ATP – Structure & Function
Anaerobic and Aerobic Respiration
Mitochondria Structure and Function

pp 17, 31, 86, 113,270-272, 349

pp 277-278, 272-275

Mrs Cooper ATP – On Your Own
https://www.youtube.com/watch?v=LL3OgI1wYrU

Mito pp 16-17, 276
Res pp 272-275, 277-278

G11 Biology 2017-2018

Learning Objective

1. Know the structure and function of ATP.
2. Compare the formation of ATP in aerobic and anaerobic respiration.
3. To establish the relationship of mitochondrial structure and processes of cellular respiration.

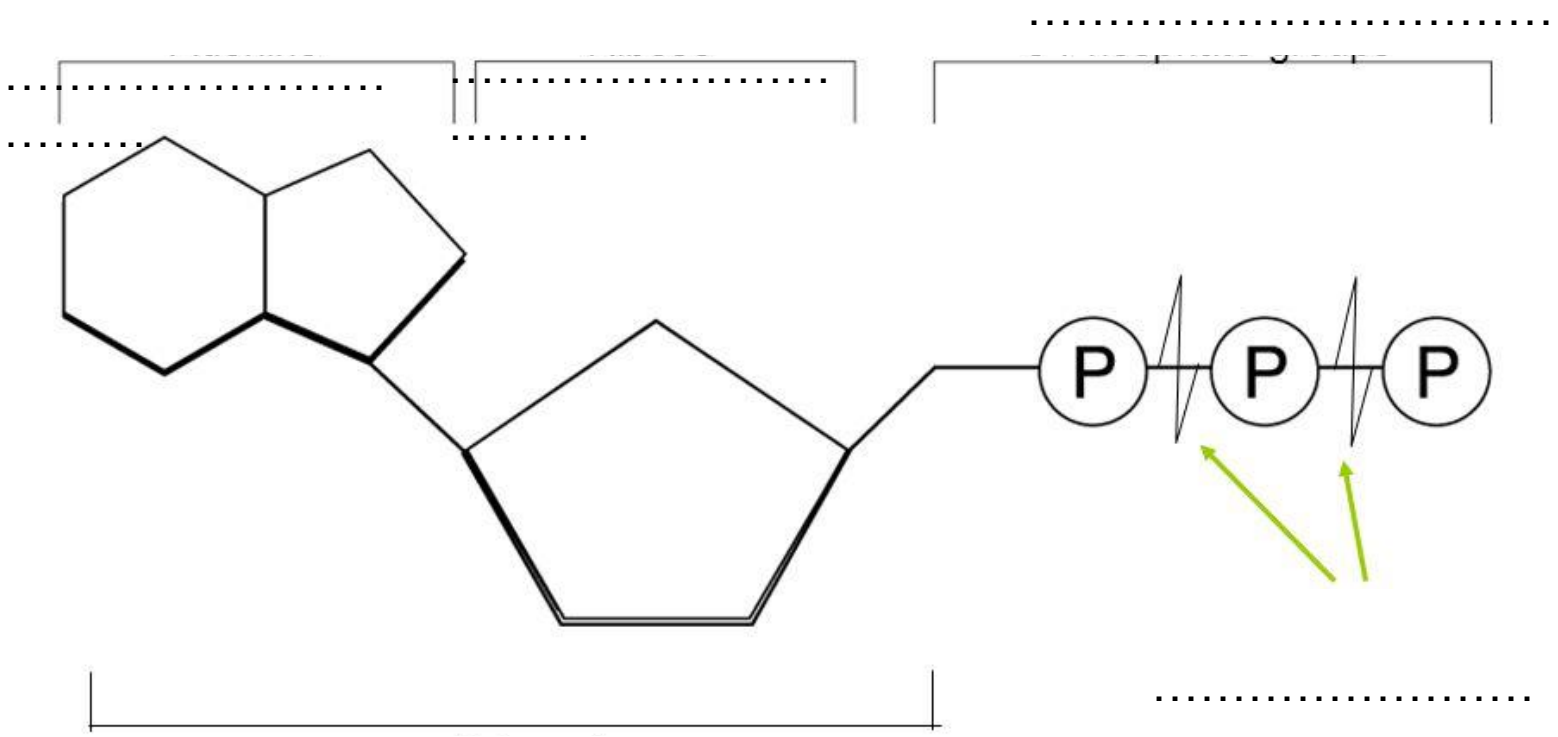
Success Criteria – To Be Determined

Terminology

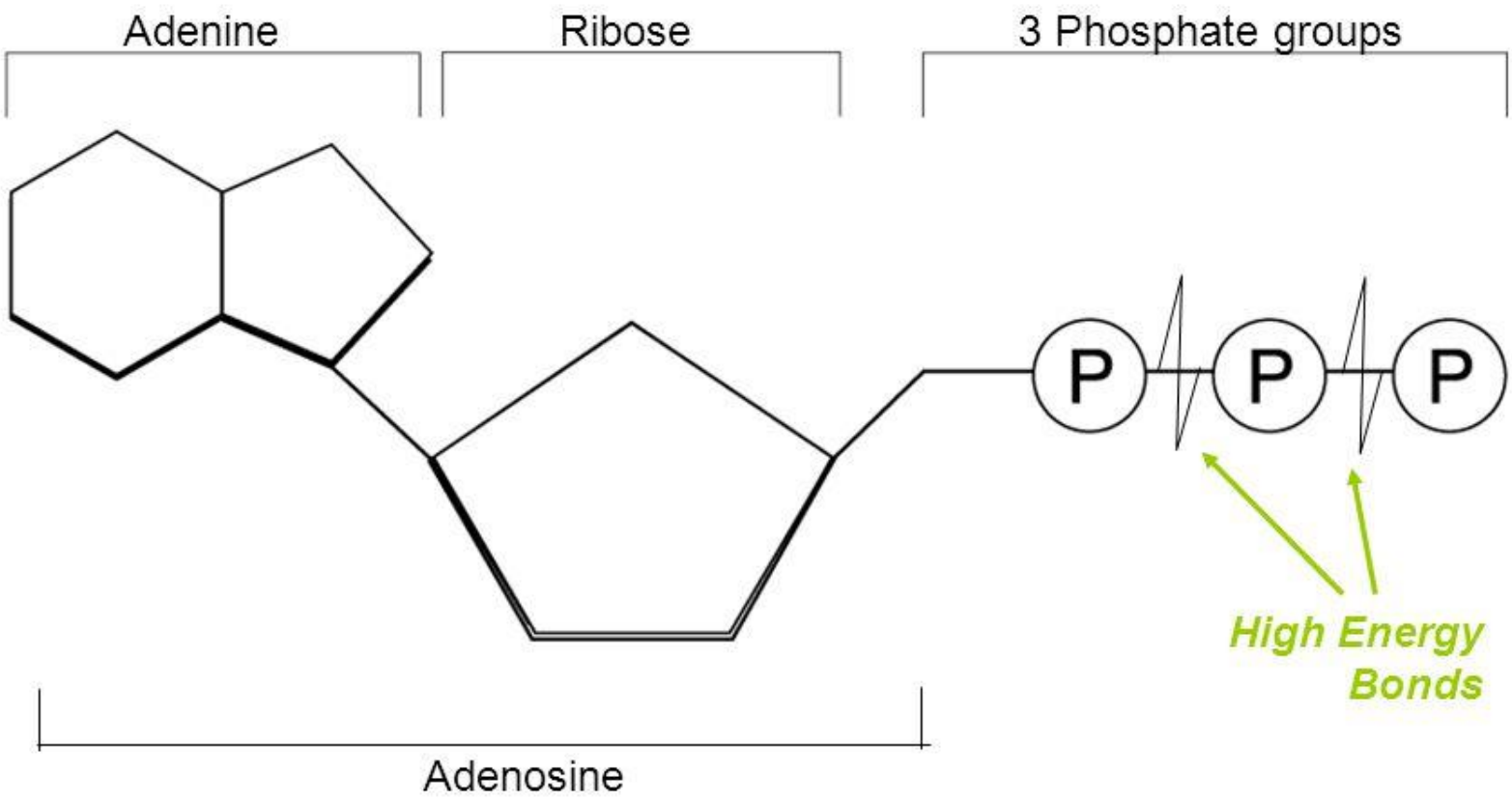
Prof Dave ATP – 4 min **In class**
https://www.youtube.com/watch?v=-6VyMFQ7rRo

English	Google Russian ☺
Adenosine Triphosphate (ATP)	Аденозинтрифосфат (АТФ)
Inorganic phosphate Pi	Неорганический фосфат Pi
currency	валюта
hydrolysis / condensation	гидролиз / конденсация
Metabolic	метаболический
catabolic, breakdown	катаболизм, пробой
anabolic, build	анаболический, строить
Anaerobic / aerobic	Анаэробные / аэробные
respiratory pathways	дыхательные пути
substrate level phosphorylation	фосфорилирование уровня субстрата
oxidative phosphorylation	окислительного фосфорилирования

Adenine High Energy Bonds Phosphate Ribose Nucleoside



Adenosine Triphosphate - ATP



Adenosine TriphosPhate

Universal Energy Currency – **all living things use ATP as an energy source**

Structure of adenosine triphosphate (ATP)

The ATP molecule (Figure 1) is a phosphorylated nucleotide and it has three parts:

- **Adenine** – a nitrogen-containing organic base belonging to the group called purines.
- **Ribose** – a sugar molecule with a 5-carbon ring structure (pentose sugar) that acts as the backbone to which the other parts are attached.
- **Phosphates** – a chain of three phosphate groups.

