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C-CMP = COMPLEX ORGANIC COMPOUNDS

AMINO ACIDS & NUCLEOTIDES

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C-CMP = COMPLEX ORGANIC COMPOUNDS

AMINO ACIDS & NUCLEOTIDES

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OCEANS HIGH ORGANIC CONTENT

“P”



SHALLOW COAST

OCEANS HIGH ORGANIC CONTENT



“PRIMORDIAL SOUP”



SHALLOW COAST

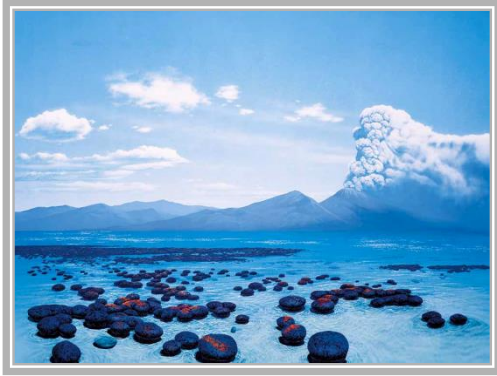
OCEANS HIGH ORGANIC CONTENT

“PRIMORDIAL SOUP”

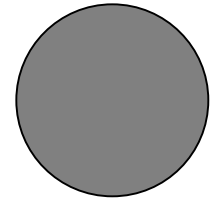
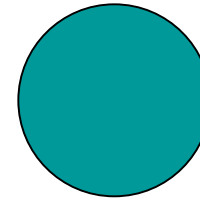
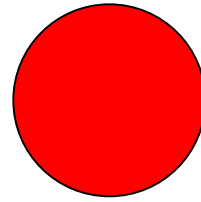
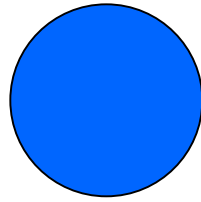
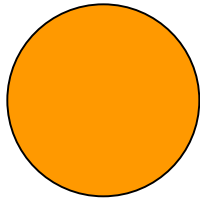
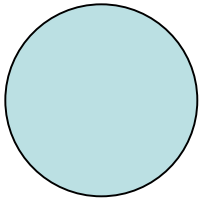
ORGANIC CMPS
ASSOCIATE & ORGANIZE

SHALLOW COAST





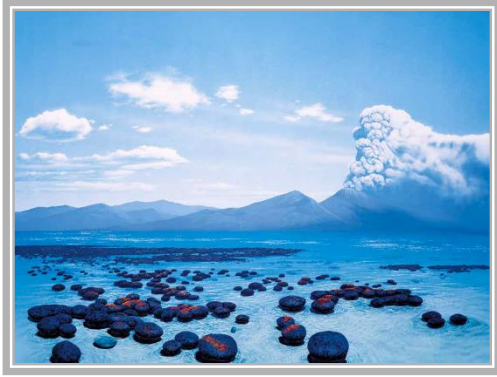
ORGANIC COMPOUNDS



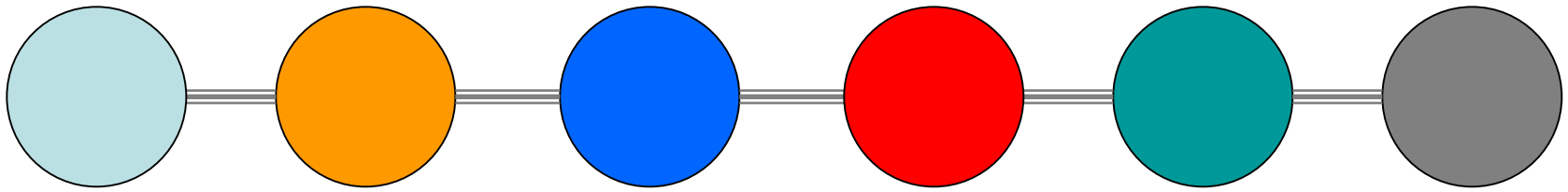
MONOMER

**ORGANIC CMPS
ASSOCIATE & ORGANIZE**

“PRIMORDIAL SOUP”



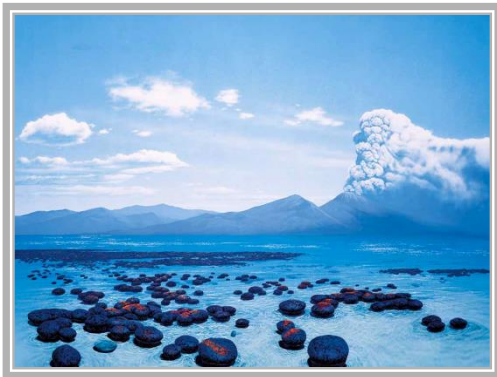
ORGANIC COMPOUNDS



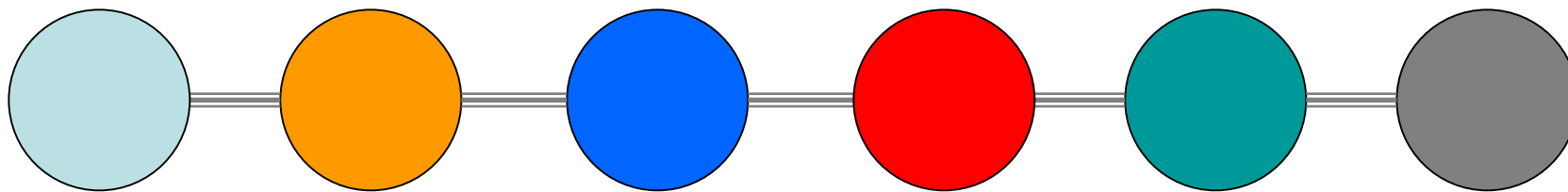
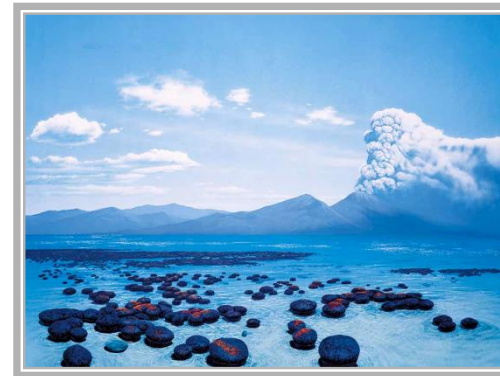
MONOMER

== = BOND

“PRIMORDIAL SOUP”

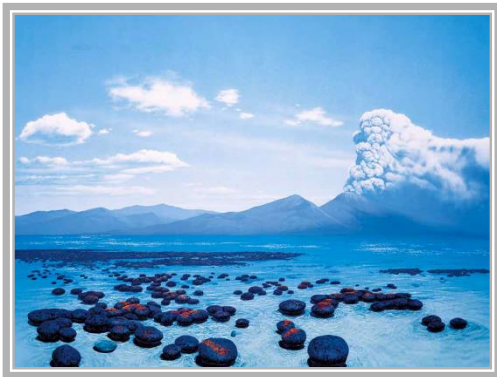


ORGANIC COMPOUNDS

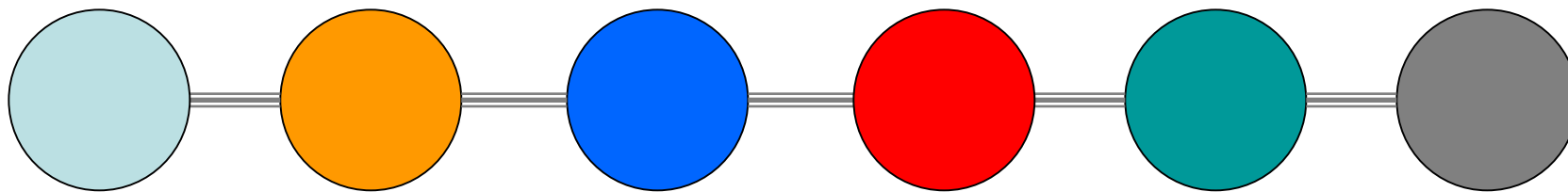
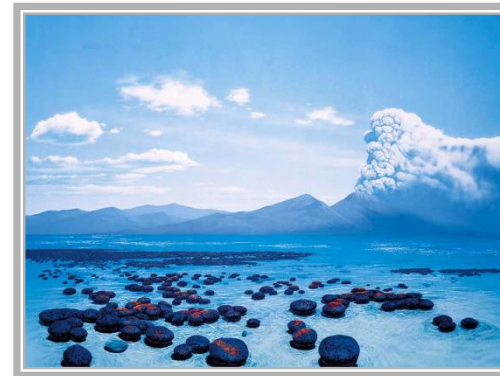


MONOMER **== = BOND**

?

