Biochemistry Basics

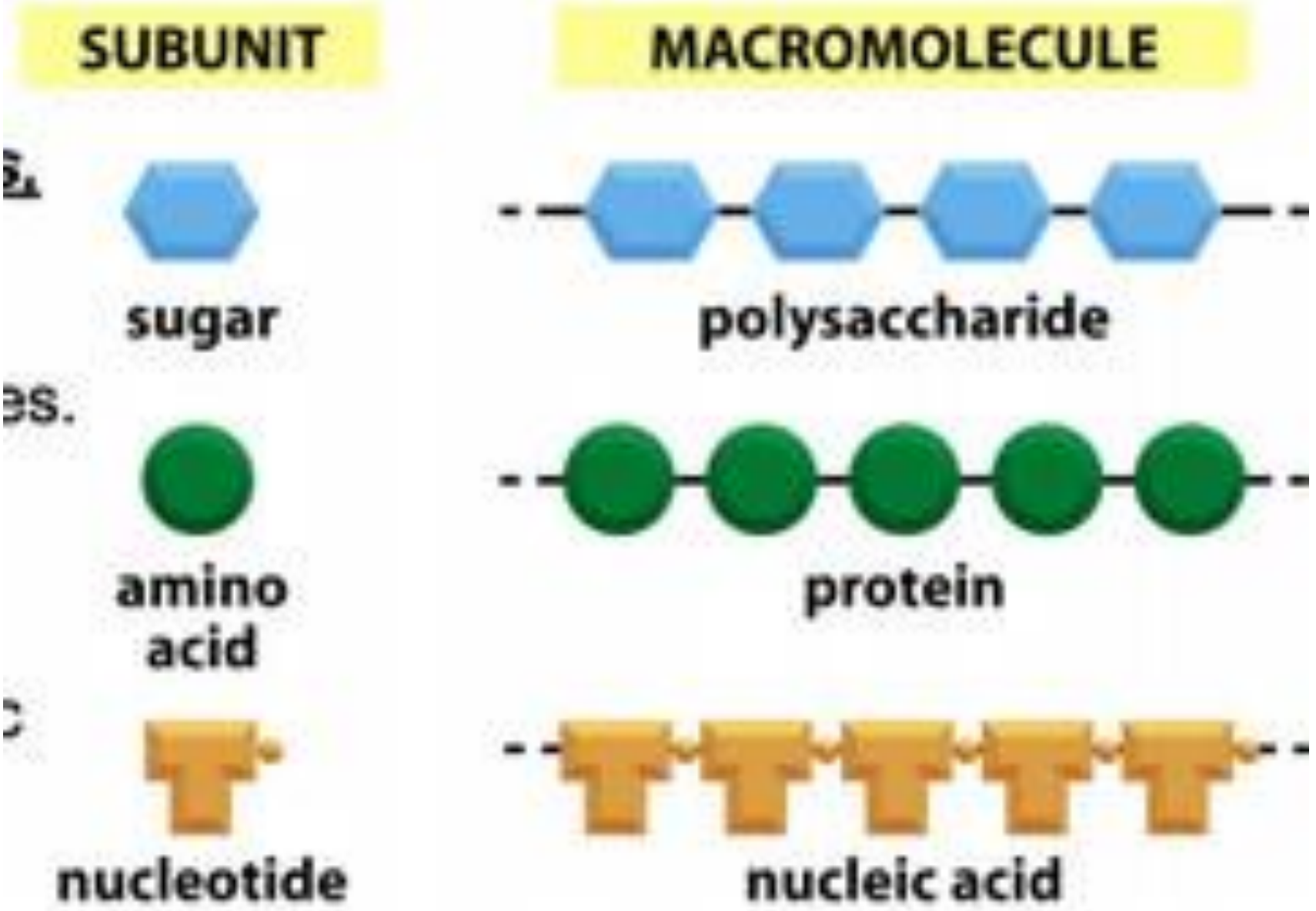
- All living things are made of CHONPS

Bonding Basics

- Covalent bonds – strong
  - Polar covalent – unequal sharing - hydrophilic
  - Non polar covalent – equal sharing – hydrophobic
- Hydrogen bonds – weak
  - But super important in large quantities
- Cell membranes are semipermeable because they are made of phospholipids

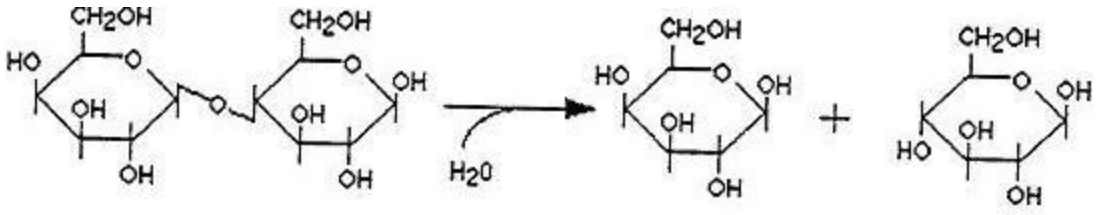
Dehydration Synthesis

- Links subunits together to make larger molecule
- Anabolic reaction
- Releases water
- Usually endergonic


SUBUNIT
MACROMOLECULE
sugar
polysaccharide
amino acid
protein
nucleotide
nucleic acid

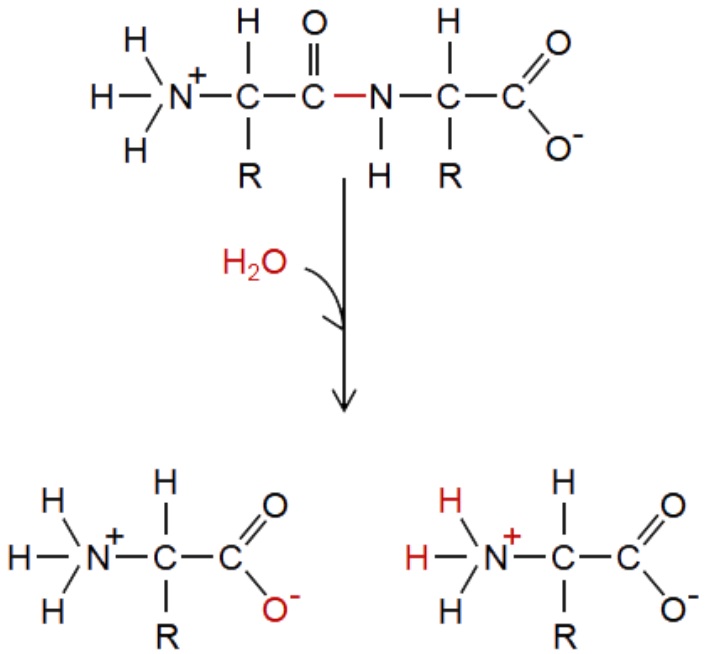
Hydrolysis

- Breaks larger molecules apart into their subunits (like in digestion)
- Consumes water
- Usually exergonic
- Catabolic