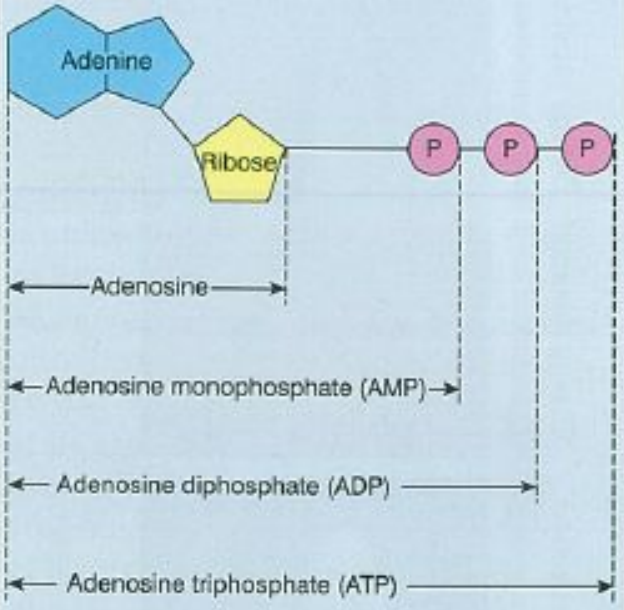
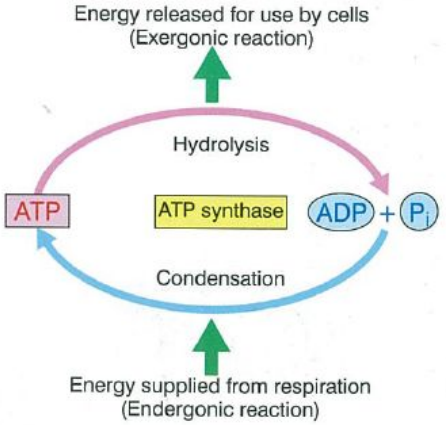


Figure 1 Structure of ATP

Reasons for ATP's Universal Success

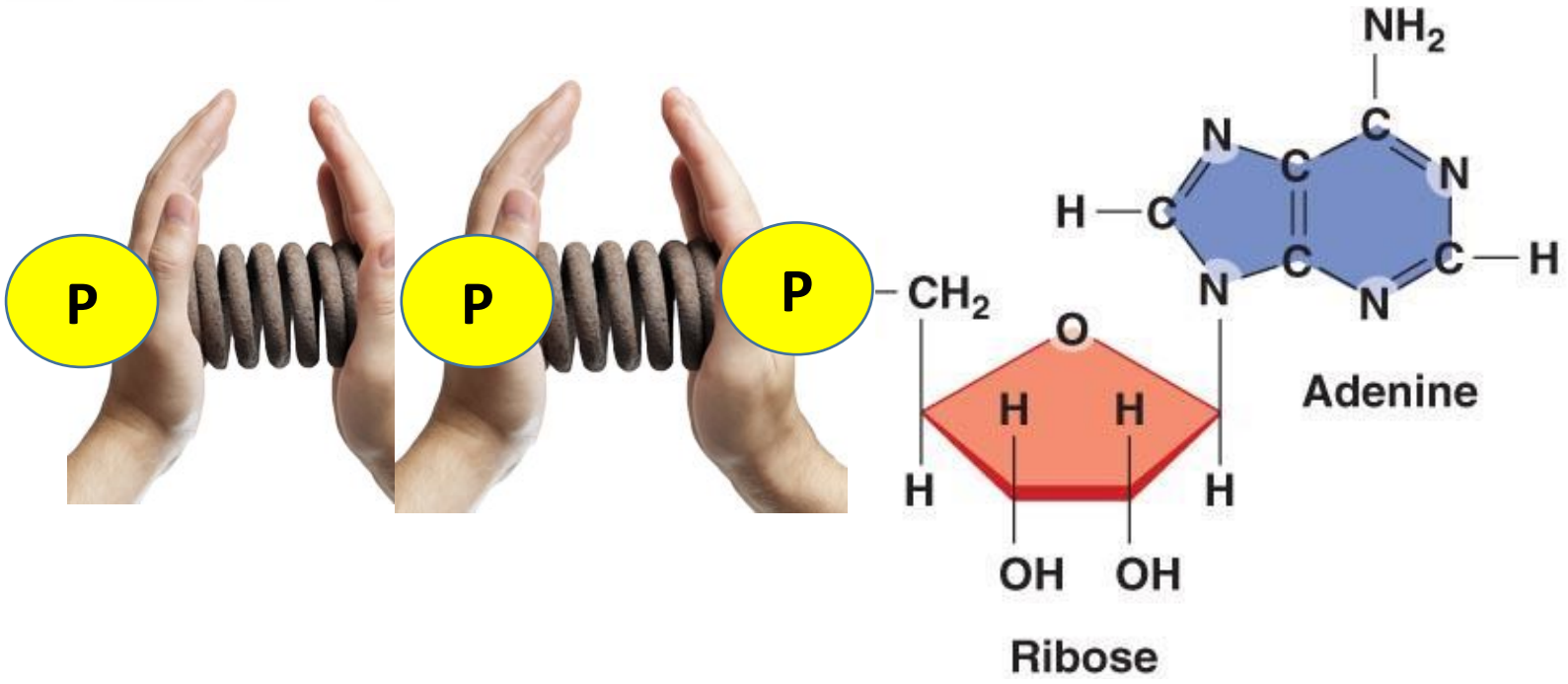
1. **ATP is water soluble**
2. **ATP diffuses though a cell easily.**
3. **It easily hydrolyzed to release energy**
4. **It recycles/cycles ATP □□ ADP + Pi**

Phosphate bonds are are easily broken
-Easily release their energy
-ATP is Recycled ☺ □
-ATP releases a lot of energy 30.5 kJ



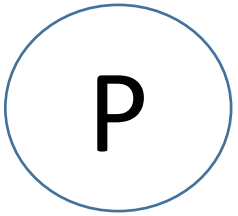
$$\underset{\text{adenosine triphosphate}}{ATP} + \underset{\text{water}}{H_2O} \rightleftharpoons \underset{\text{adenosine diphosphate}}{ADP} + \underset{\text{inorganic phosphate}}{P_i} + \underset{\text{energy}}{30.5\,kJ}$$

$$\underset{\substack{\text{adenosine}\\\text{triphosphate}}}{ATP} + \underset{\text{water}}{H_2O} \rightleftharpoons \underset{\substack{\text{adenosine}\\\text{diphosphate}}}{ADP} + \underset{\substack{\text{inorganic}\\\text{phosphate}}}{P_i} + \underset{\text{energy}}{30.5\,kJ}$$



Energy stored bond between phosphates like a coiled spring.

Diagram and Label on your desk
ATP, ADP, AMP

Inorganic Phosphate 

or Pi

Adenine

Ribose

Check your neighbors work!

How do living things use ATP?

List as many as you can on your desk ☺️

Compare with your neighbors ☺️ ☺️

Just a few ways living things use ATP.

DNA replication – growth and development

Protein synthesis – growth, development, and important biological molecules (enzymes, hormones, muscle tissue)

Movement – muscles must to have ATP power contraction

Body heat – the metabolic reactions release the energy stored in ATP to your body.

Active Transport – ATP provides energy to move molecules against the gradient.

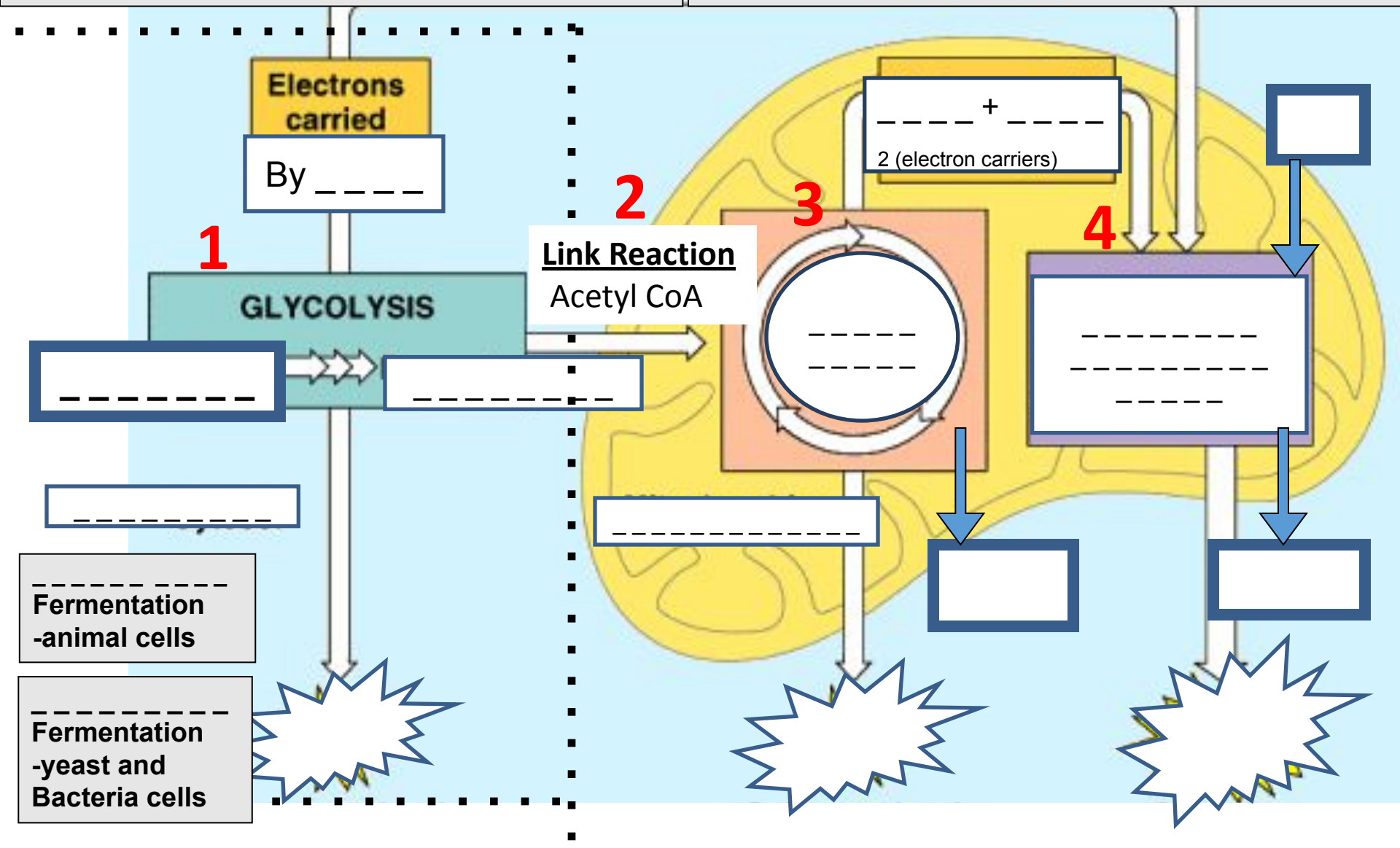
An amoeba eating food phagocytosis
https://www.youtube.com/watch?v=W6rnhiMxtKU