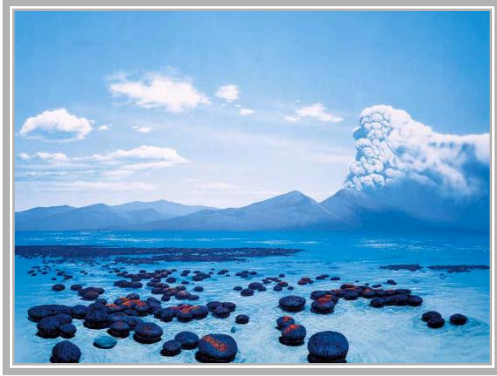


ORGANIC COMPOUNDS

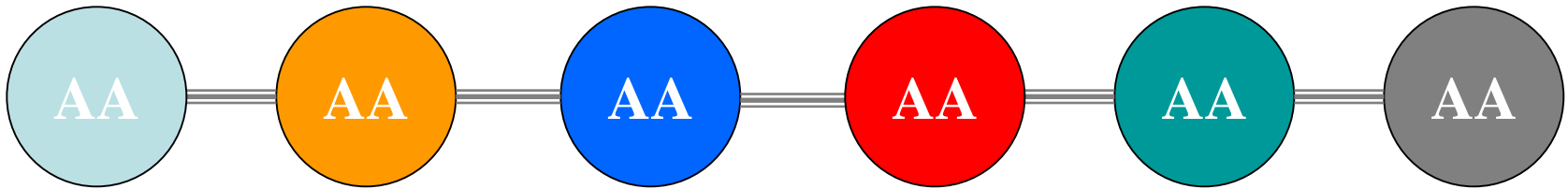
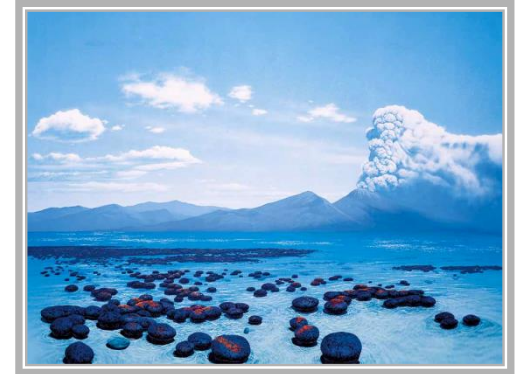


MONOMER **== = BOND**

POLYMER

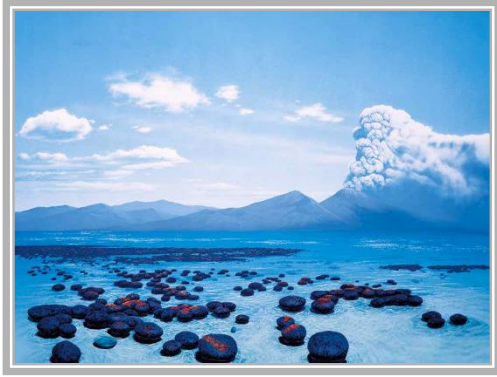


ORGANIC COMPOUNDS

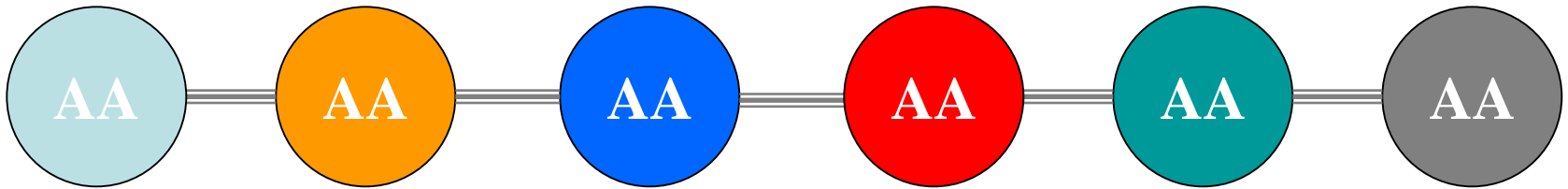


AMINO ACID
MONOMERS == = PEPTIDE BOND

POLYMER



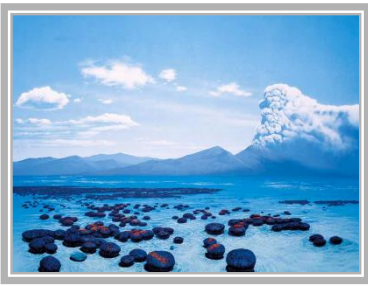
ORGANIC COMPOUNDS



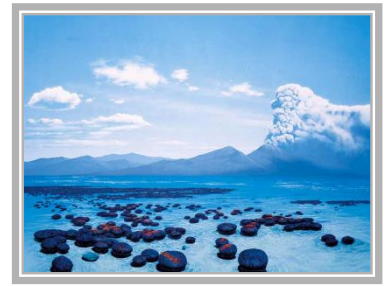
AMINO ACID
MONOMERS == = PEPTIDE BOND



PROTEINS



ORGANIC COMPOUNDS



B

NT

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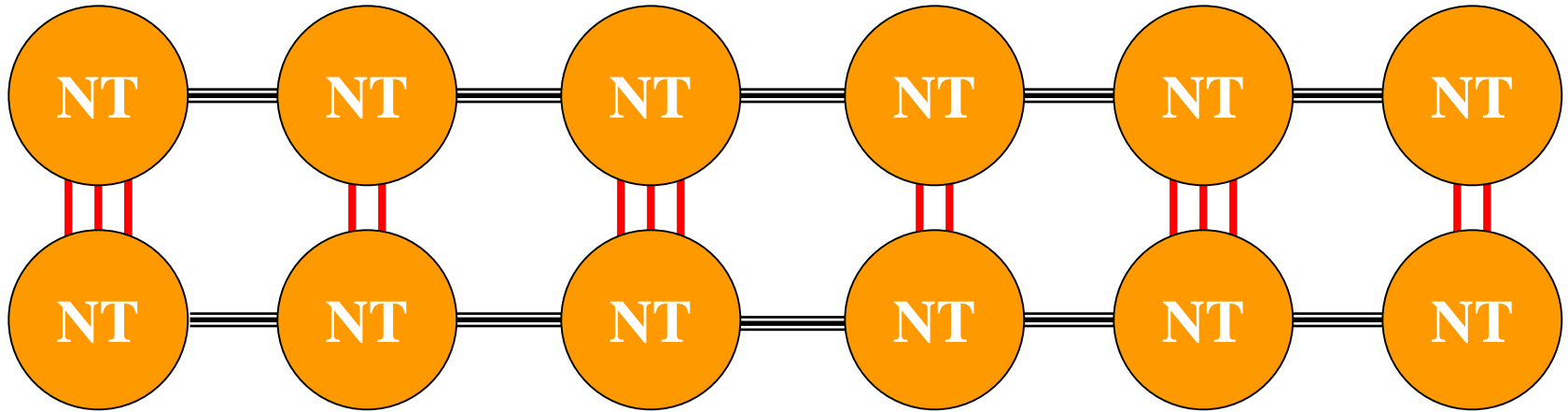
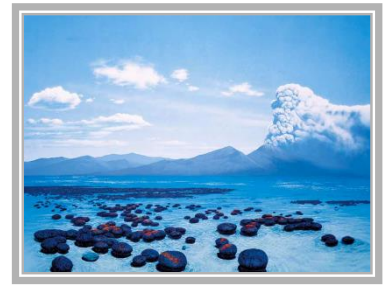
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**NUCLEOTIDE
MONOMERS**