Galactose Glucose Galactose Glucose

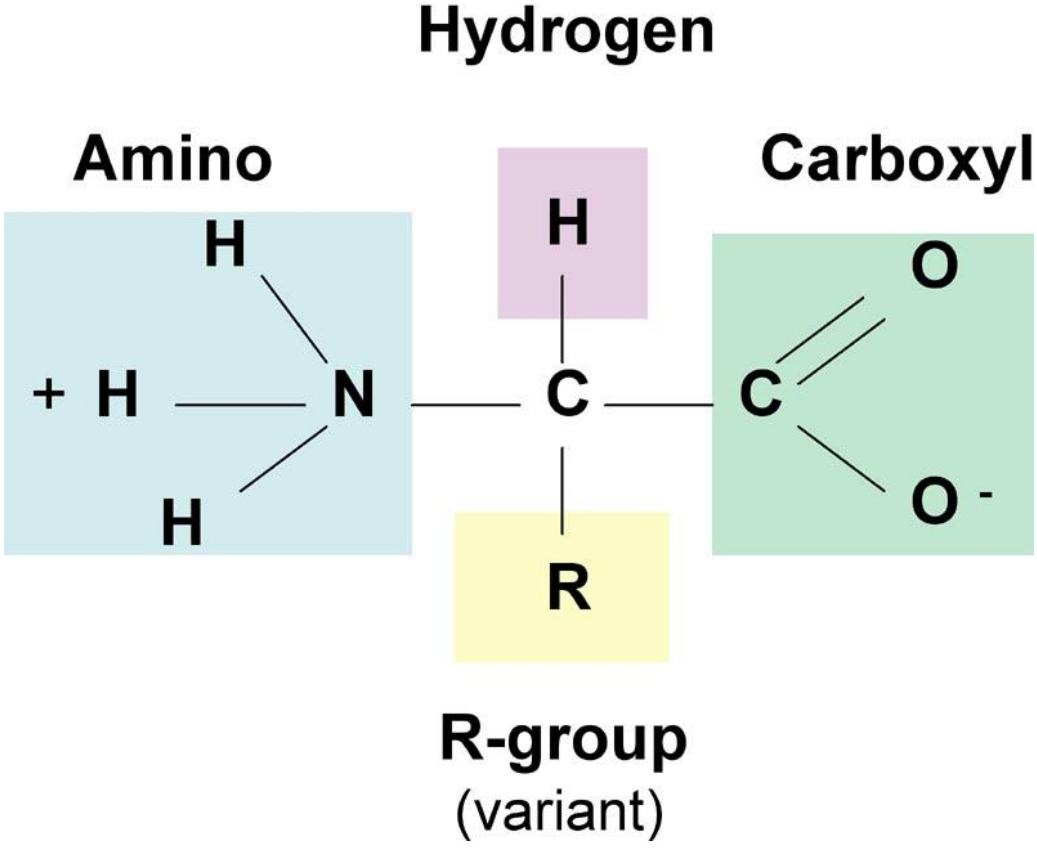
=Lactose



Protein Structure

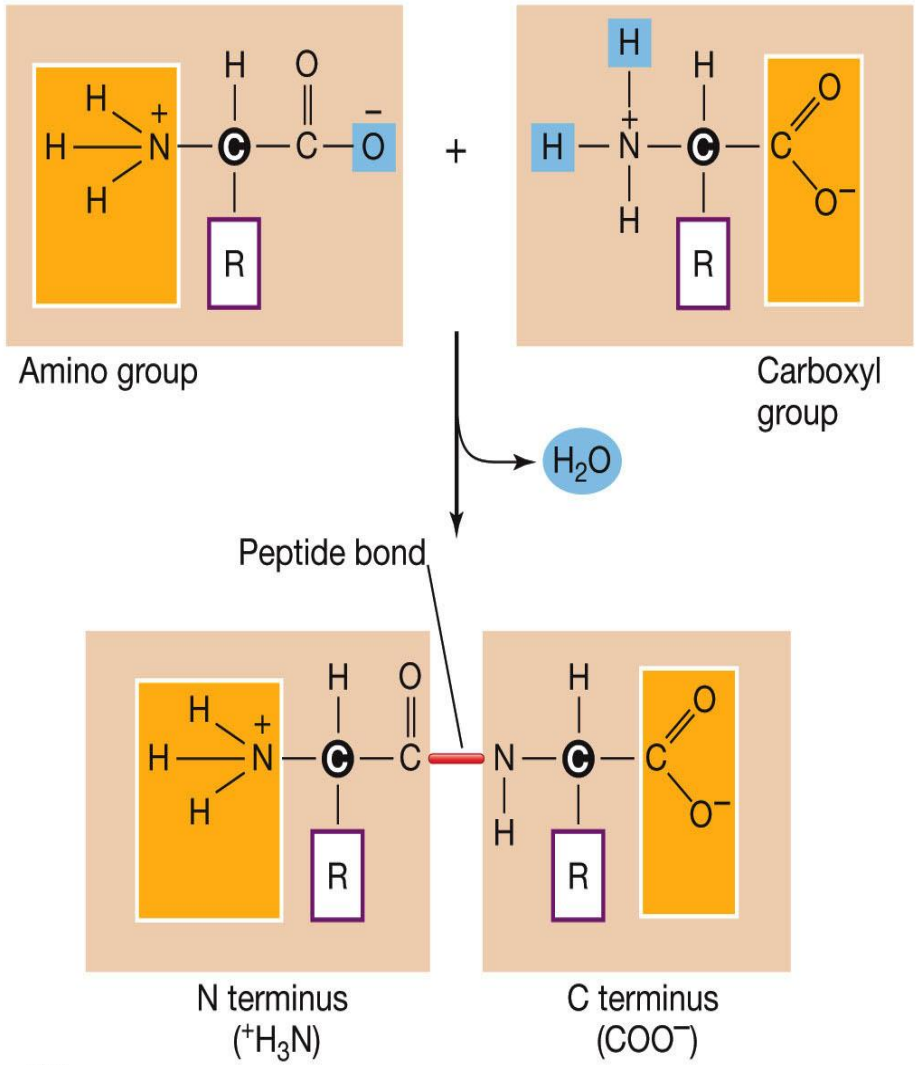
- Structure determines function
- Proteins are made of chains of amino acids

Amino Acid Structure

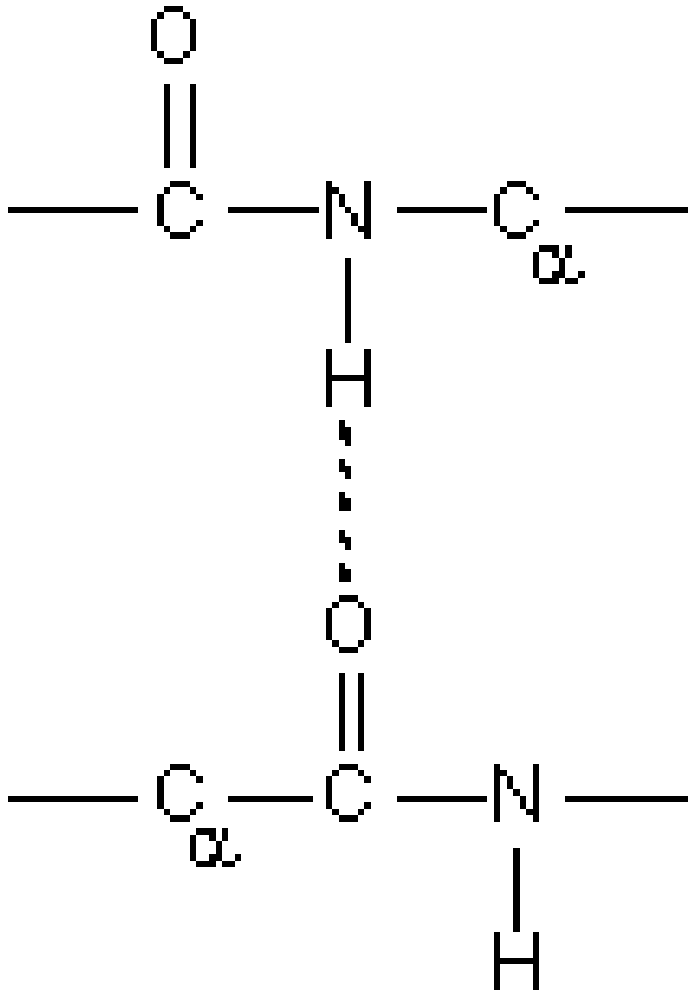


Primary Structure

- Amino acids bond together covalently by **peptide bonds** to form the polypeptide chain.
  - Dehydration synthesis



LIFE 8e, Figure 3.6



peptide backbone H-bond
(H & R-group on α-C omitted)