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

oxygen + glucose → carbon dioxide + water + energy

_ _ _ _ _ _ _ _ _ respiration in **ALL** Cells

_ _ _ _ _ _ _ respiration in **Eukaryotic Cells**



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

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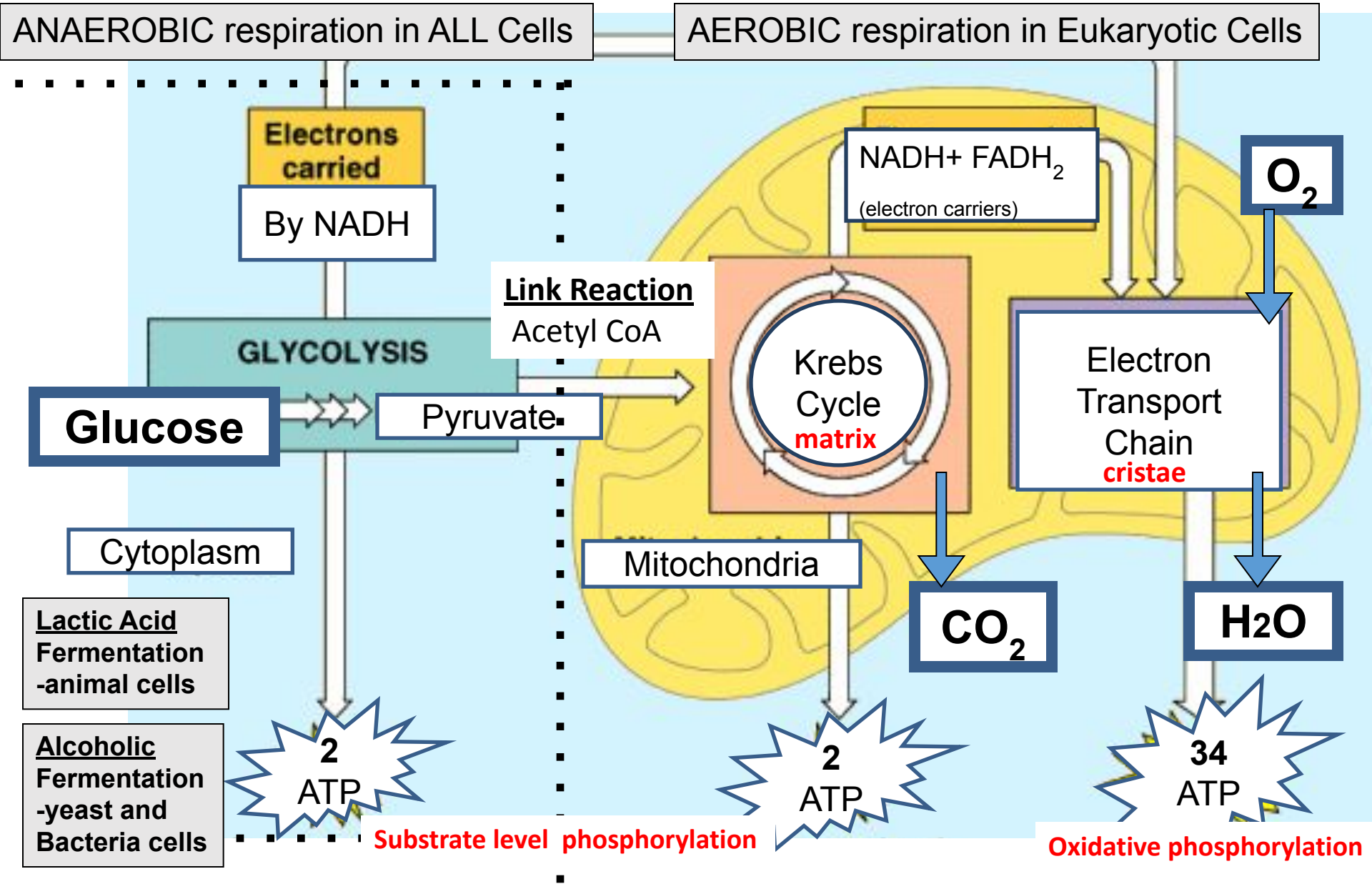
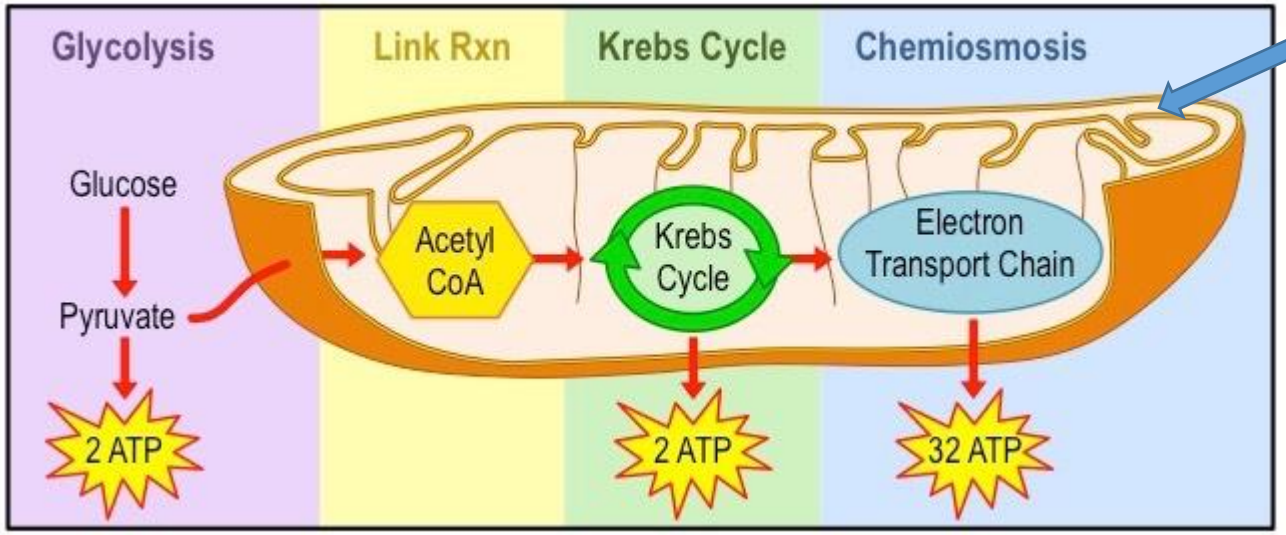


Cellular Respiration

Cytoplasm **matrix** **matrix** **Inner mitochondrial membrane - cristae**
Ox Phos / ETC