POLYMER



ORGANIC COMPOUNDS

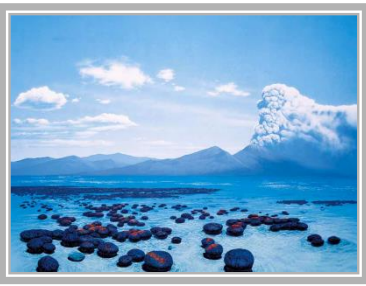


**NUCLEOTIDE
MONOMERS**

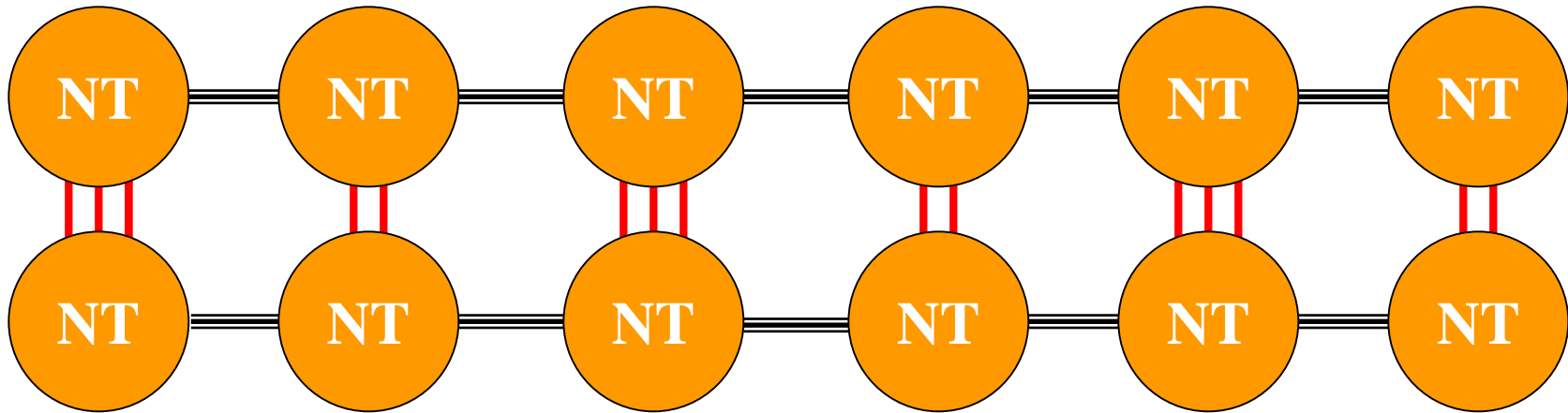
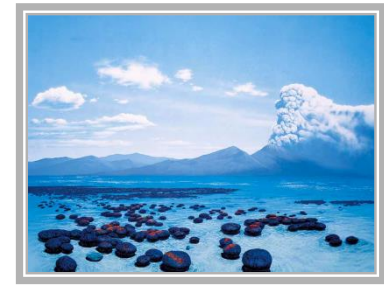
== = PHOSPHODIESTER BOND

— = HYDROGEN BOND

POLYMER

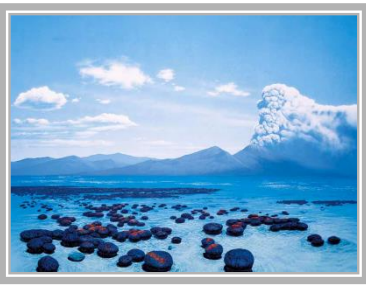


ORGANIC COMPOUNDS

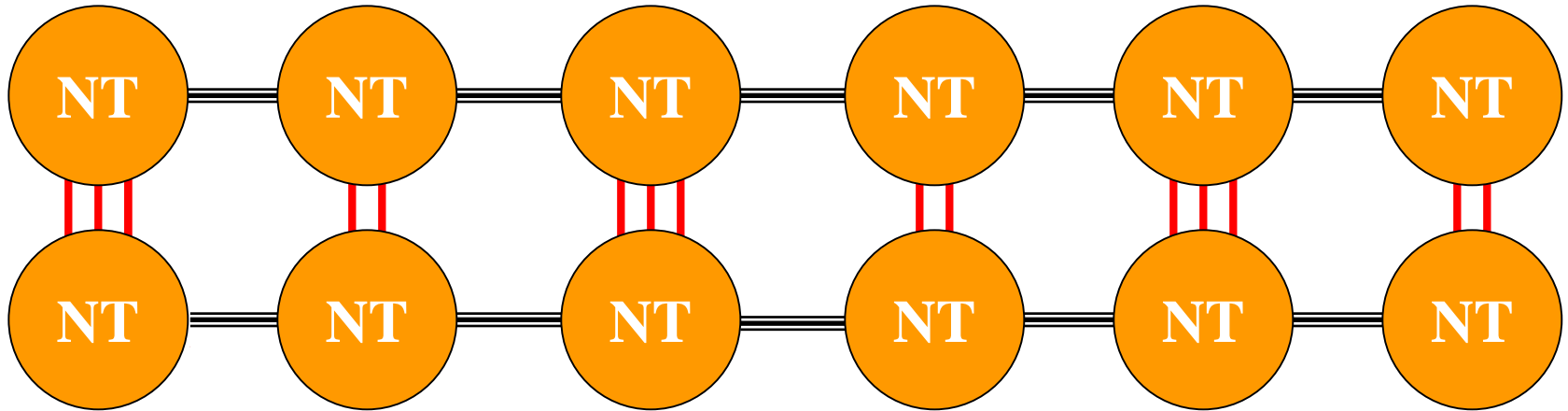
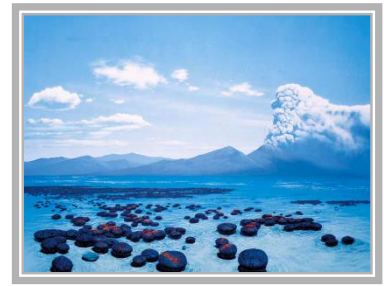


NUCLEOTIDE **==** = **PHOSPHODIESTER BOND**
MONOMERS **—** = **HYDROGEN BOND**

NUCLEIC ACIDS



ORGANIC COMPOUNDS



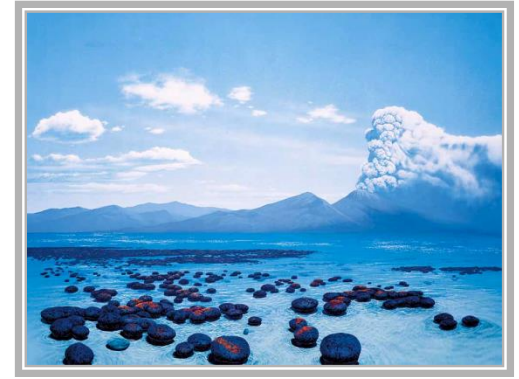
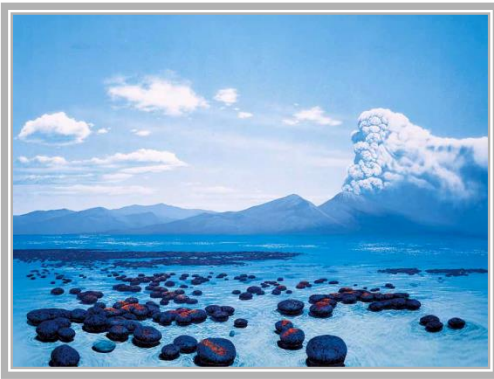
**NUCLEOTIDE
MONOMERS**

