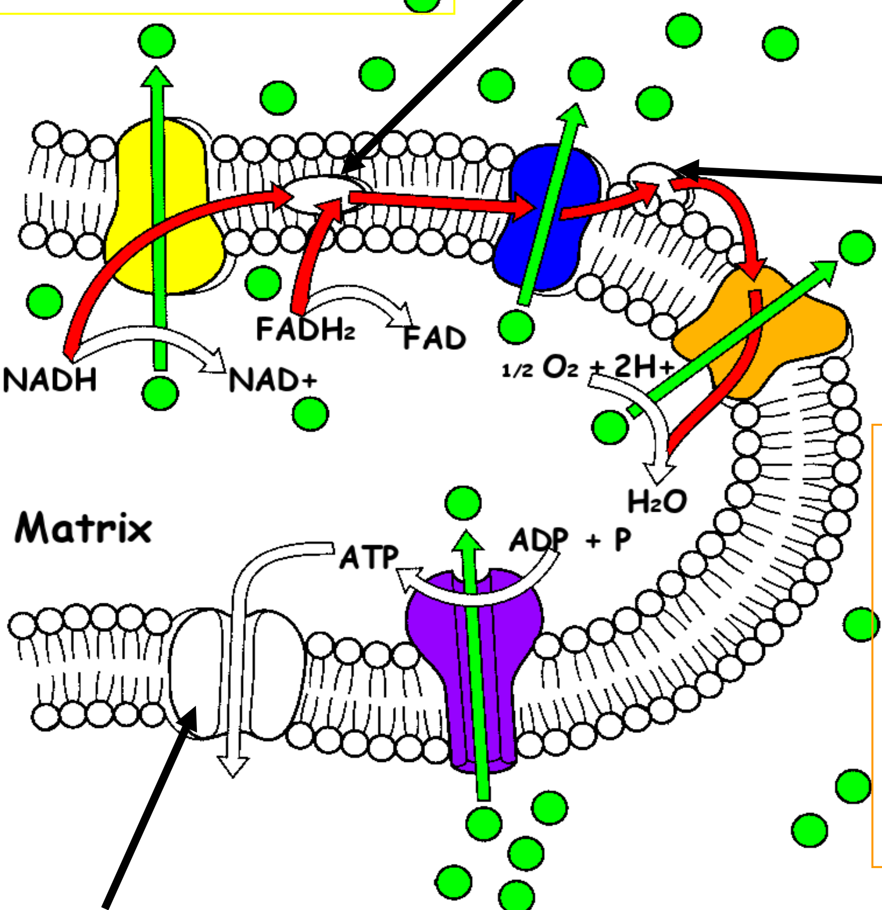
- Carries e- to next complex
- Accepts e- from $FADH_2$

Complex 2 (blue)

- When complex 2 accepts e- must also accept H+
- H+ released into intermembrane space when e- released

Cytochrome C

- Carries e- to next complex



Complex 3 (orange)

- When complex 3 accepts e- must also accept H+
- H+ released into intermembrane space when e- released
- e- passed to O_2
  $2e^- + 2H^+ + \frac{1}{2} O_2 \rightarrow H_2O$