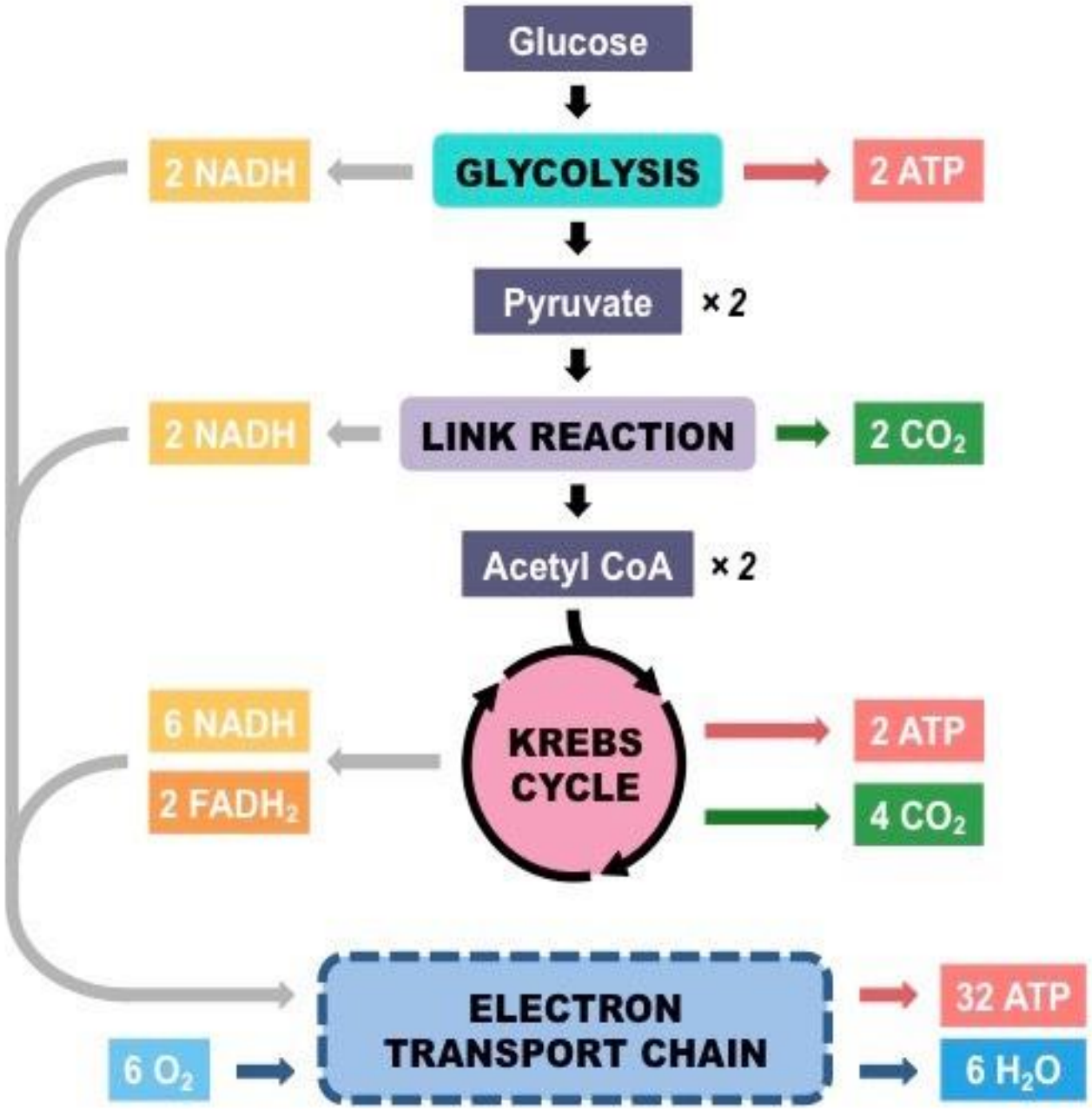


Inner membrane space
Proton Motive Force
PMF **H+ H+**
Gradient that runs ATPase

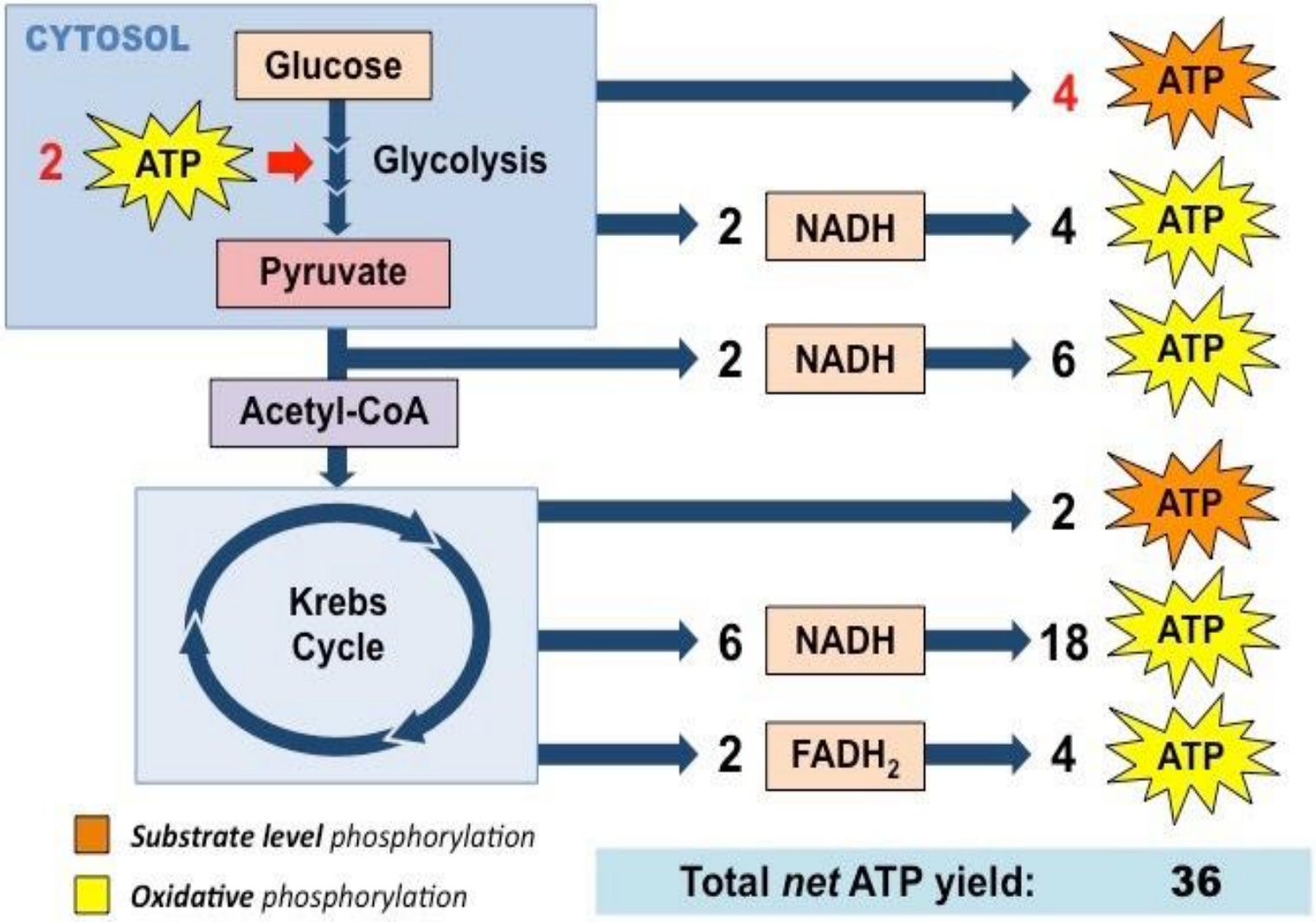
Mitochondria size 1 – 10µm

Vocabulary

Final electron acceptor
Stalked particle
Rotor
Coiled spring
Oxygen debt


Glucose
GLYCOLYSIS
2 NADH
2 ATP
Pyruvate
× 2
LINK REACTION
2 NADH
2 CO_2
Acetyl CoA
× 2
KREBS CYCLE
6 NADH
2 $FADH_2$
2 ATP
4 CO_2
ELECTRON TRANSPORT CHAIN
6 O_2
32 ATP
6 H_2O

ATP Production



1 NADH □ 2.5 -3 ATP

1 $FADH_2$ □ 1.5- 2 ATP

Aerobic Respiration
ATP Molecules from 1 Glucose

Substrate Level phosphorylation

Glycolysis……
……. 2

Krebs……
……2

Oxidative phosphorylation

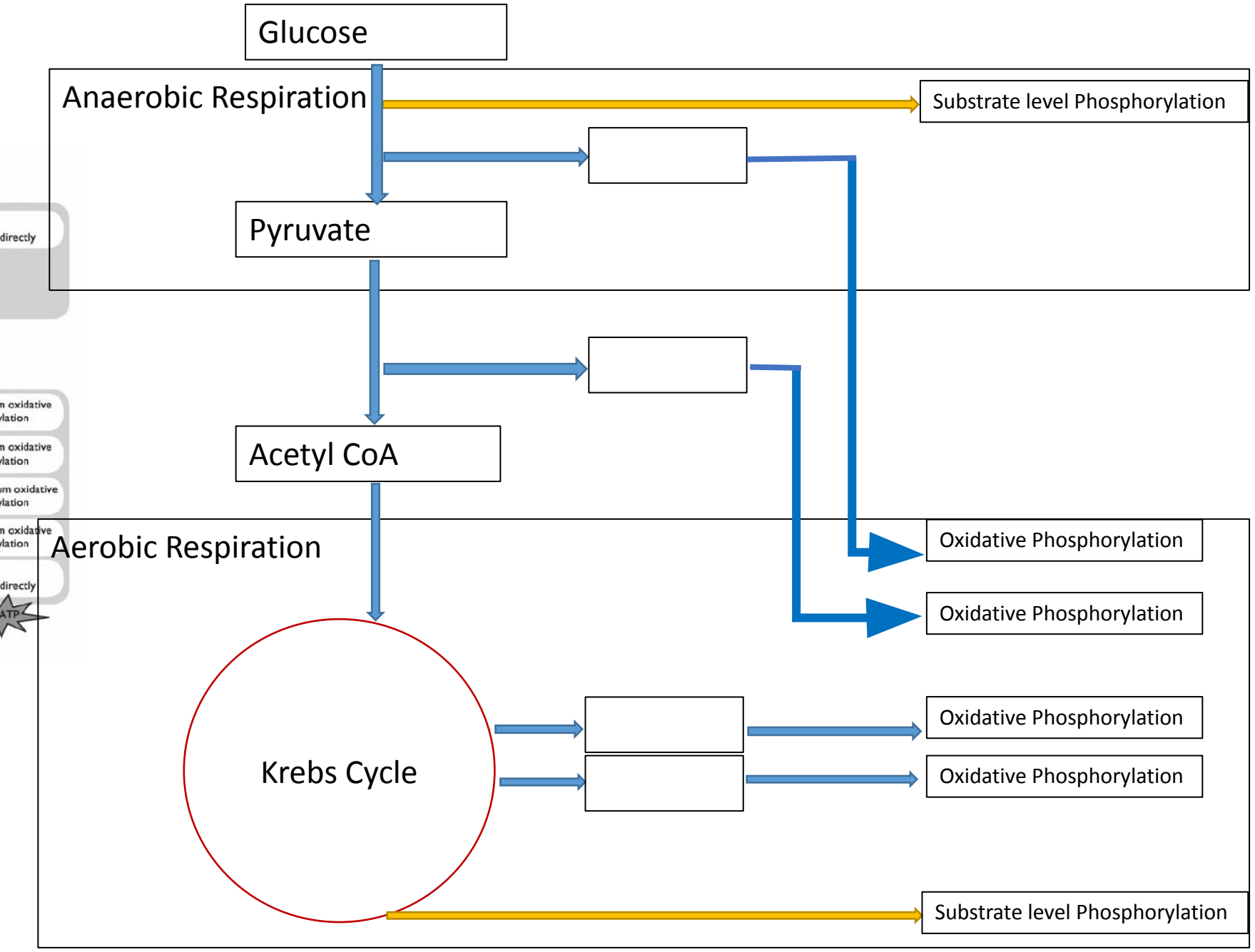
2 reduced from NAD from glycolysis ……..6

8 reduced from NAD from Krebs cycle …….24

2 reduced from FAD from Krebs cycle …… 4

Perspective

Aerobic Respiration is only 33% efficient. A car is 25% efficient.


Glucose
Anaerobic Respiration
Substrate level Phosphorylation
Pyruvate
Acetyl CoA
Aerobic Respiration
Oxidative Phosphorylation
Oxidative Phosphorylation
Krebs Cycle
Oxidative Phosphorylation
Oxidative Phosphorylation
Substrate level Phosphorylation

Substrate-level phosphorylation

-direct formation of ATP from the transfer of a phosphate from a substrate to ADP.

-occurs in glycolysis and the Krebs cycle.

Oxidative Phosphorylation (ETC)

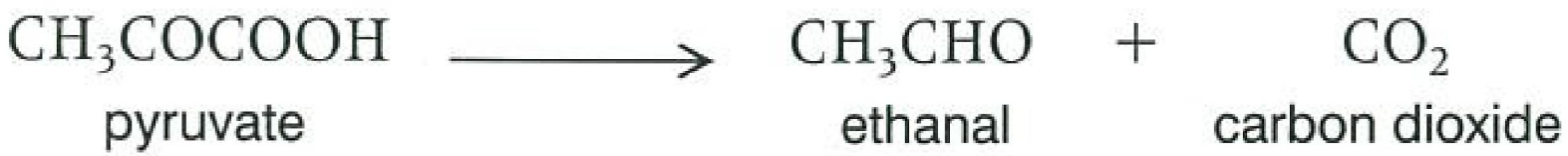
-indirect formation of ATP from the oxidation of NADH and $FADH_2$ and the next step of the transfer of electrons and pumping of protons and using O_2 as a final acceptor