== = PHOSPHODIESTER BOND

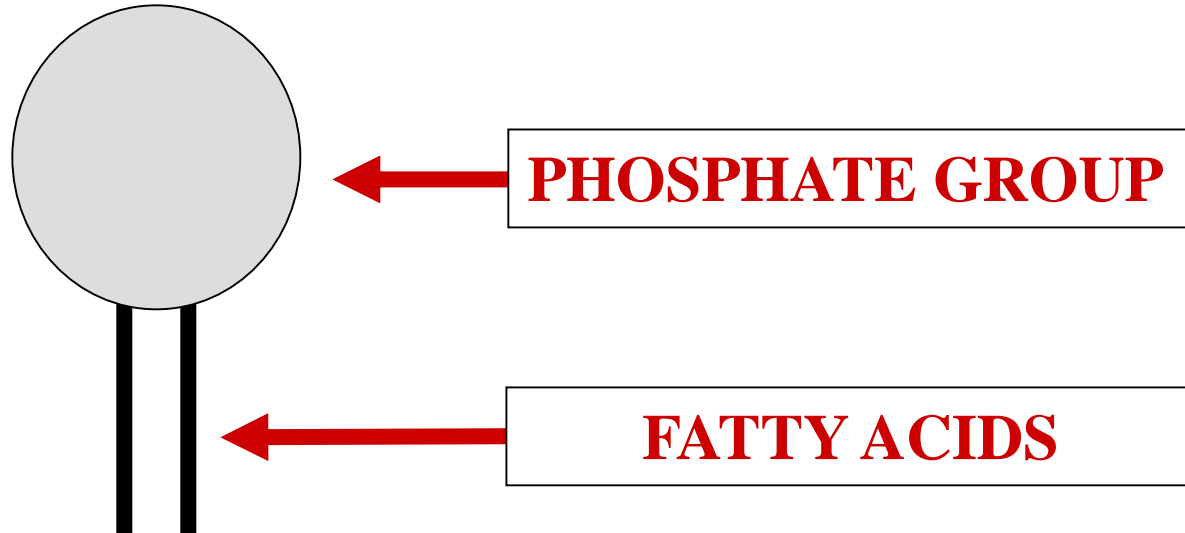
— = HYDROGEN BOND

**NUCLEIC ACIDS
DNA & RNA**

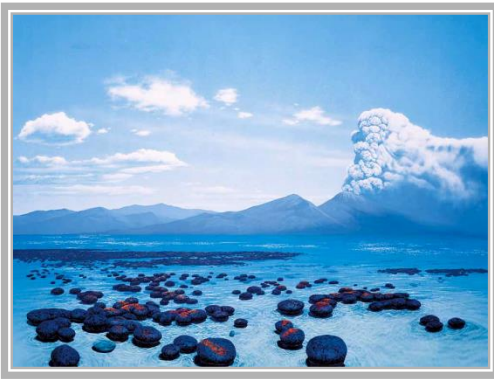
ORGANIC COMPOUNDS



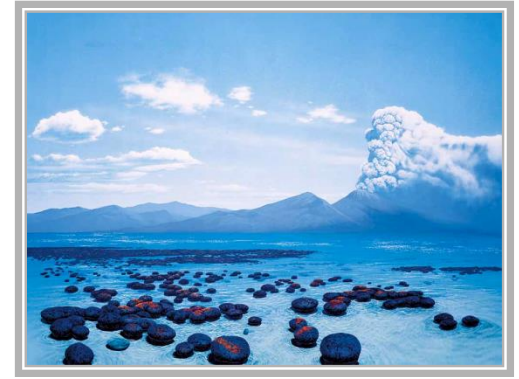
P



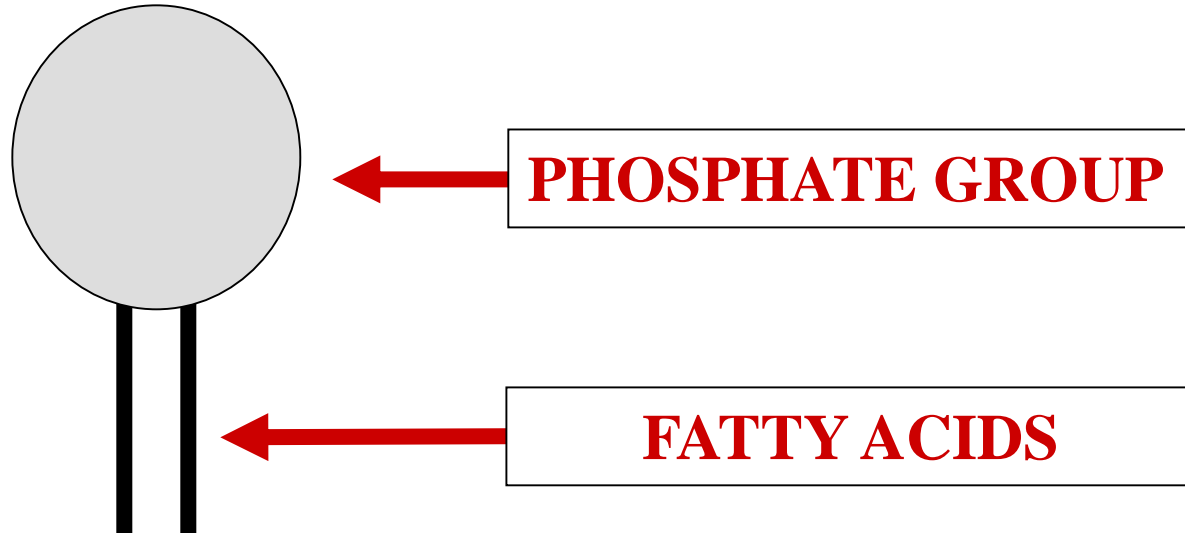
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ORGANIC COMPOUNDS