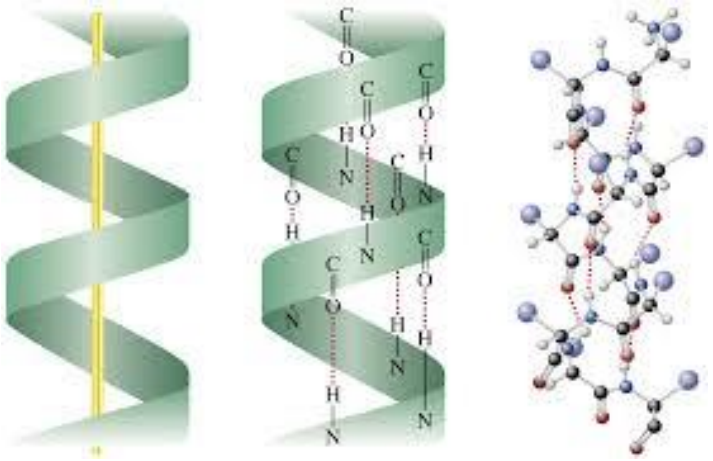
2nd structure of a protein

H-bonds

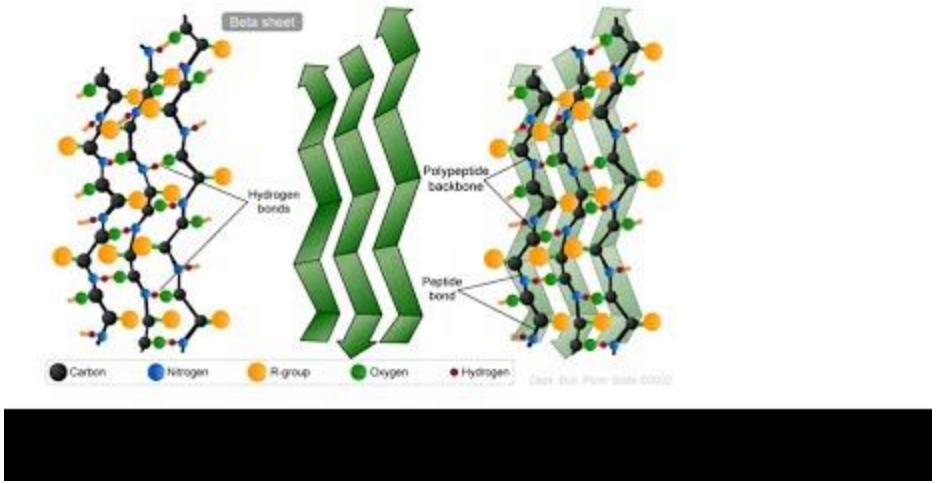
R groups are NOT involved in H-bonds

Secondary Structure

- Alpha helix

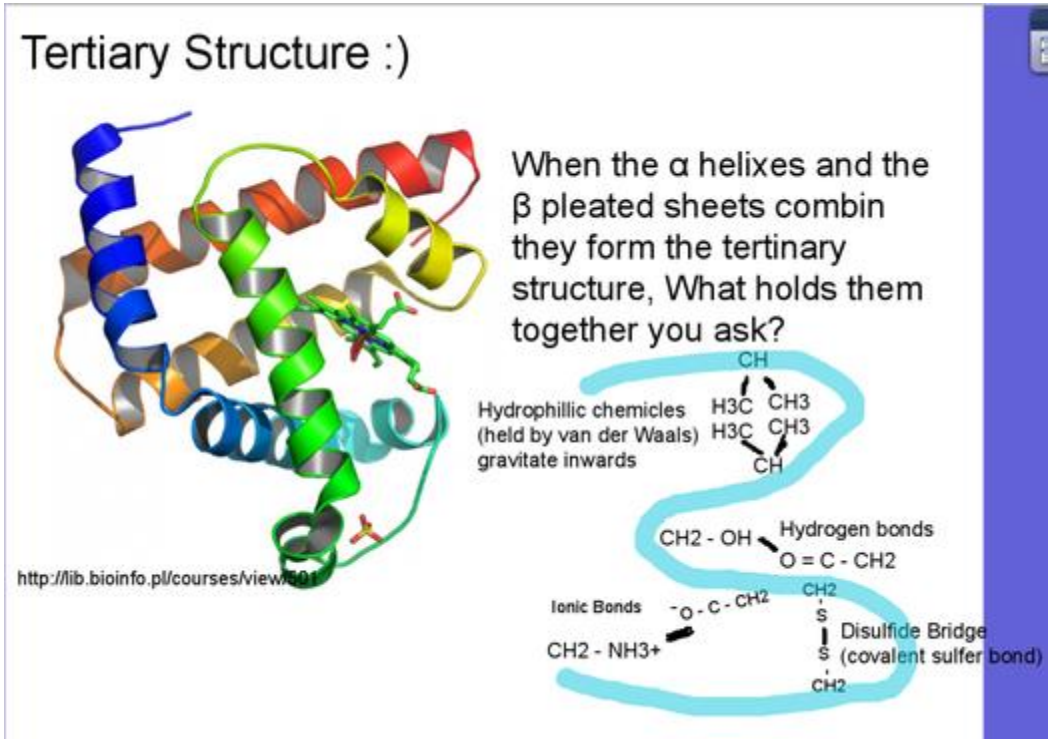


Beta Sheets

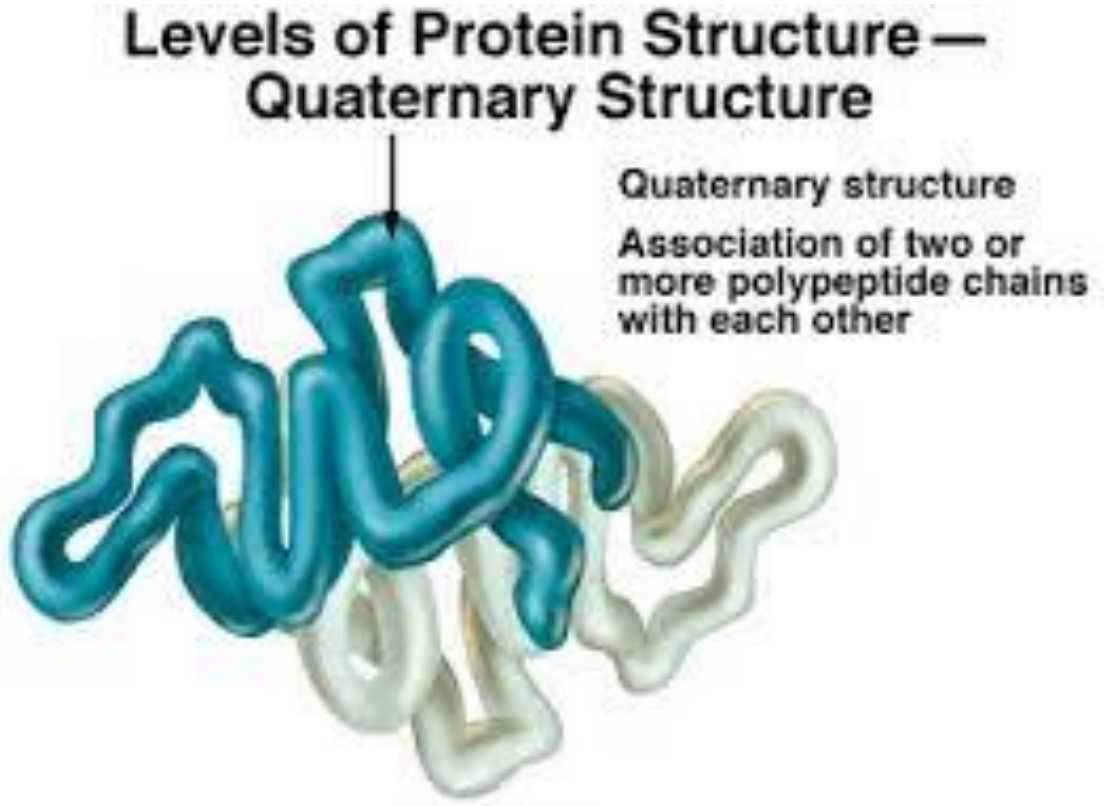


Tertiary Structure

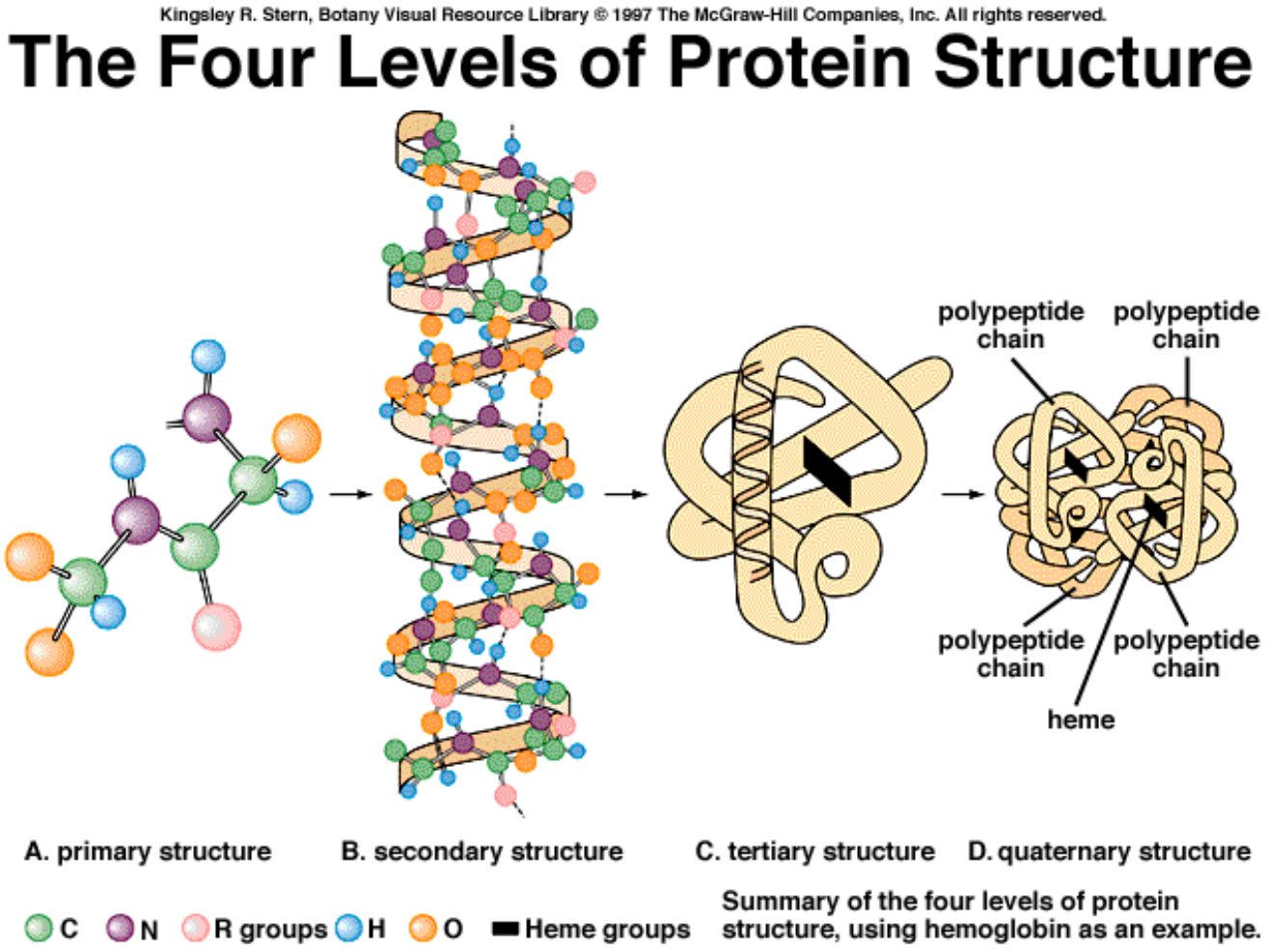
- Driven by hydrophobic interactions, disulfide bridges, van der waals forces



Quaternary Structure



Four levels of protein structure



Questions 1-4

A. Protein
B. Carbohydrate
C. Nucleic acid
D. Lipids
E. Steroids

#1—Synthesized at the ribosome

#2—Includes glycogen, chitin, cellulose, and glucose

#3– Used for insulation and buoyancy in marine Arctic animals

#4—Used to carry the genetic code

Questions 1-4

A. Protein
B. Carbohydrate
C. Nucleic acid
D. Lipids
E. Steroids

#1—Synthesized at the ribosome **A**

#2—Includes glycogen, chitin, cellulose, and glucose **B**

#3– Used for insulation and buoyancy in marine Arctic animals **D**

#4—Used to carry the genetic code **C**

Water Short Answer

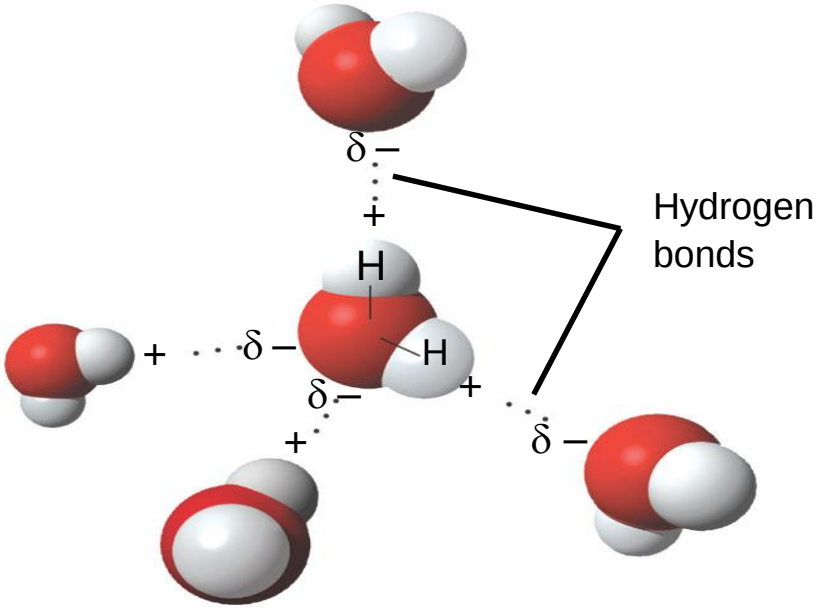
- **The unique properties (characteristics) of water make life possible on Earth. Select three properties of water and:**

a) for each property, identify and define the property and explain it in terms of the physical/chemical nature of water.

b) for each property, describe one example of how the property affects the functioning of living organisms.