-occurs via the electron transport chain

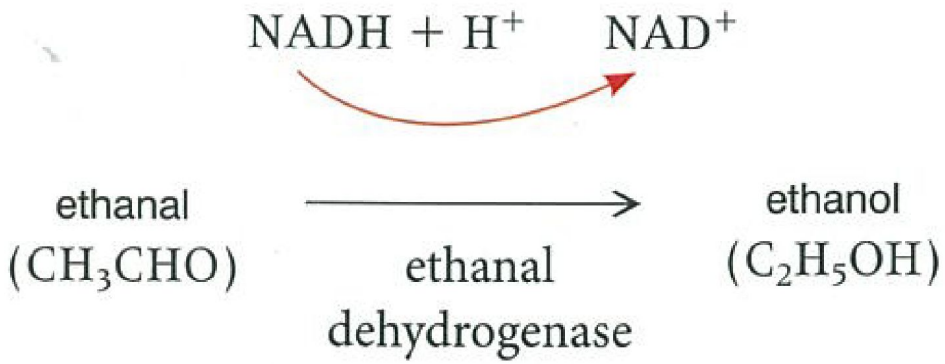
Anaerobic Respiration

Alcoholic Fermentation – 2 step process

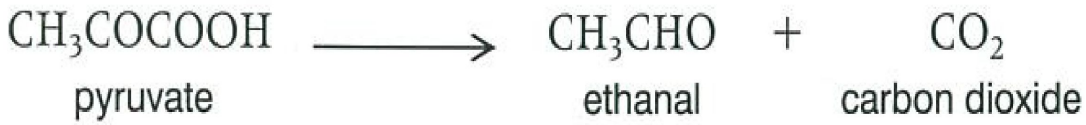
1. Decarboxylation of pyruvate



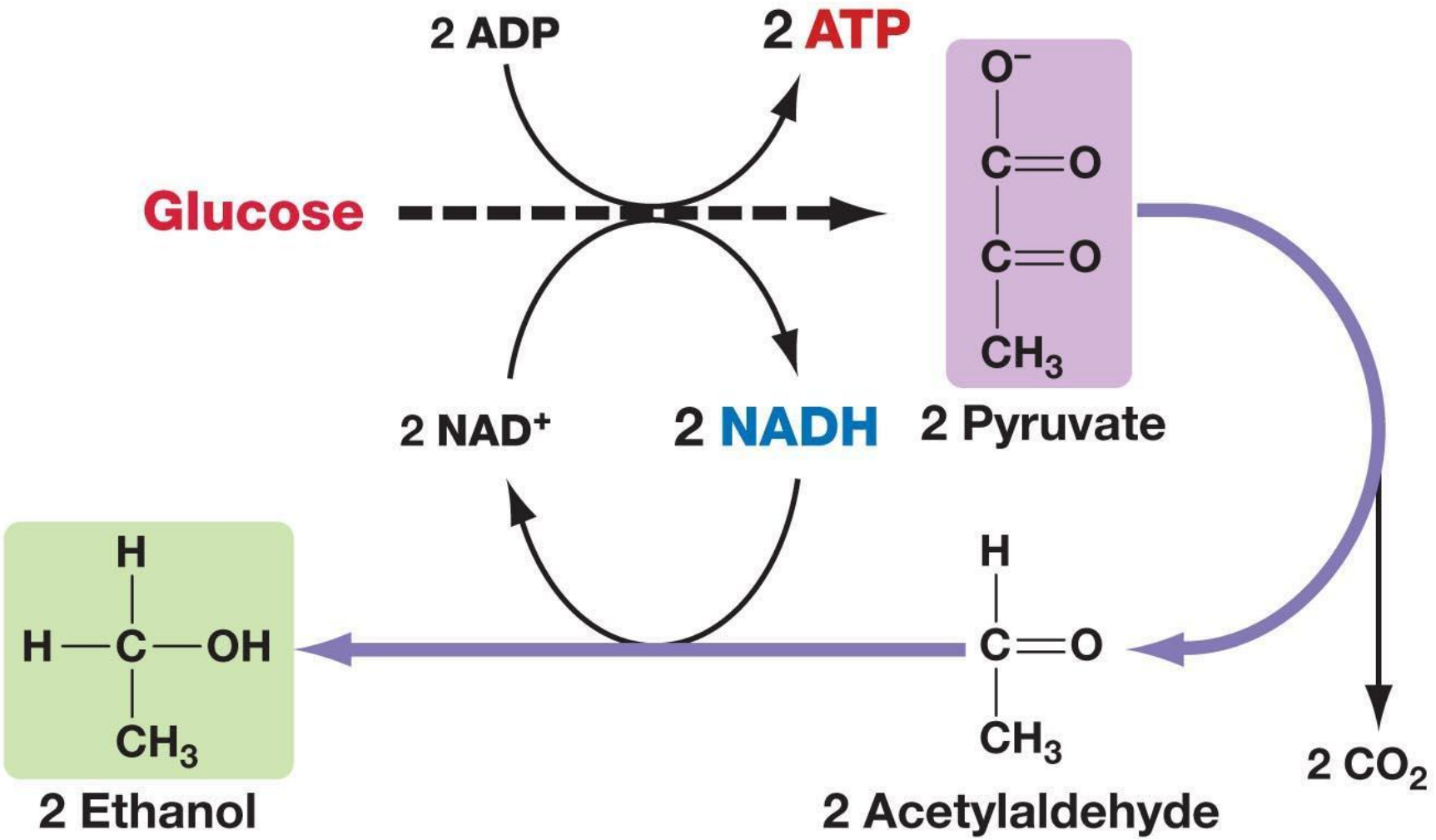
2. Ethanol accepts 1 hydrogen from NADH + H+ to form Ethanol



Summary Diagram



(b) Alcohol fermentation occurs in yeast.



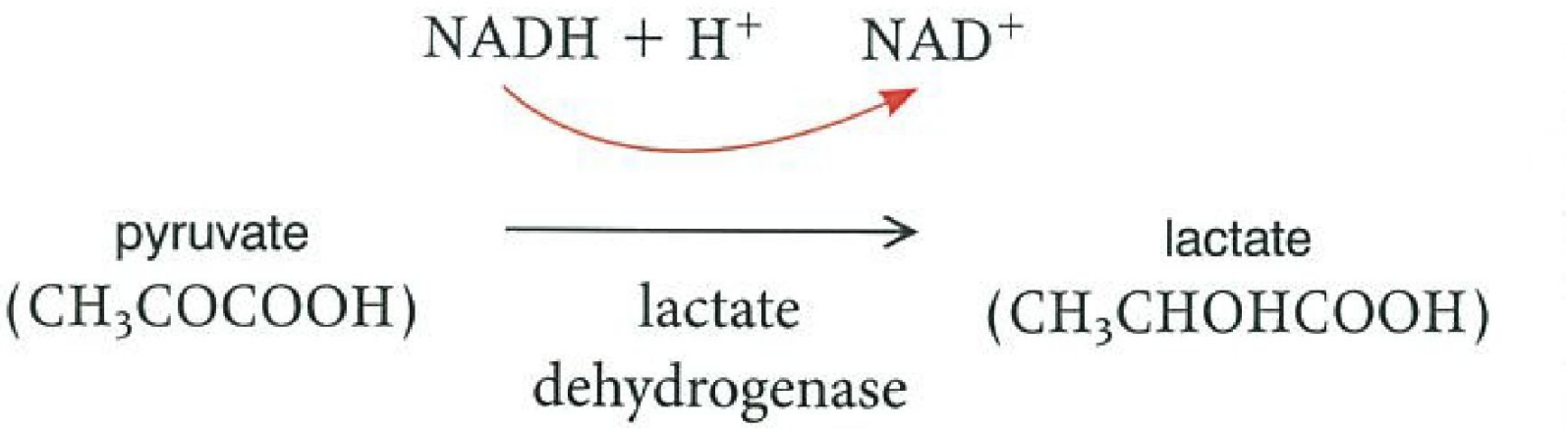
Anaerobic Respiration

Lactic Acid Fermentation in animals to overcome lack of oxygen

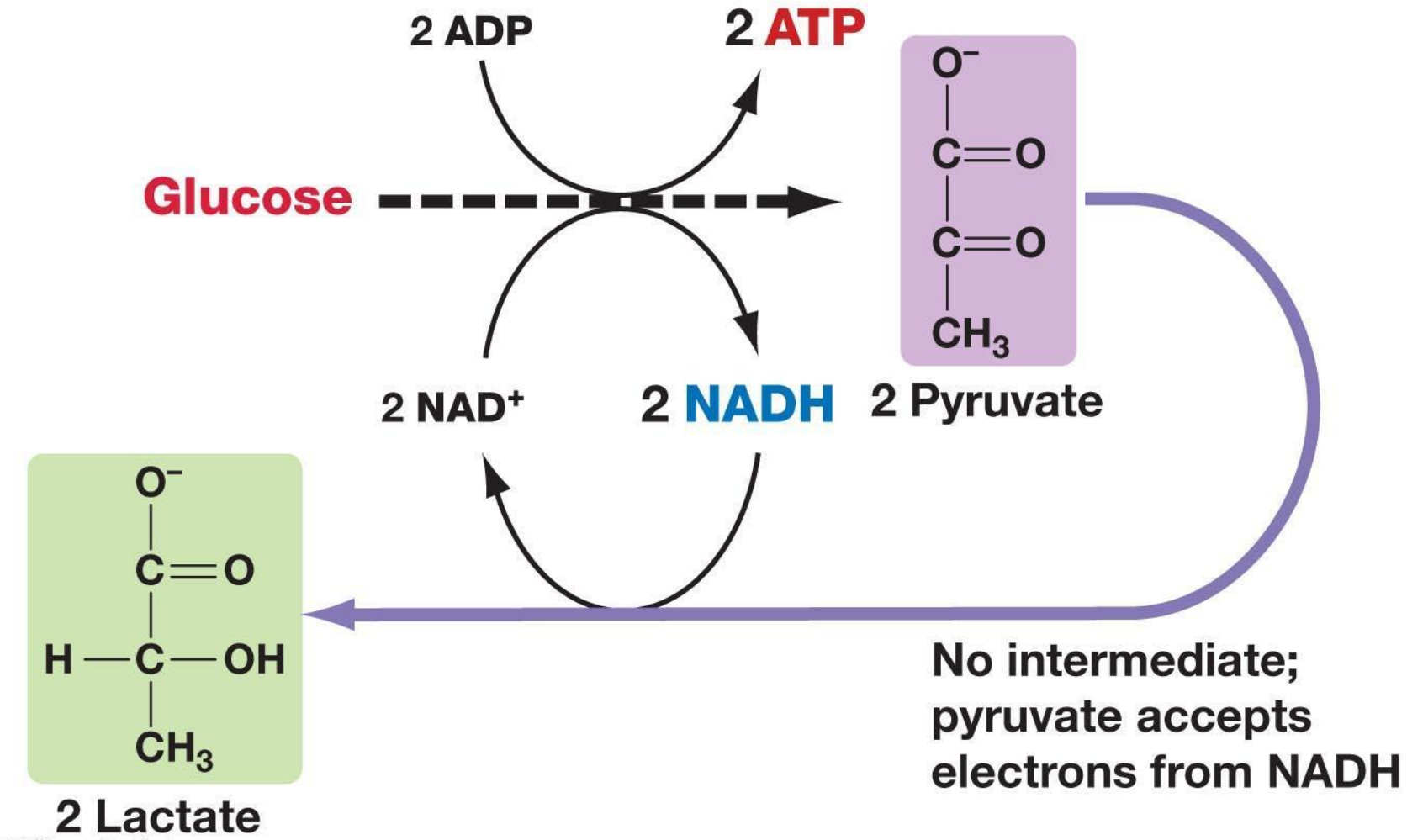
Oxygen Debt – when oxygen is used up more rapidly than it can be supplied.

Once oxygen is available again NADH is regenerated and lactate returns to pyruvate