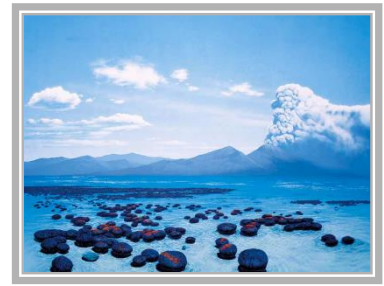
AS



PHOSPHOLIPID



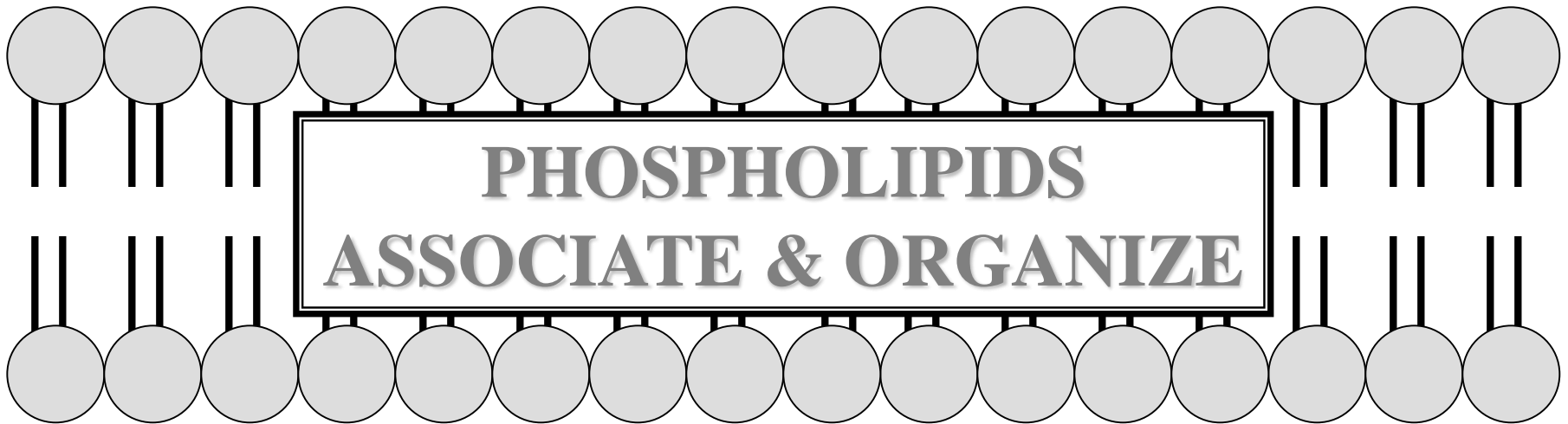
ORGANIC COMPOUNDS



WATER

WATER

WATER

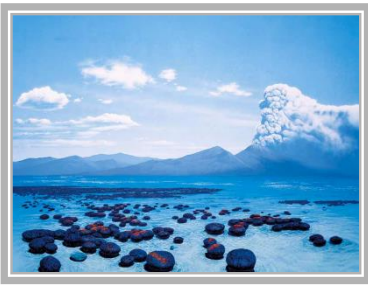


WATER

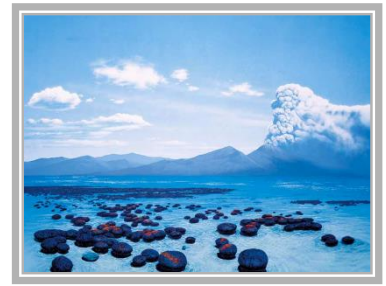
WATER

WATER

PHOSPHOLIPIDS



ORGANIC COMPOUNDS

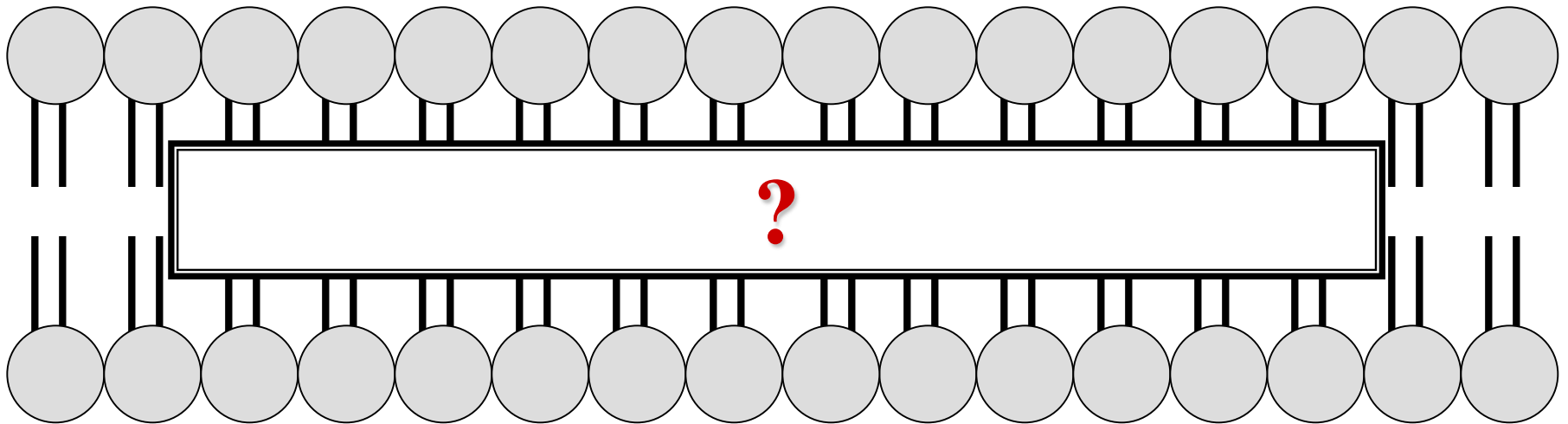


B

WATER

WATER

WATER



WATER

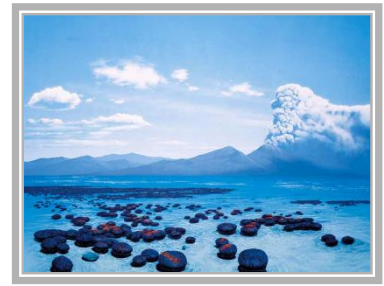
WATER