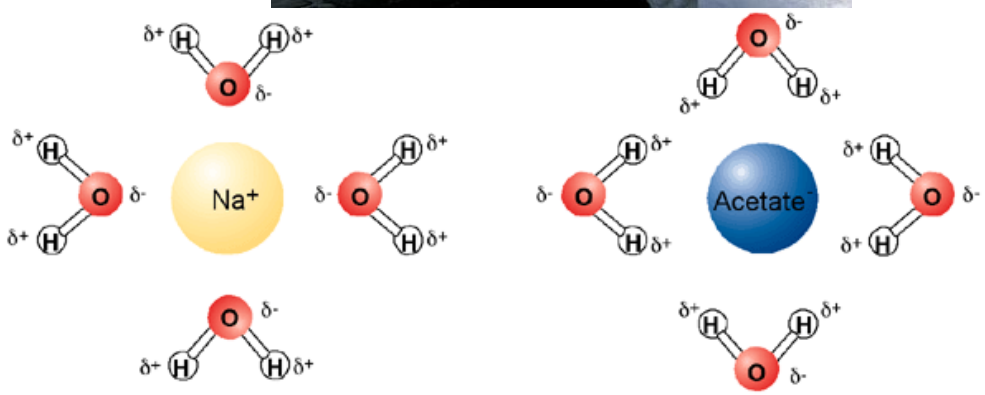
The polarity of water molecules results in hydrogen bonding

- The polarity of water molecules
  - Allows them to form hydrogen bonds with each other
  - Contributes to the various properties water exhibits



Four properties of water contribute to Earth's fitness for life

1. Cohesion
2. Moderation of Temperature
3. Insulation of bodies of water by floating ice
4. The solvent of life (universal solvent)



Question 5: Which of the following is responsible for the cohesive property of water?

(A) Hydrogen bonds between the oxygen atoms of two adjacent water molecules

(B) Covalent bonds between the hydrogen atom of two adjacent water molecules

(C) Hydrogen bonds between the oxygen atom of one water molecule and a hydrogen atom of another water molecule

(D) Covalent bonds between the oxygen atom of one water molecule and a hydrogen atom of another water molecule

(E) Hydrogen bonds between water molecules and other types of molecules

Question 5: Which of the following is responsible for the cohesive property of water?

(A) Hydrogen bonds between the oxygen atoms of two adjacent water molecules

(B) Covalent bonds between the hydrogen atom of two adjacent water molecules

(C) Hydrogen bonds between the oxygen atom of one water molecule and a hydrogen atom of another water molecule

(D) Covalent bonds between the oxygen atom of one water molecule and a hydrogen atom of another water molecule

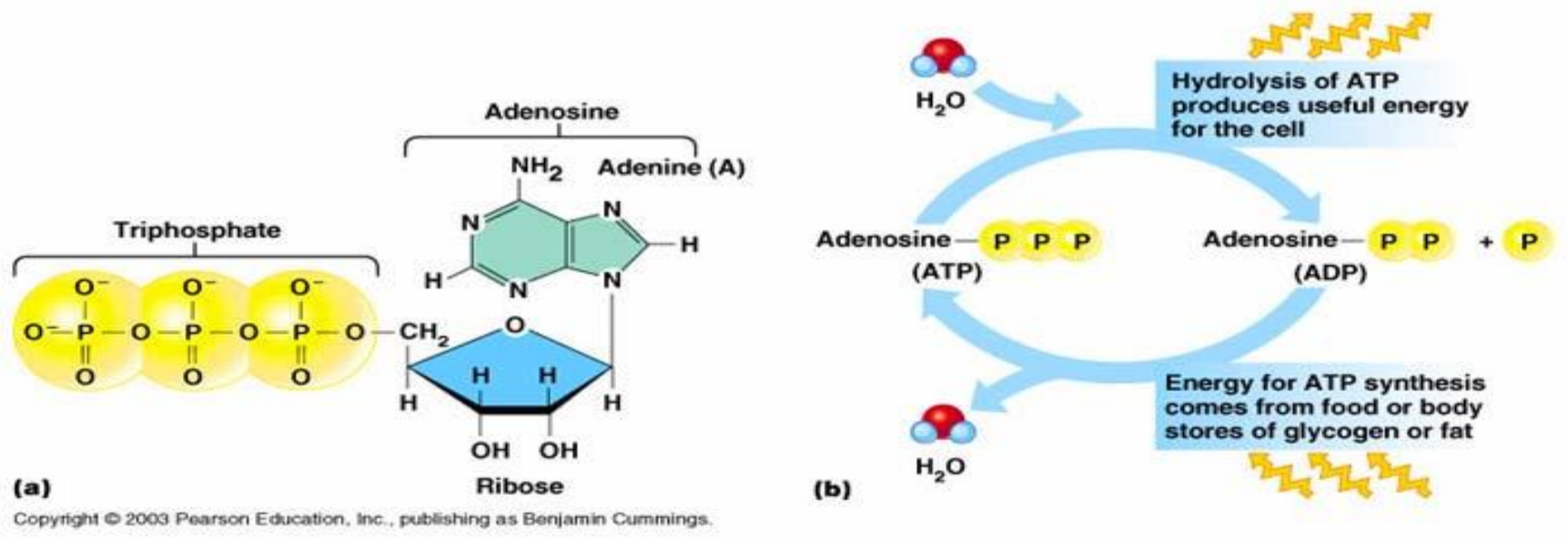
(E) Hydrogen bonds between water molecules and other types of molecules

ATP--ADP

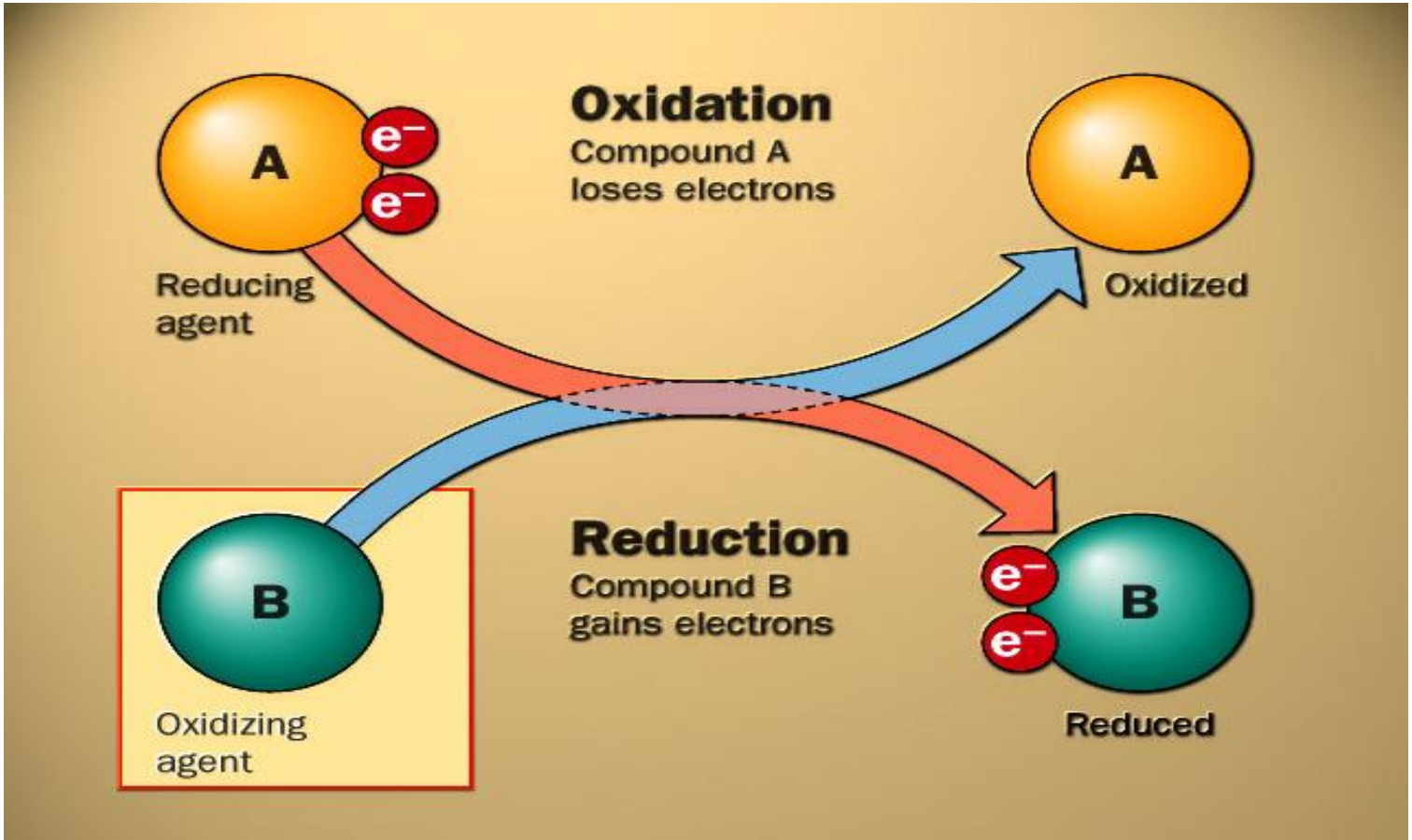
- **PHOSPHORYLATION**... adding a phosphate to ADP