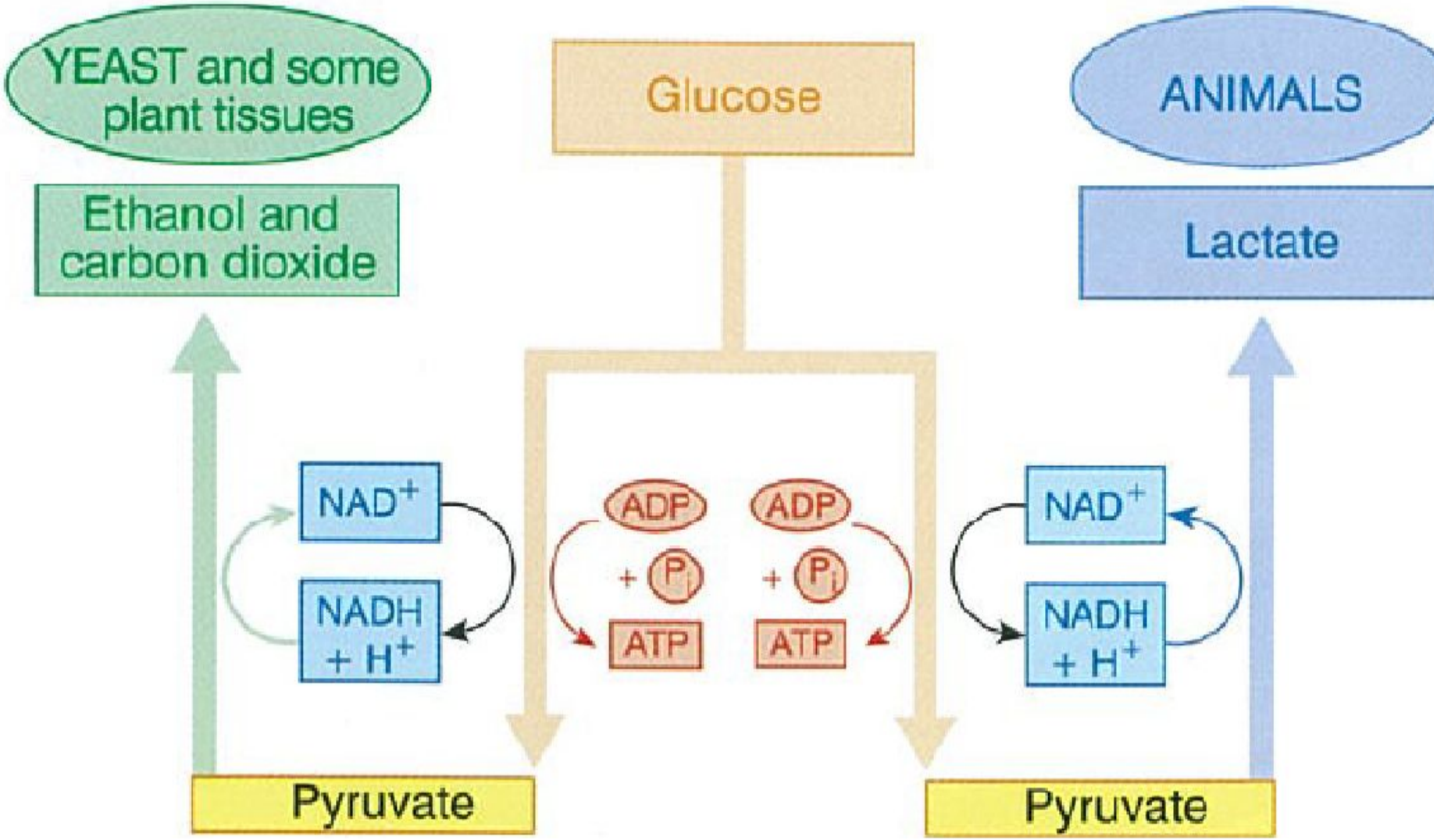
1. Each pyruvate takes up 2- hydrogens from NADH + H to form lactate (Lactic Acid)



(a) Lactic acid fermentation occurs in humans.

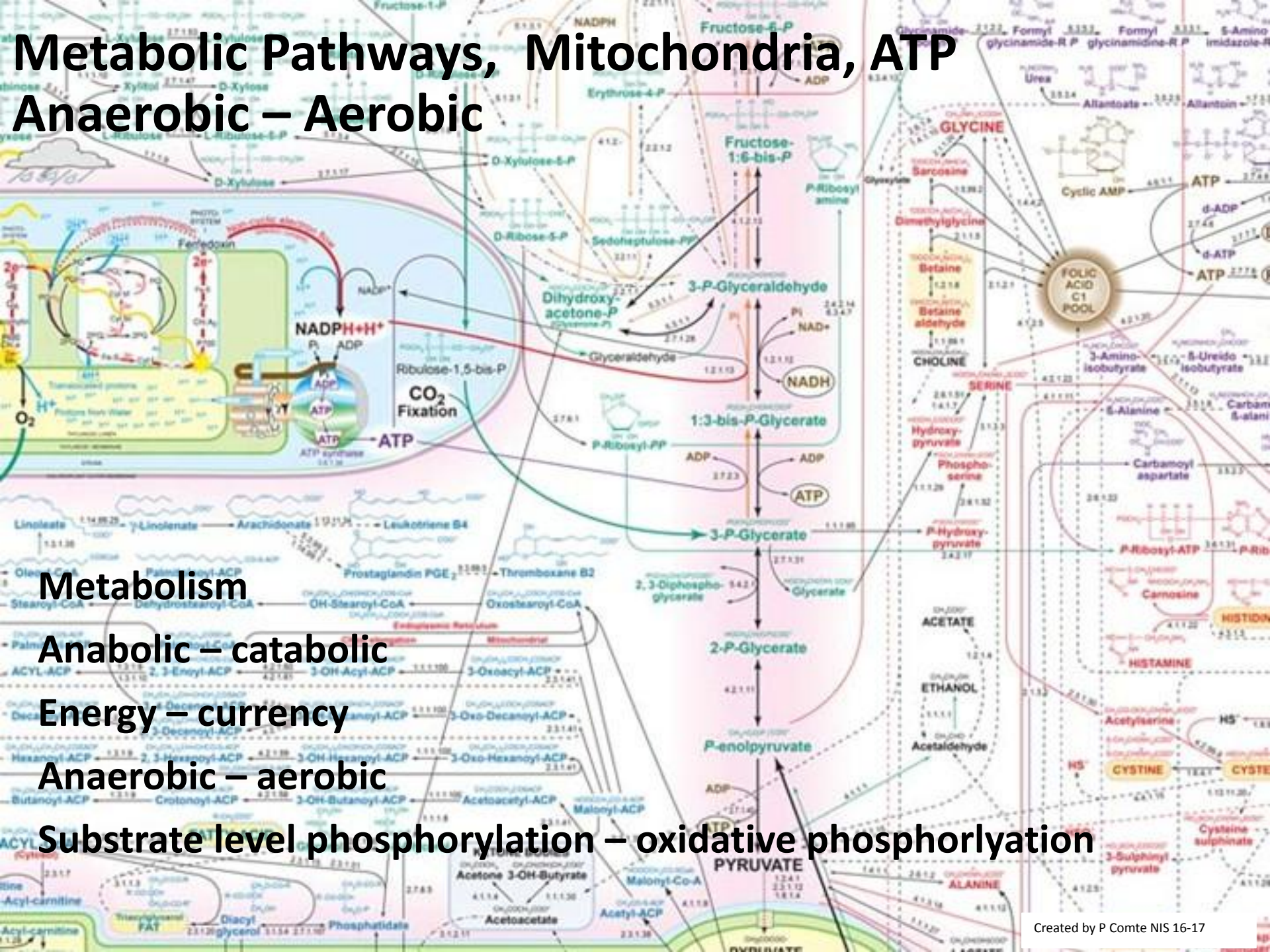


How the NAD+ needed for glycolysis is **regenerated** during fermentation in yeast and animal cells.



End

Metabolic Pathways, Mitochondria, ATP Anaerobic – Aerobic



Metabolism

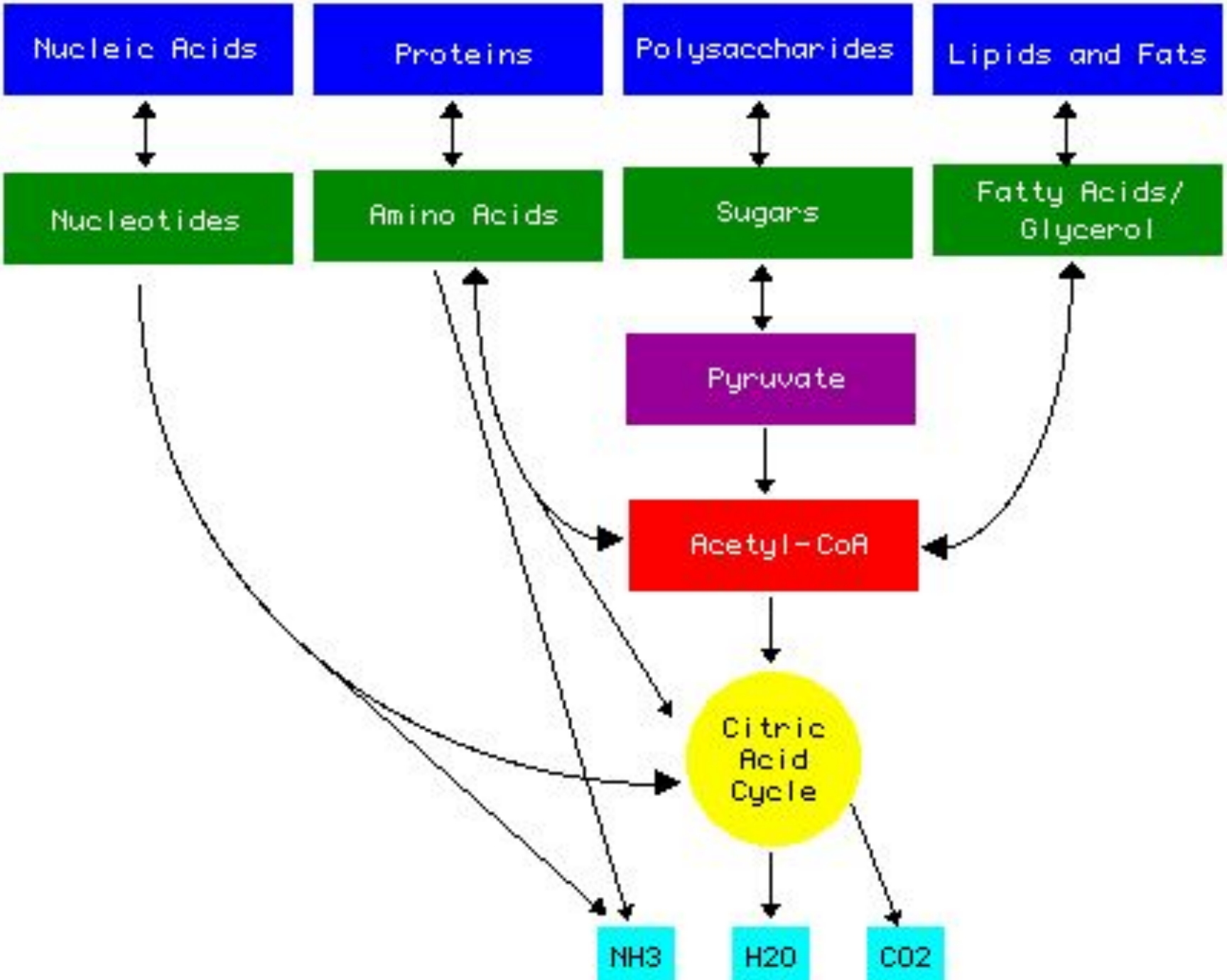
Anabolic – catabolic

Energy – currency

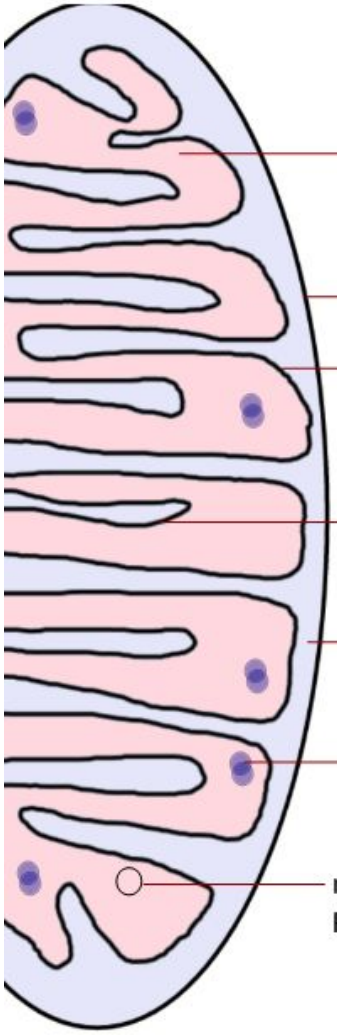
Anaerobic – aerobic

Substrate level phosphorylation – oxidative phosphorlyation

Created by P Comte NIS 16-17


Nucleic Acids
Proteins
Polysaccharides
Lipids and Fats
Nucleotides
Amino Acids
Sugars
Fatty Acids/
Glycerol
Pyruvate
Acetyl-CoA
Citric
Acid
Cycle
NH3
H2O
CO2