WATER

PHOSPHOLIPIDS



ORGANIC COMPOUNDS

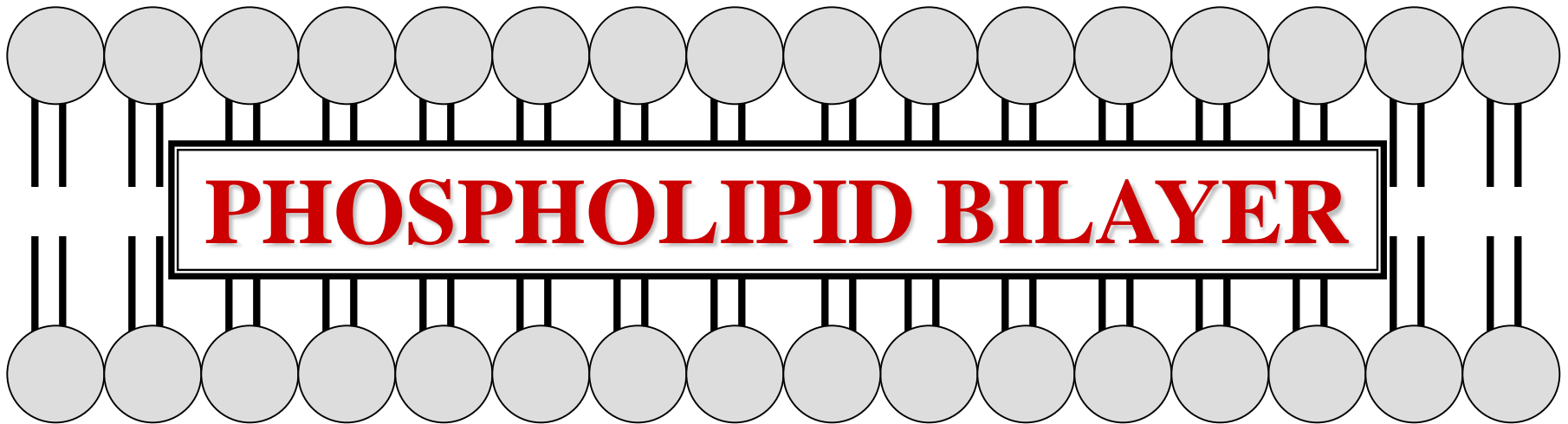


M

WATER

WATER

WATER



WATER

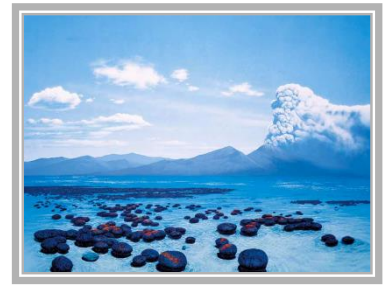
WATER

WATER

PHOSPHOLIPIDS



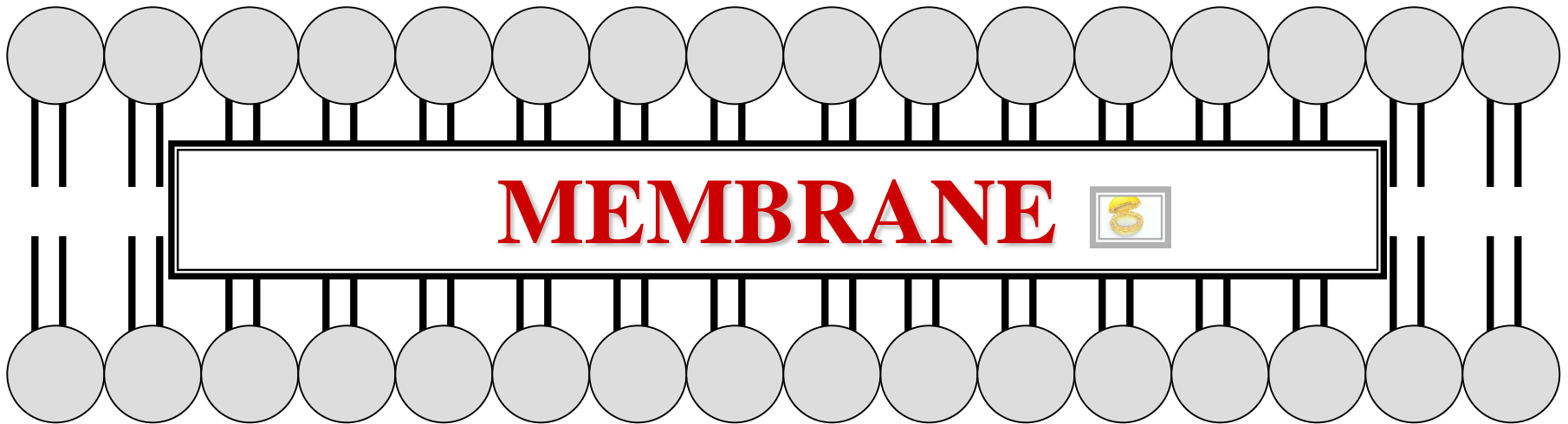
ORGANIC COMPOUNDS



WATER

WATER

WATER

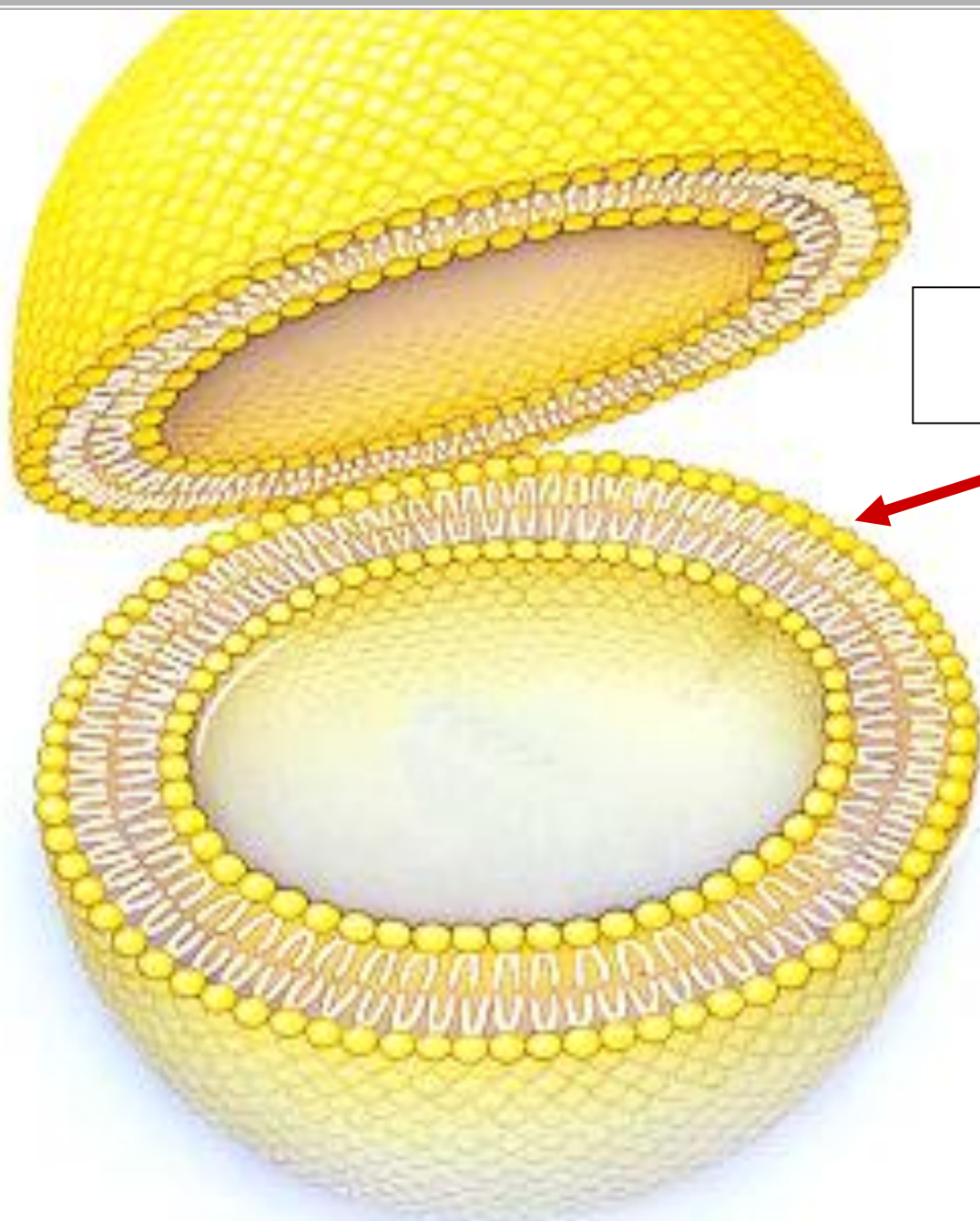


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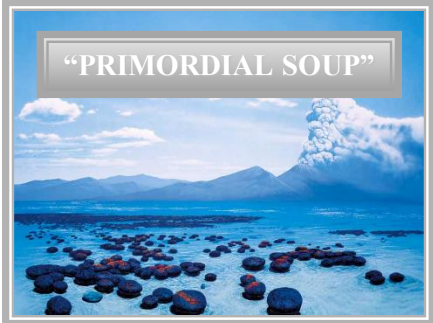
WATER