ADP + P ------> ATP

- ATP holds more energy than ADP

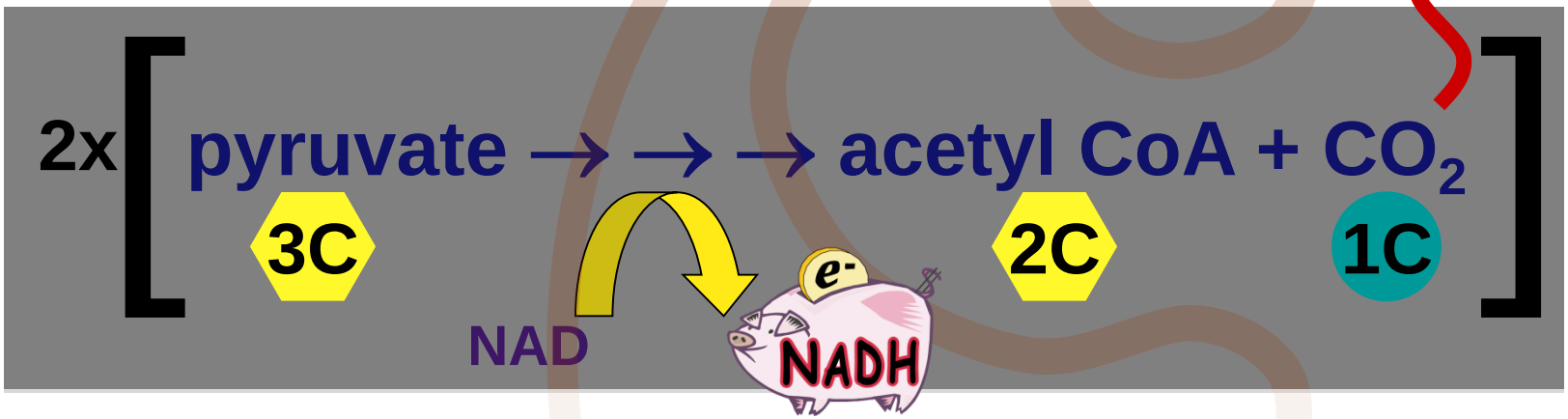


OIL RIG


A
e⁻
e⁻
Reducing agent
Oxidation
Compound A loses electrons
A
Oxidized
B
Oxidizing agent
Reduction
Compound B gains electrons
e⁻
e⁻
B
Reduced

Oxidation of pyruvate

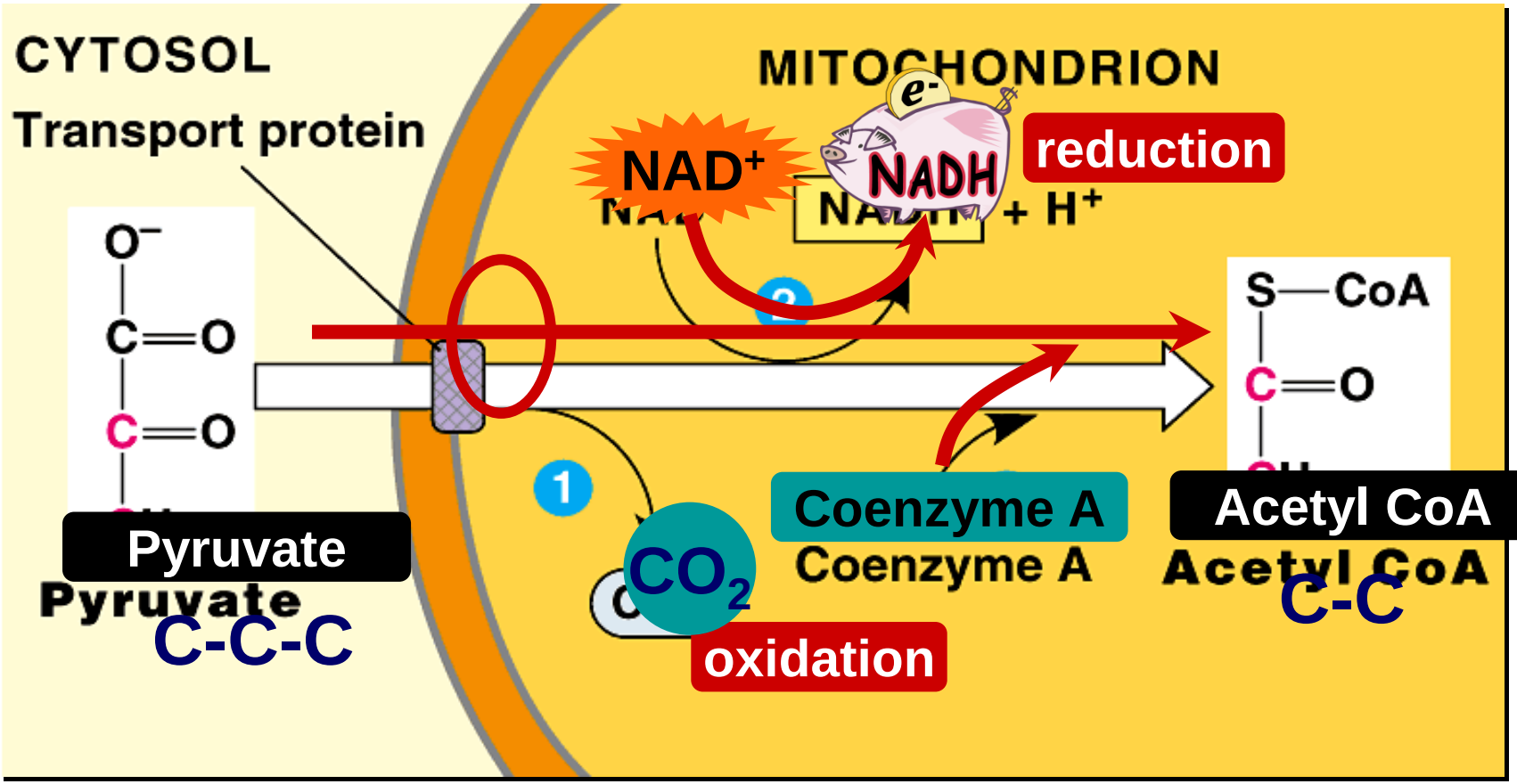
- Pyruvate enters mitochondrial matrix



  - 3 step oxidation process
  - releases 2 CO_2 (count the carbons!)
  - reduces 2 NAD → 2 NADH (moves e^-)
  - produces 2 acetyl CoA

- Acetyl CoA enters Krebs cycle

Pyruvate oxidized to Acetyl CoA



2 x [Yield = 2C sugar + NADH + CO_2]