If oxygen is present, reactions move to the mitochondria:



Matrix
contains enzymes and solutes for
Link Reaction and Krebs Cycle

Outer Mitochondrial Membrane

Inner Mitochondrial Membrane
site for electron transport chain and oxidative phosporylation

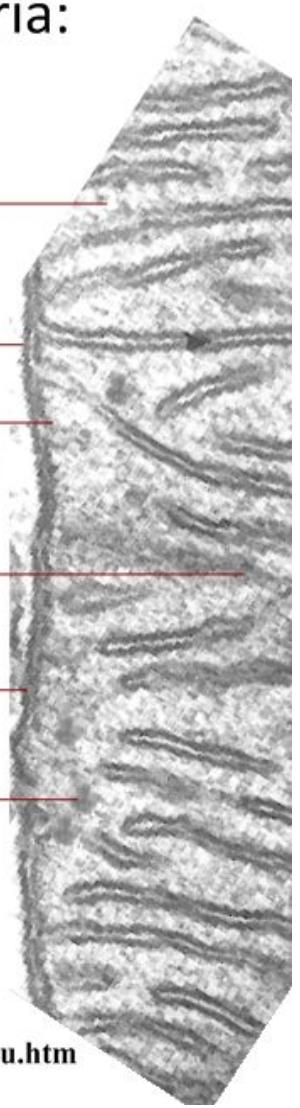
folded into

Cristae
to maximise surface area for reactions

Small Inter-membrane Space
more efficient generation of H+ concentration gradient

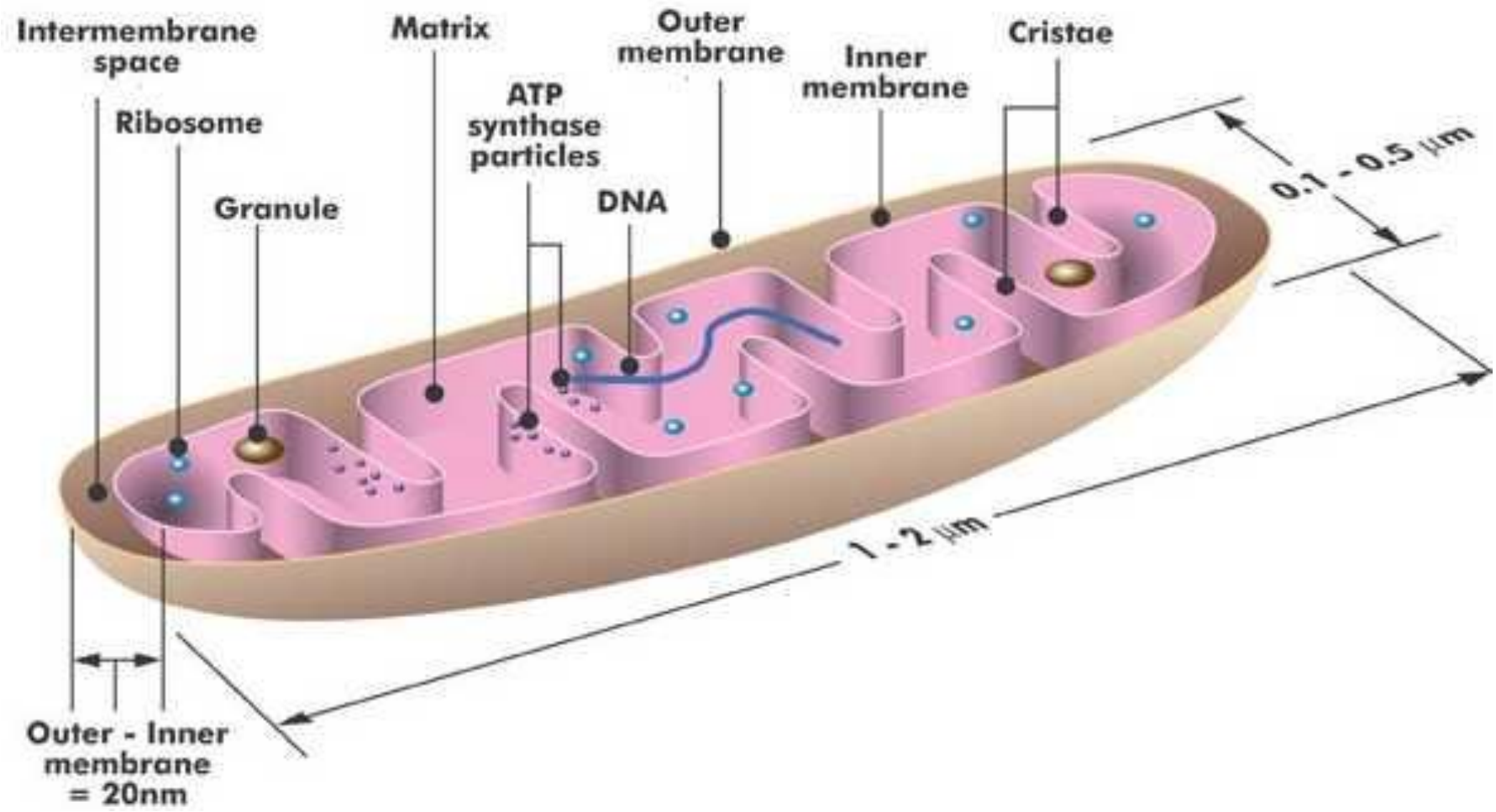
70S Ribosomes
protein production

naked loops of DNA (mitochondrial DNA/ mDNA)
Passed unchanged from mother to child