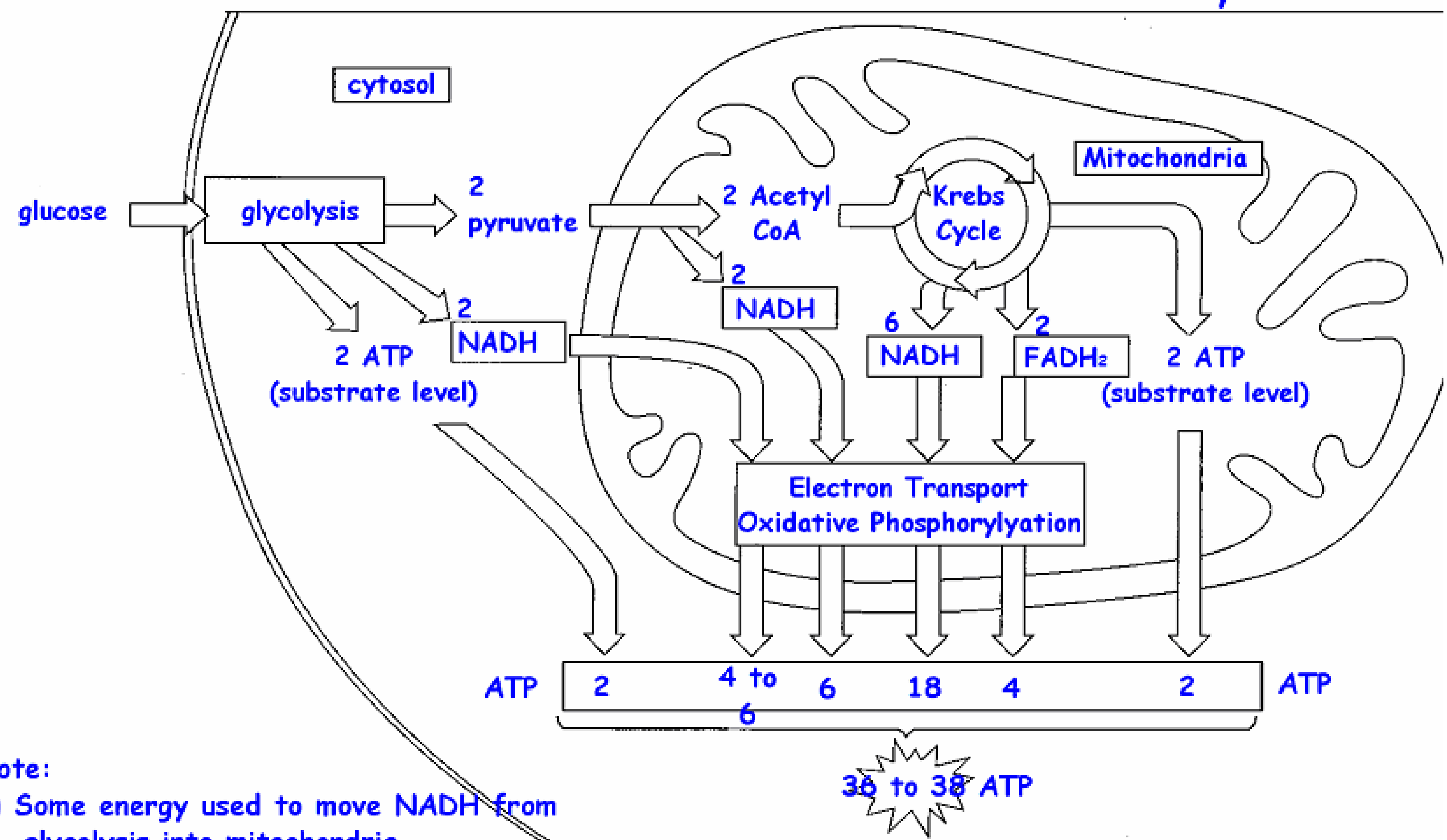
Transport protein

- Moves ATP out of matrix and out of mitochondrion

ATP Synthase Complex (purple)

- ATP synthase allows H+ to move down conc. gradient
- ATP synthase uses KE of H+ moving down conc. gradient to add P to ADP making ATP

ATP Production Summary



Note:
1) Some energy used to move NADH from glycolysis into mitochondria
2) $FADH_2$ adds electrons at lower level in ETC

ALCOHOL FERMENTATION

Glucose → 2 pyruvate
- 2 ATP produced
- 2 NADH produced

Pyruvate → acetyl aldehyde + CO_2

Acetyl aldehyde → ethanol
- Uses 2 NADH (NADH consumed to regenerate NAD+)

LACTIC ACID FERMENTATION

Glucose → 2 pyruvate
- 2 ATP produced
- 2 NADH produced

2 pyruvate → 2 lactate (ionized form of lactic acid)
- Uses 2 NADH (NADH consumed to regenerate NAD+)