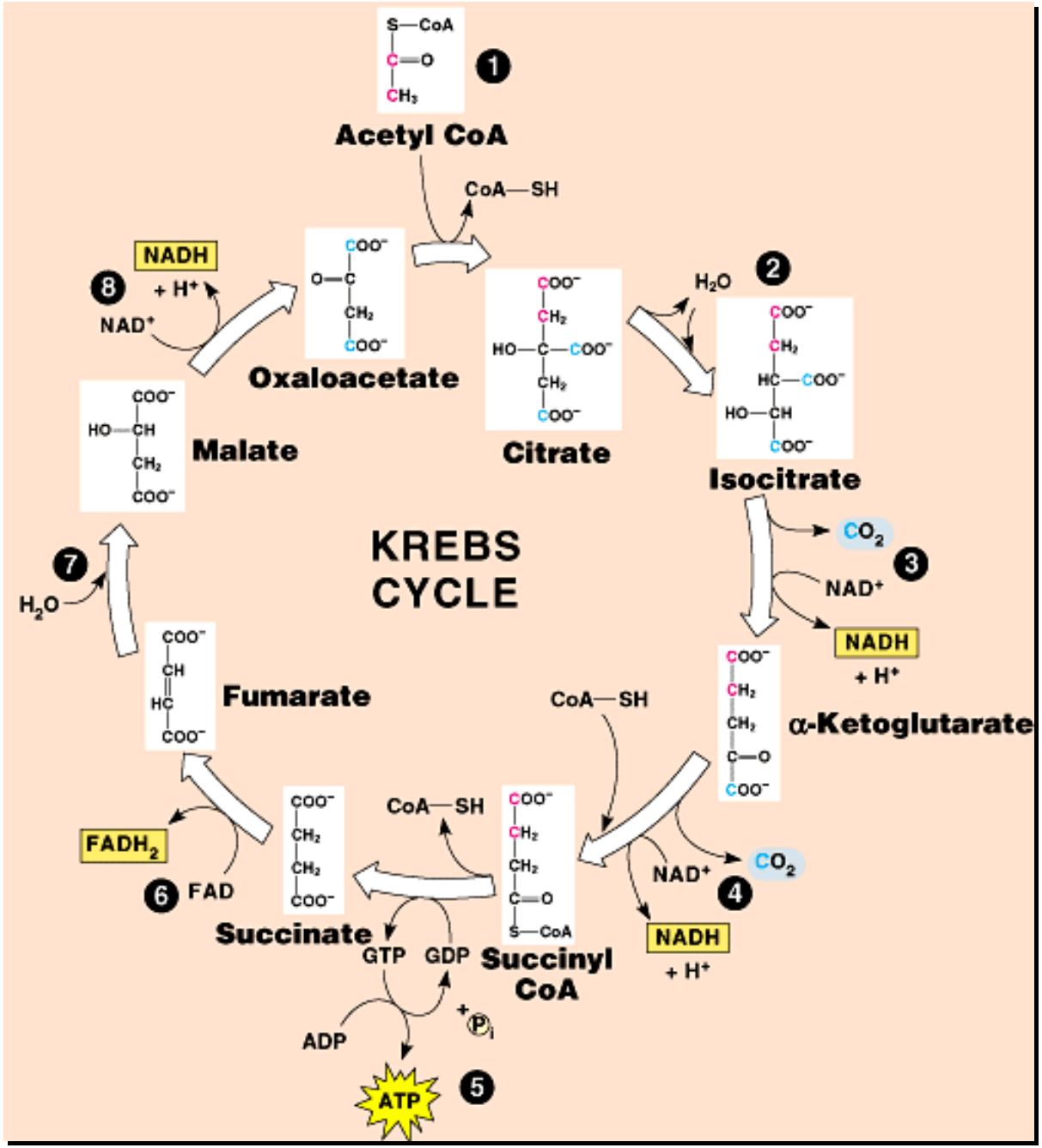
So we fully oxidized glucose

$C_6H_{12}O_6$

↓

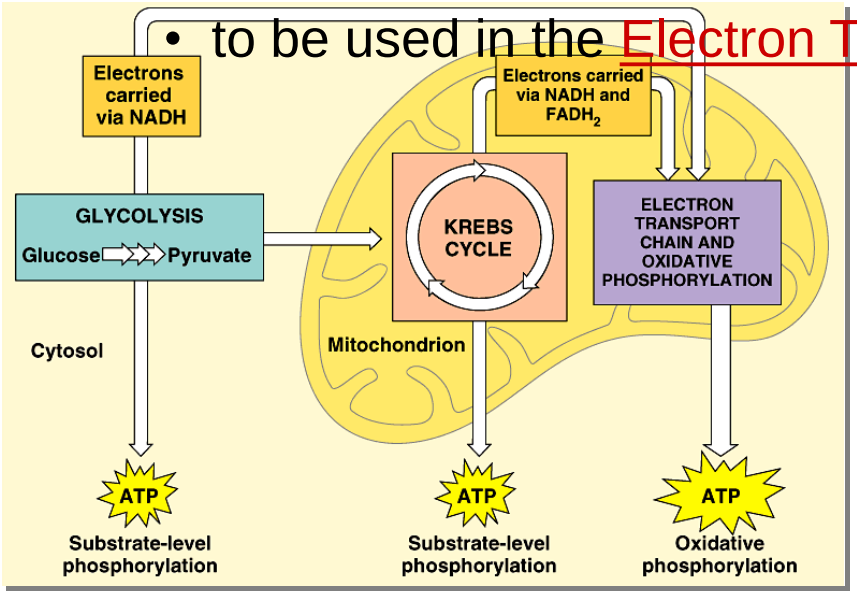
CO_2

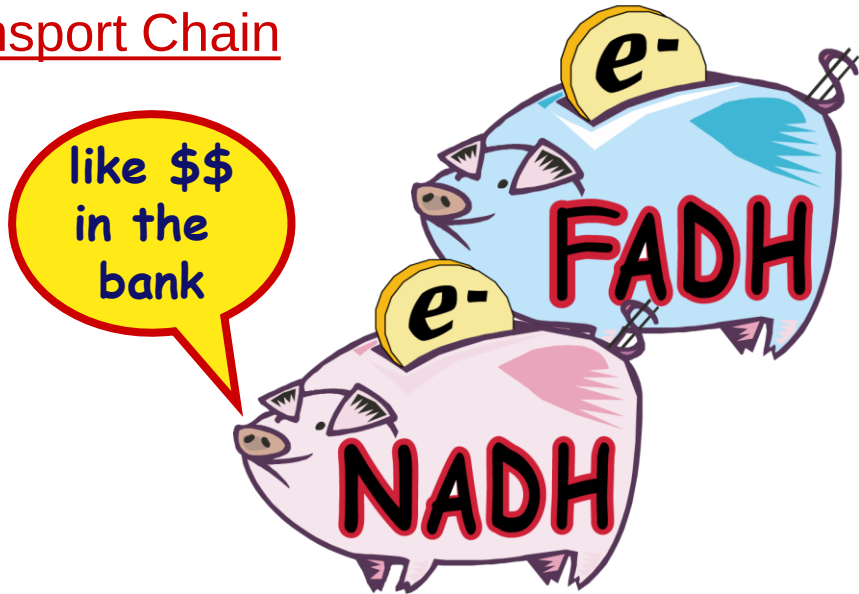
& ended up with 4 ATP!



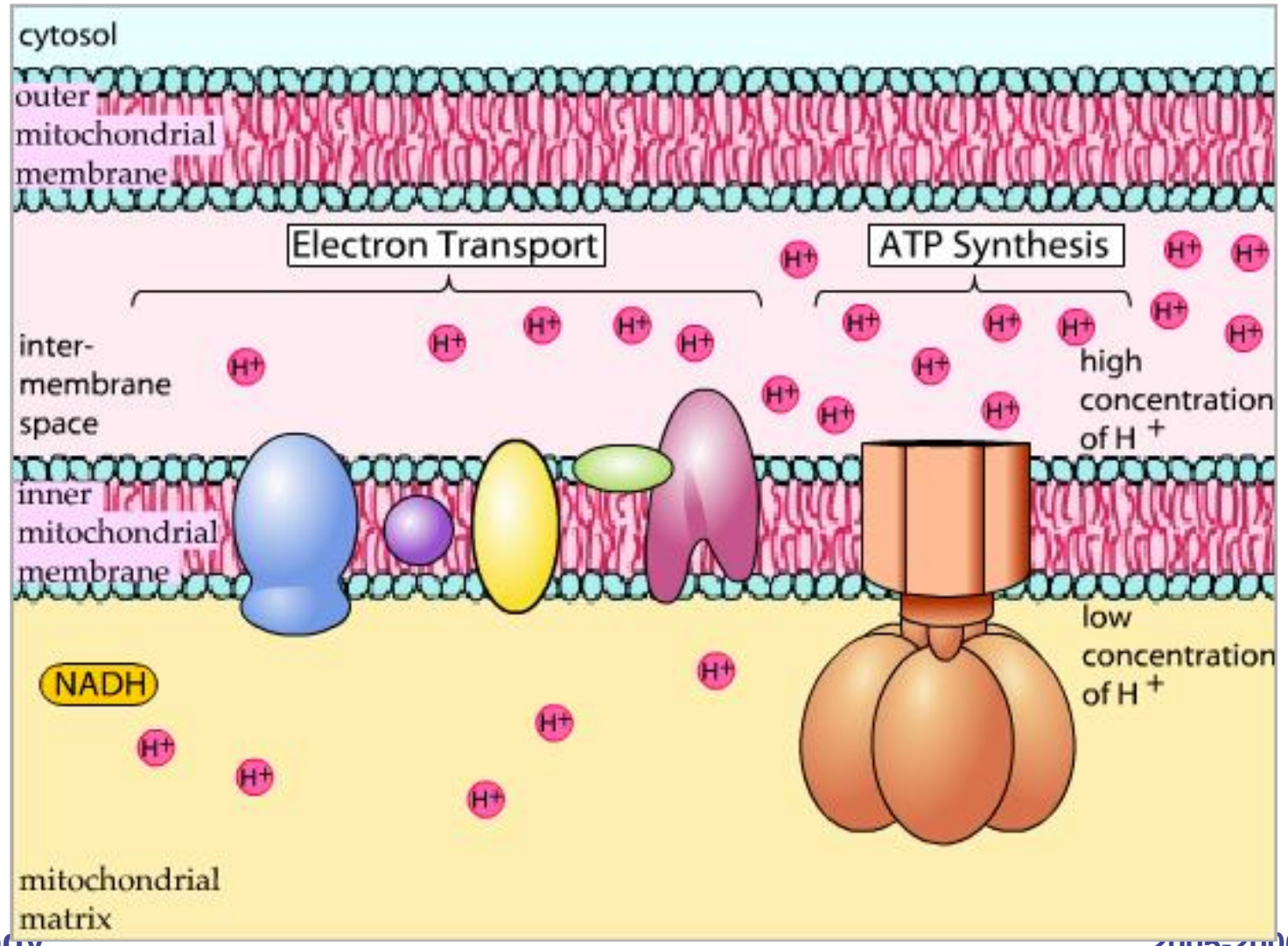
Value of Krebs cycle?

- If the yield is only 2 ATP then how was the Krebs cycle an adaptation?
  - value of $NADH$ & $FADH_2$
    - electron carriers & H carriers
      - reduced molecules move electrons
      - reduced molecules move H^+ ions
    - to be used in the Electron Transport Chain