WATER

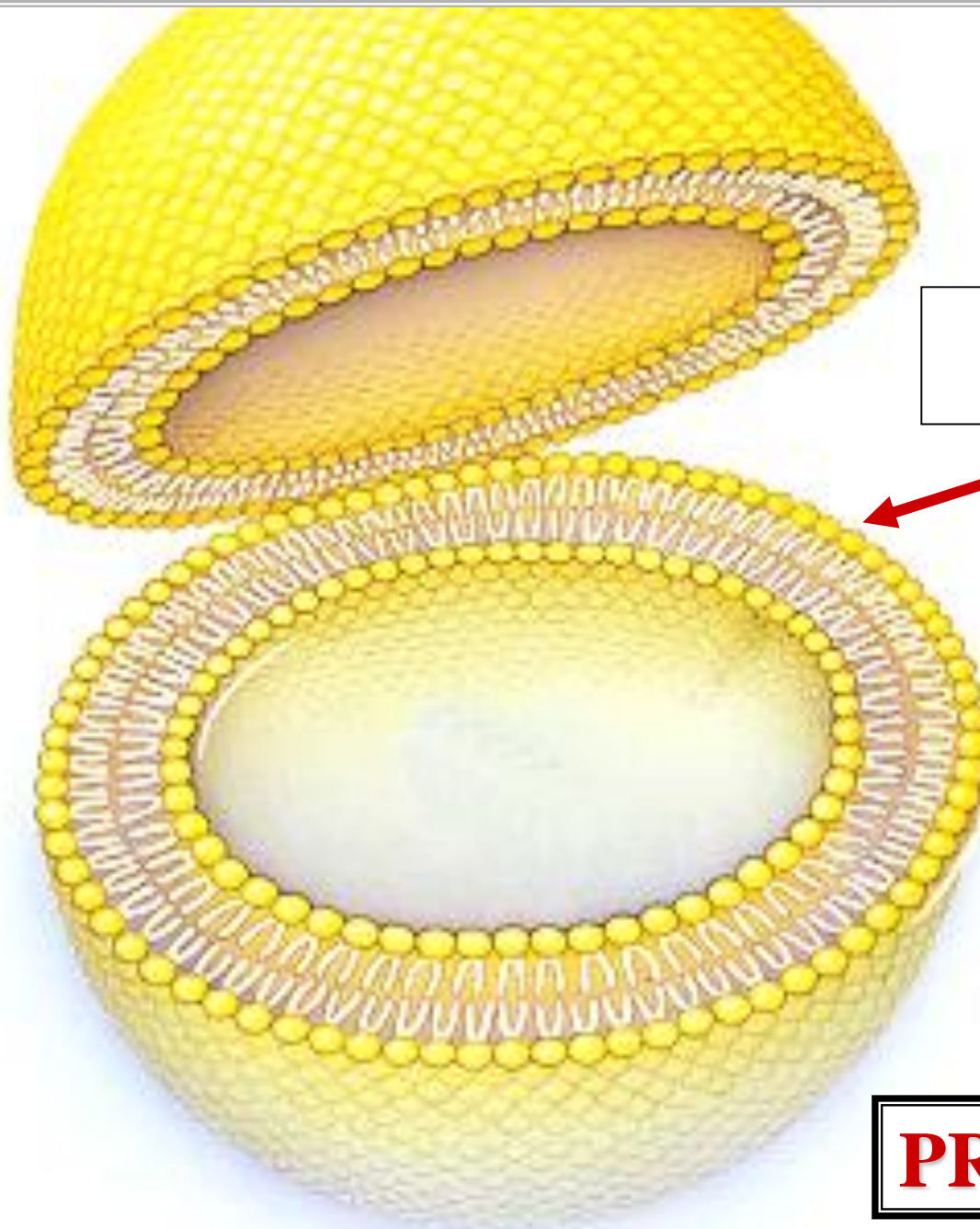
PHOSPHOLIPIDS



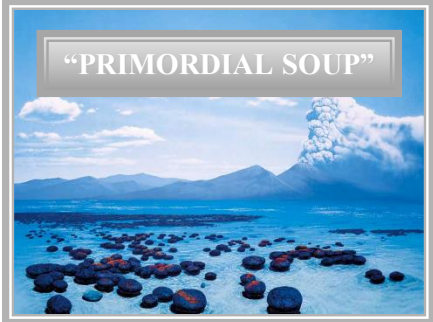
**PRIMITIVE
MEMBRANE**



“PRIMORDIAL SOUP”



**PRIMITIVE
MEMBRANE**



“PRIMORDIAL SOUP”