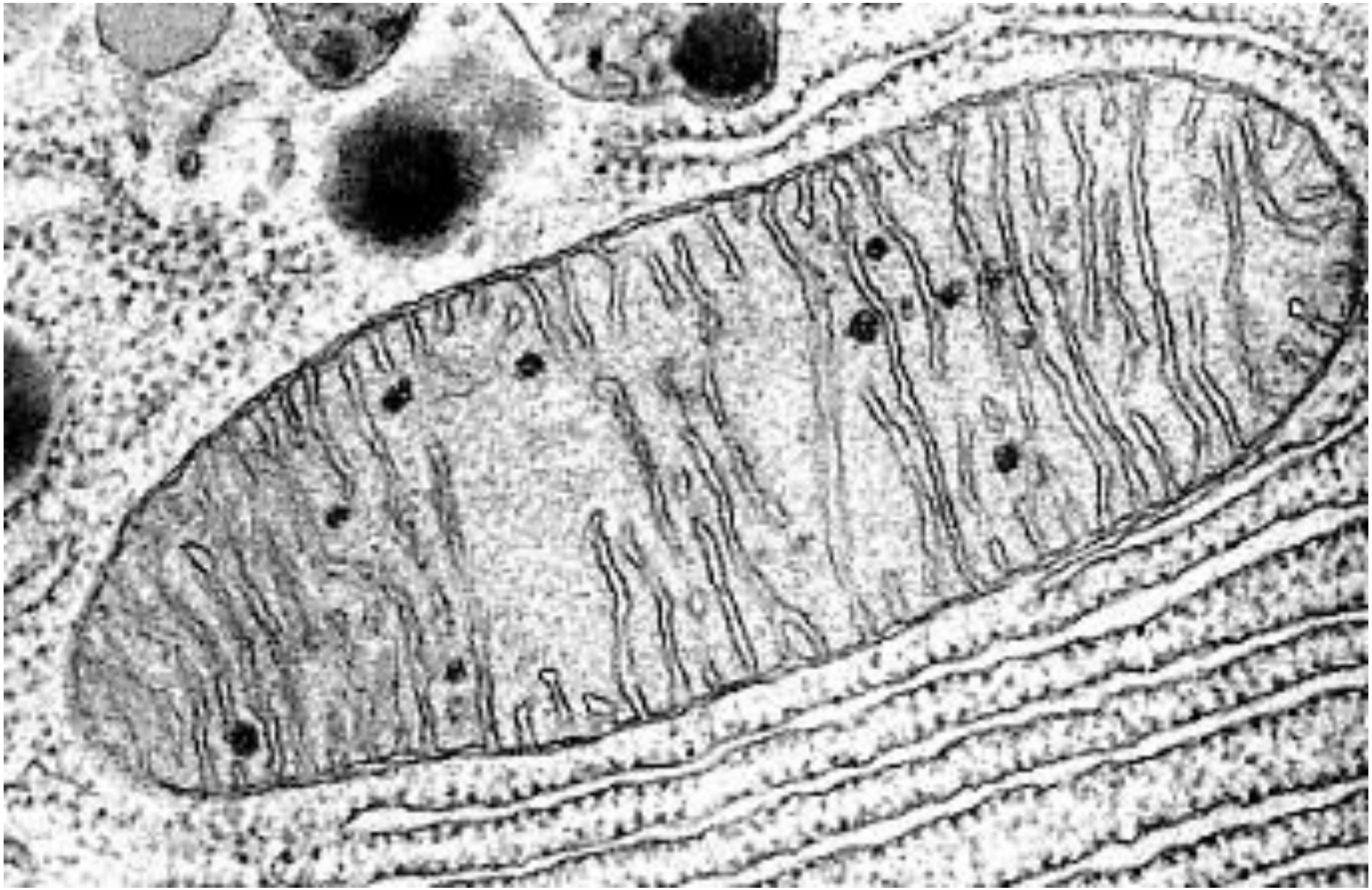


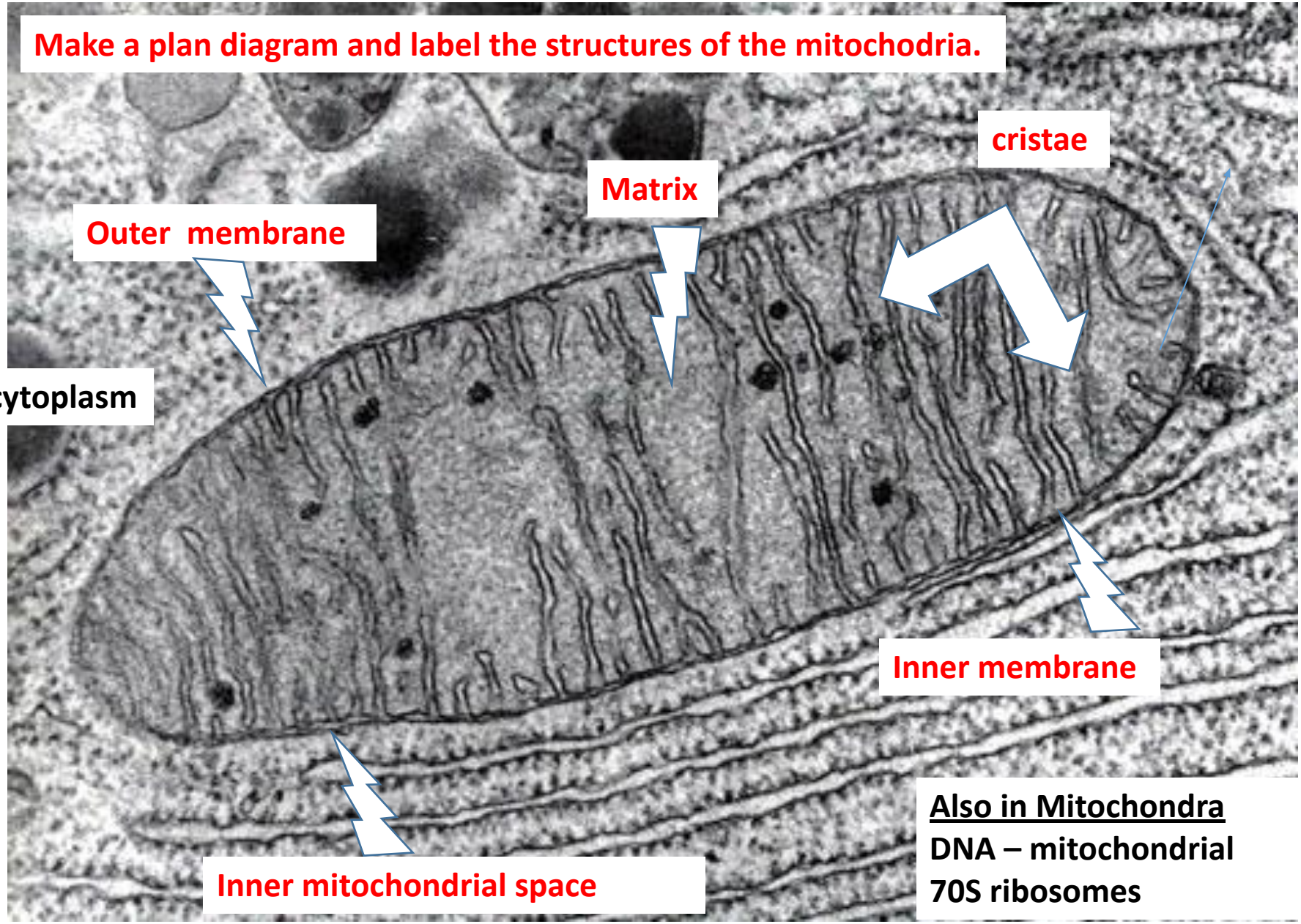
1µm

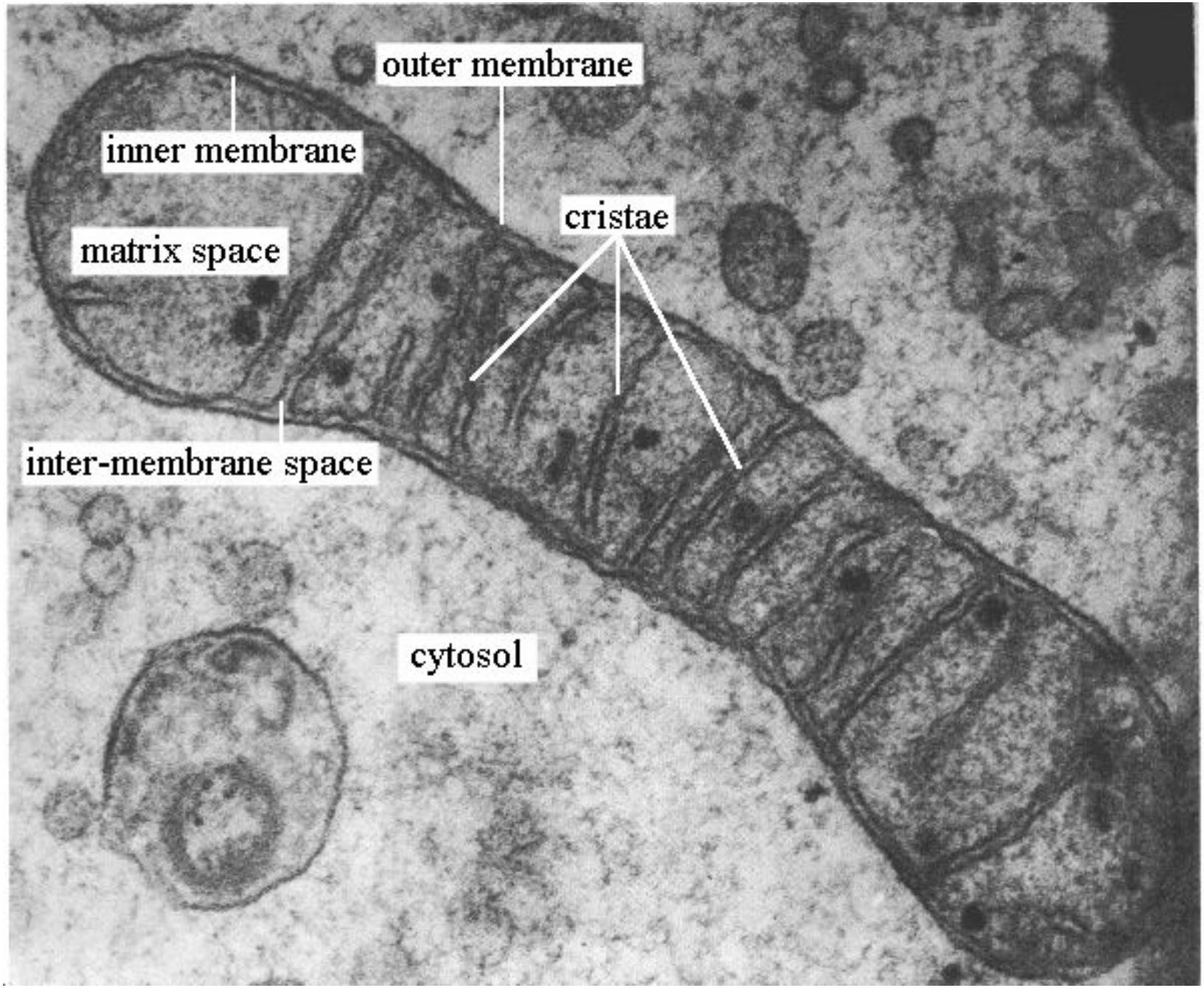
http://www.udel.edu/biology/Wags/histopage/empage/ecu/ecu.htm

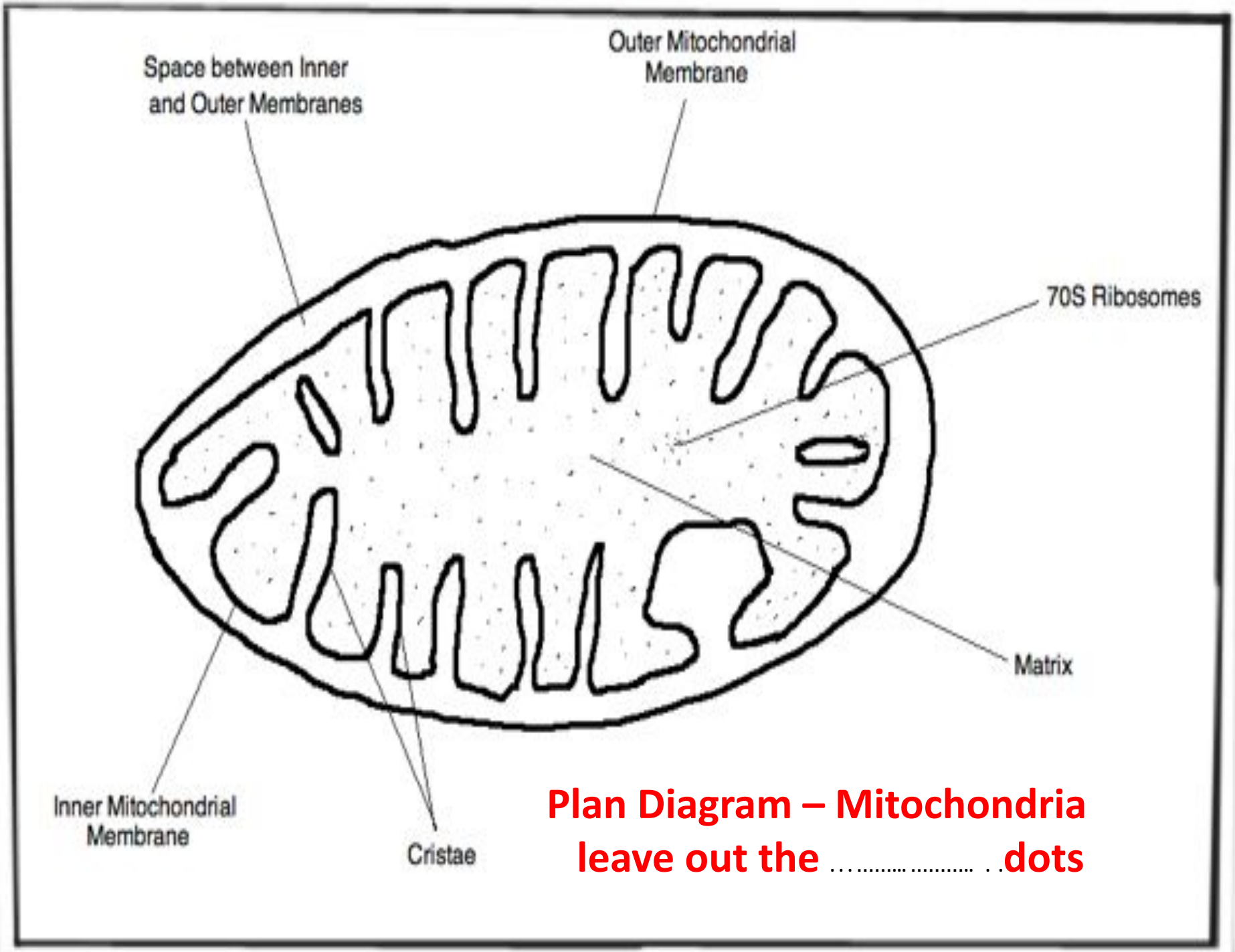

Intermembrane space
Ribosome
Granule
Matrix
ATP synthase particles
DNA
Outer membrane
Inner membrane
Cristae
0.1 - 0.5 µm
1 - 2 µm
Outer - Inner membrane = 20nm

Electron Micrograph of Mitochondria




Make a plan diagram and label the structures of the mitochodria.
cristae
Matrix
Outer membrane
cytoplasm
Inner membrane
Inner mitochondrial space
Also in Mitochondra
DNA – mitochondrial
70S ribosomes


outer membrane
inner membrane
cristae
matrix space
inter-membrane space
cytosol



Plan Diagram – Mitochondria

leave out the …….. . .dots