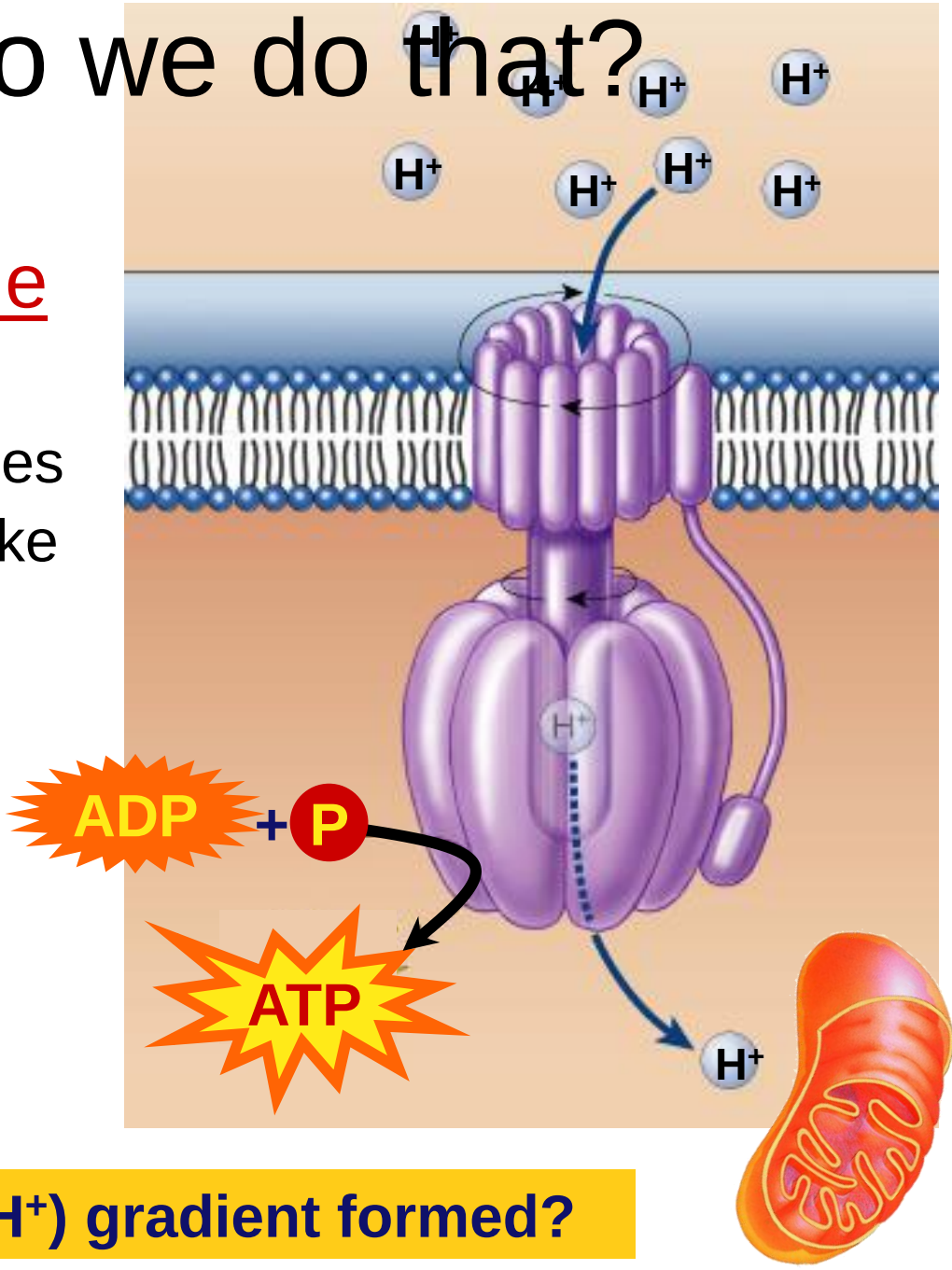


Electron Transport Chain



And how do we do that?

- ATP synthase enzyme
  - H^+ flows through it
    - conformational changes
    - bond P_i to ADP to make ATP
  - set up a H^+ gradient
    - allow the H^+ to flow down concentration gradient through ATP synthase
    - $ADP + P_i \rightarrow ATP$

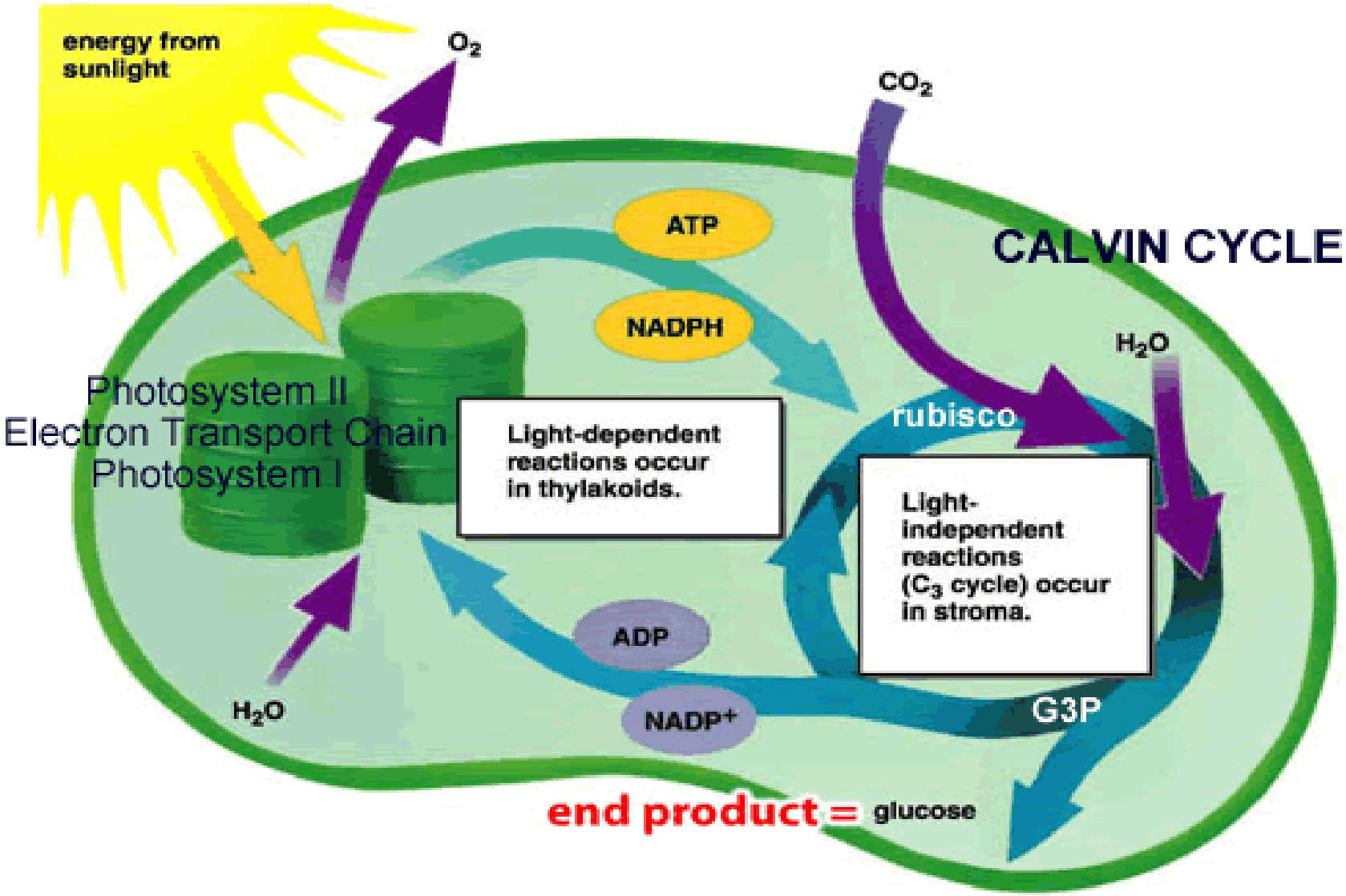


But… How is the proton (H^+) gradient formed?

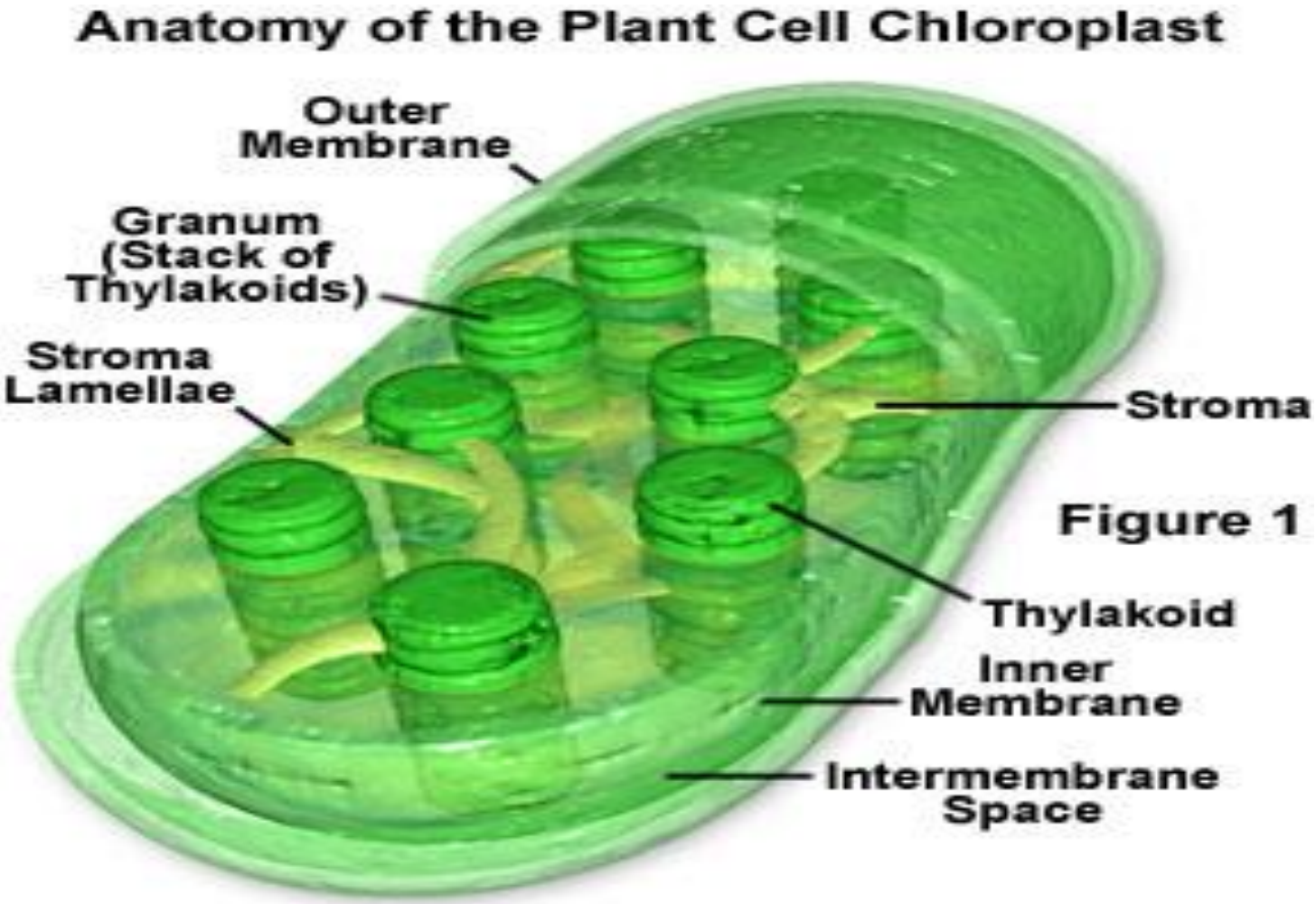
Which kind of metabolic poison would most directly interfere with glycolysis?

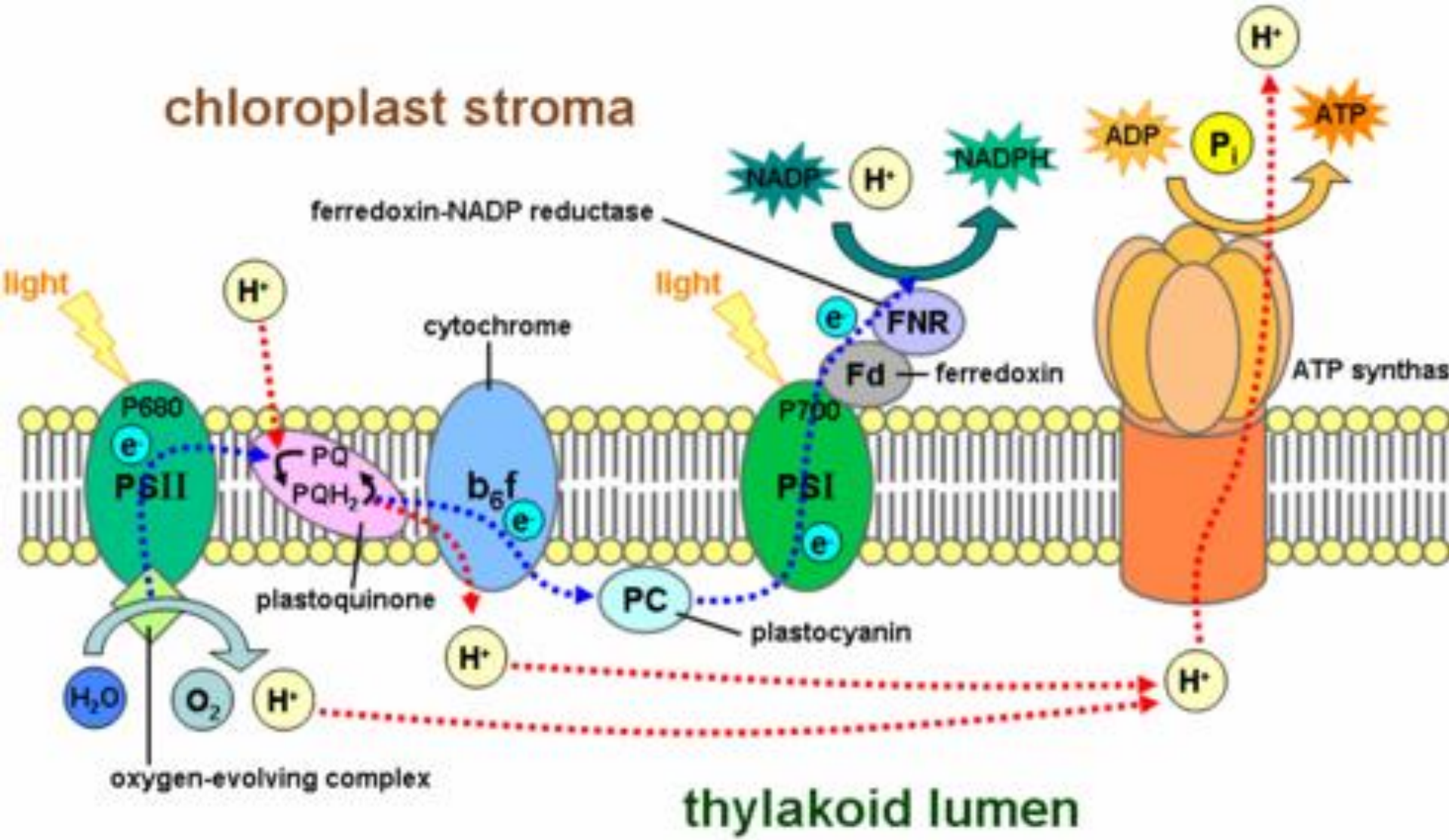
(A)an agent that reacts with oxygen and depletes its concentration in the cell
(B)an agent that closely mimics the structure of glucose but is not metabolized
(C)an agent that reacts with NADH and oxidizes it to NAD+
(D)an agent that blocks the passage of electrons along the electron transport chain

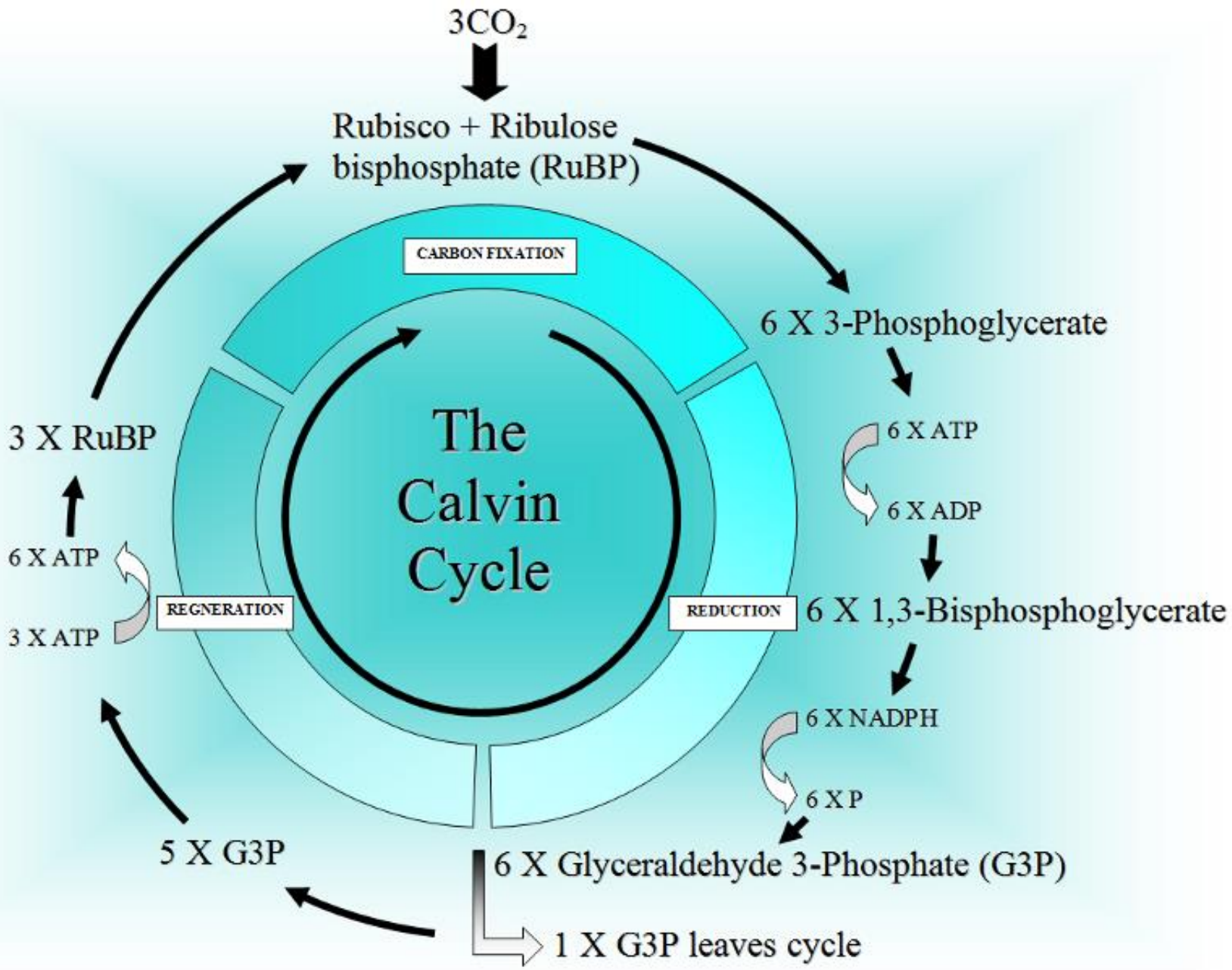
Photosynthesis



Chloroplast




chloroplast stroma
light
H+
P680
e-
PSII
PQ
PQH2
plastoquinone
cytochrome
b6f
e
PC
plastocyanin
light
P700
PSI
e
e
FNR
Fd
ferredoxin
ferredoxin-NADP reductase
NADP
H+
NADPH
ADP
Pi
ATP
H+
ATP synthas
H+
H+
H+
H2O
O2
oxygen-evolving complex
thylakoid lumen


3CO2
Rubisco + Ribulose bisphosphate (RuBP)
CARBON FIXATION
6 X 3-Phosphoglycerate
6 X ATP
6 X ADP
The Calvin Cycle
6 X 1,3-Bisphosphoglycerate
REDUCTION
6 X NADPH
6 X P
6 X Glyceraldehyde 3-Phosphate (G3P)
1 X G3P leaves cycle
5 X G3P
REGNERATION
6 X ATP
3 X ATP
3 X RuBP

The chemical reaction for photosynthesis is

$6\ CO_2 + 12\ H_2O + \text{light energy} \rightarrow C_6H_{12}O_6 + 6\ O_2 + 6\ H_2O$

If the input water is labeled with a radioactive isotope of oxygen, ^{18}O, then the oxygen gas released as the reaction proceeds is also labeled with ^{18}O. Which of the following is the most likely explanation?

(A) During the light reactions of photosynthesis, water is split, the hydrogen atoms combine with the CO2, and oxygen gas is released.
(B) During the light reactions of photosynthesis, water is split, removing electrons and protons, and oxygen gas is released.
(C) During the Calvin cycle, water is split, regenerating NADPH from NADP+, and oxygen gas is released.
(D) During the Calvin cycle, water is split, the hydrogen atoms are added to intermediates of sugar synthesis, and oxygen gas is released.