PROTOBIONT

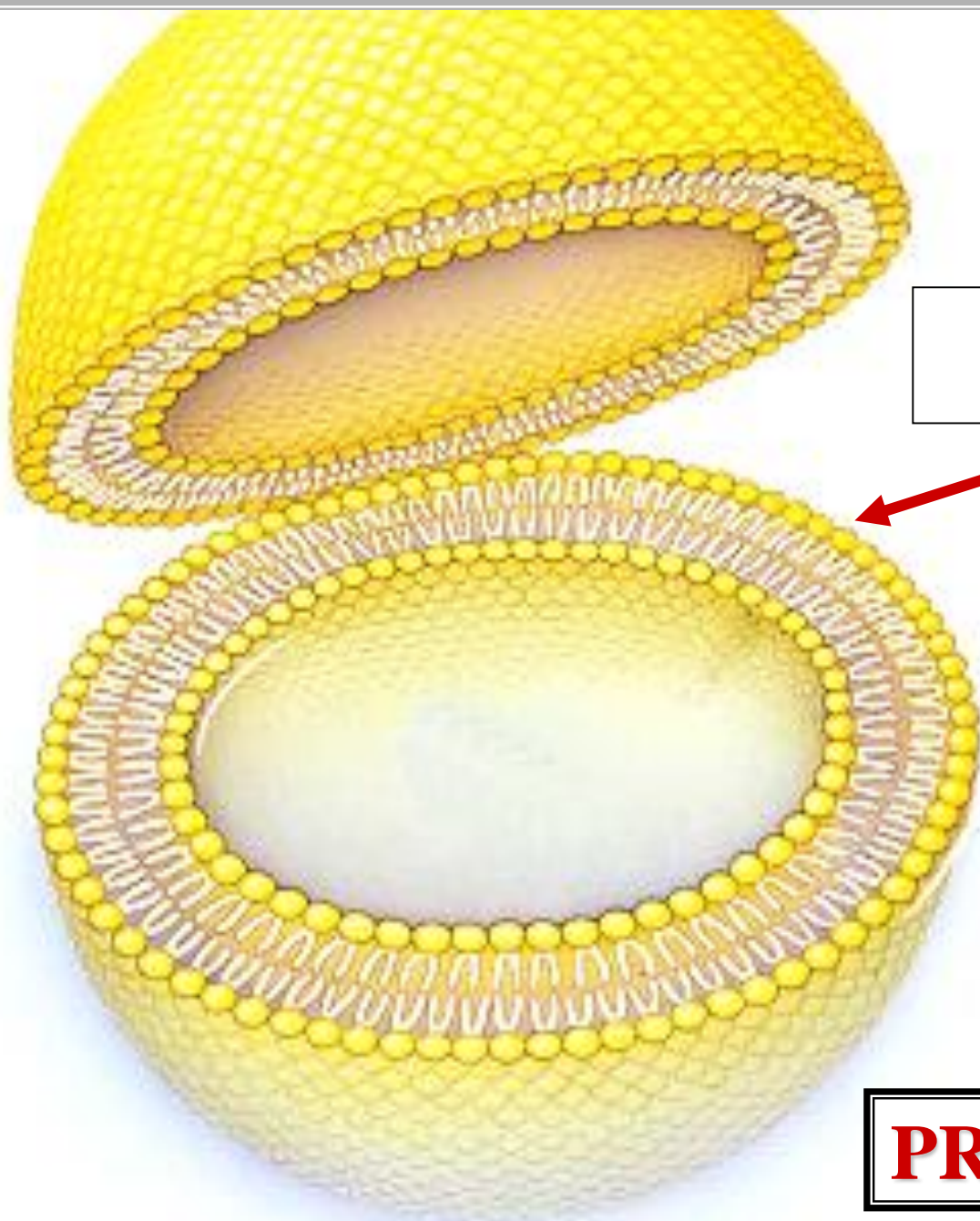
PROTOBIONTS

PROTOBIONT

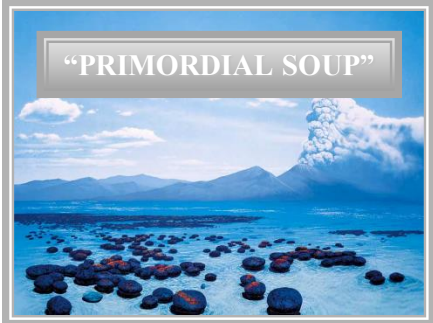
PROTOBIONT

**ABIOTIC
ORGANIC AGGREGATE**

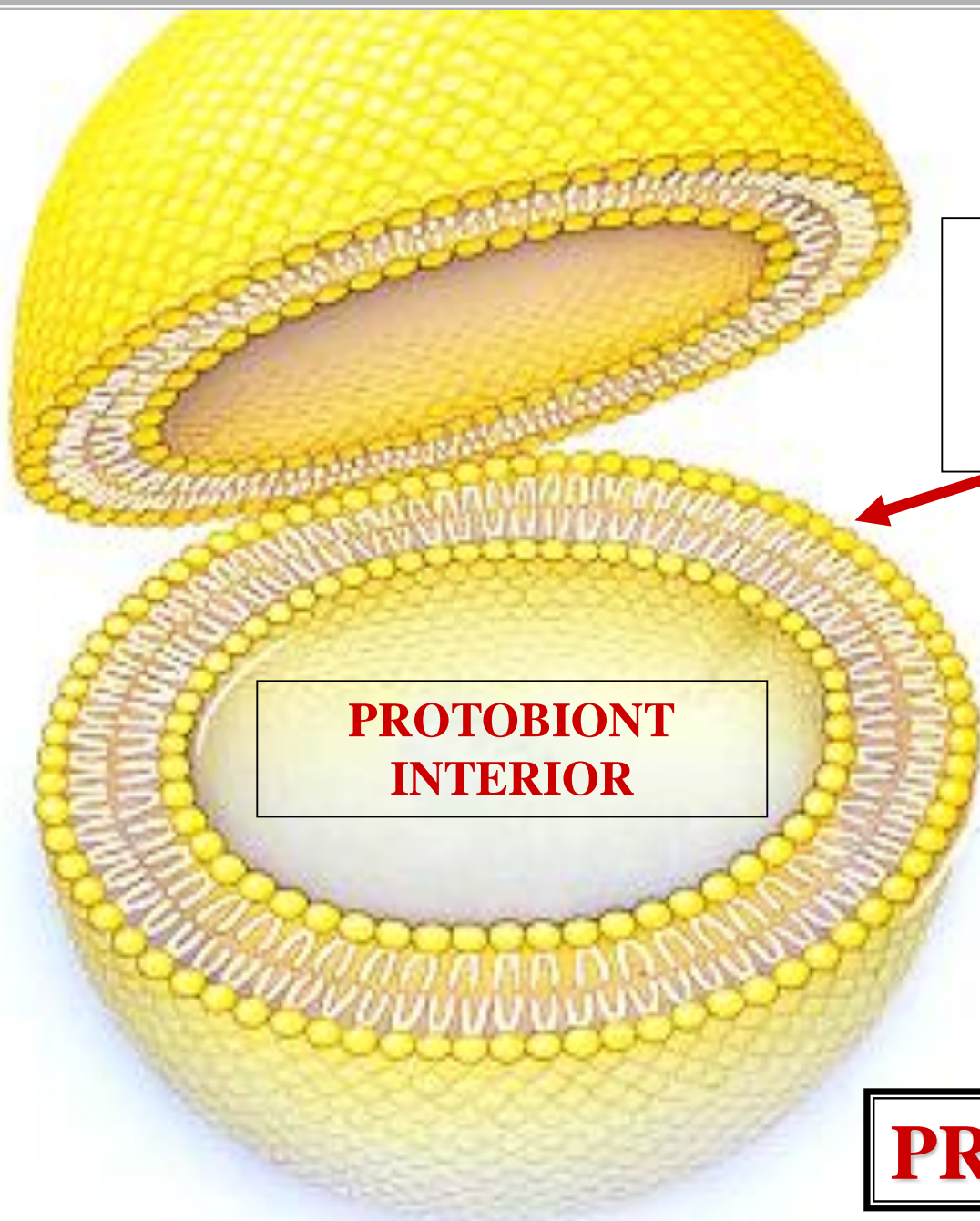
PROTOBIONT



**PRIMITIVE
MEMBRANE**

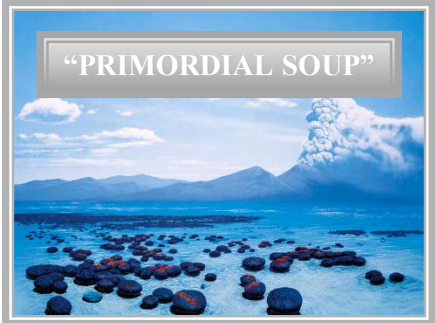


PROTOBIONT



**PRIMITIVE
MEMBRANE
REGULATES
PASSAGE**

**PROTOBIONT
INTERIOR**

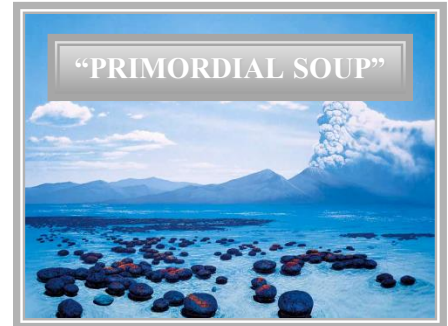


PROTOBIONT

LE

**PRIMITIVE
MEMBRANE
REGULATES
PASSAGE**

**HIGHER
ORGANIZATION**



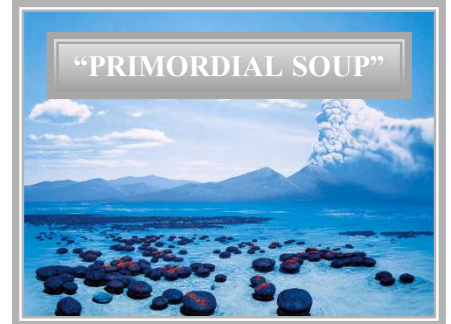
PROTOBIONT

ME

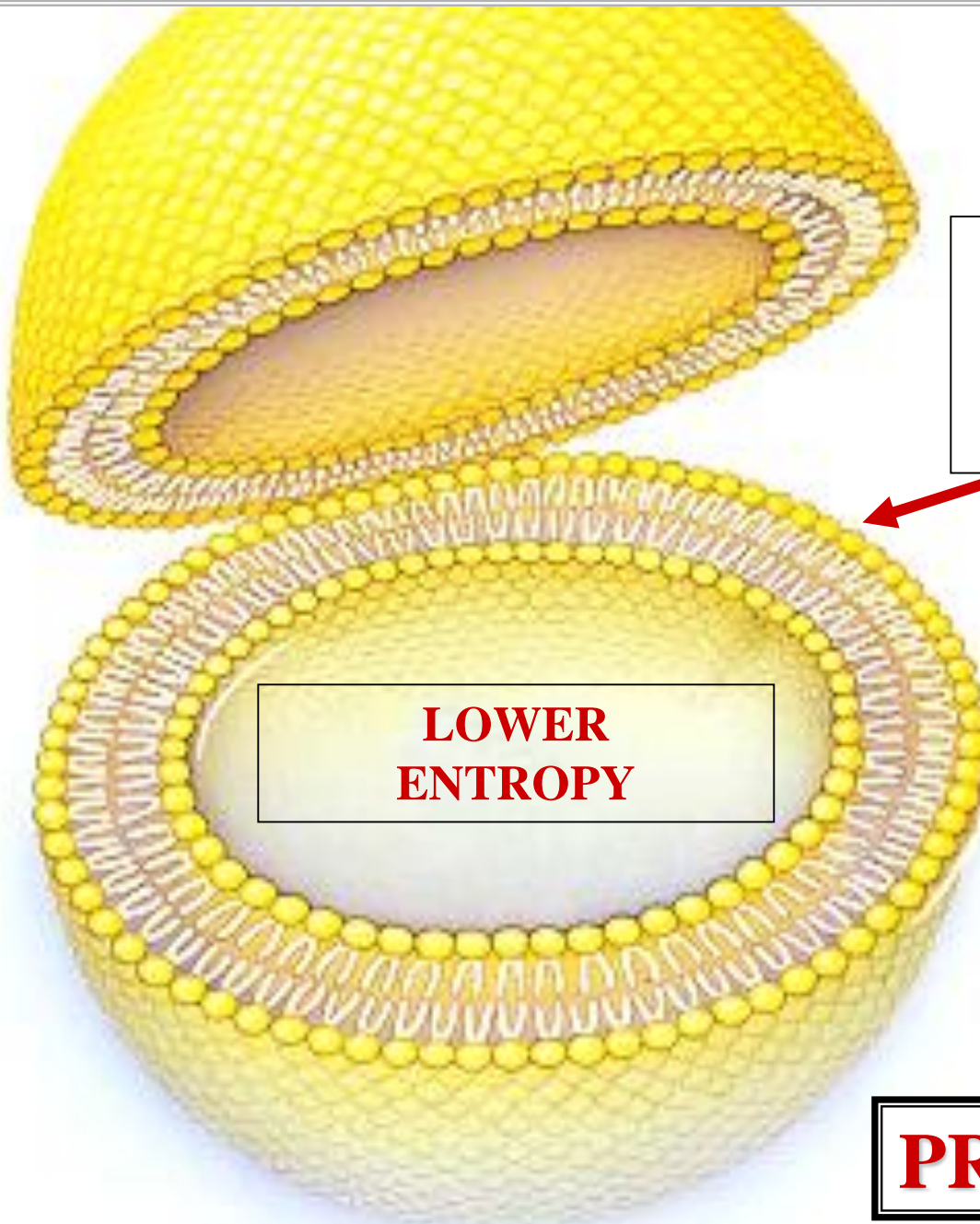
**PRIMITIVE
MEMBRANE
REGULATES
PASSAGE**

**LOWER
ENTROPY**

“PRIMORDIAL SOUP”



PROTOBIONT

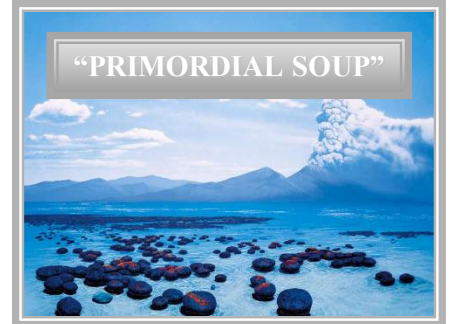


PR

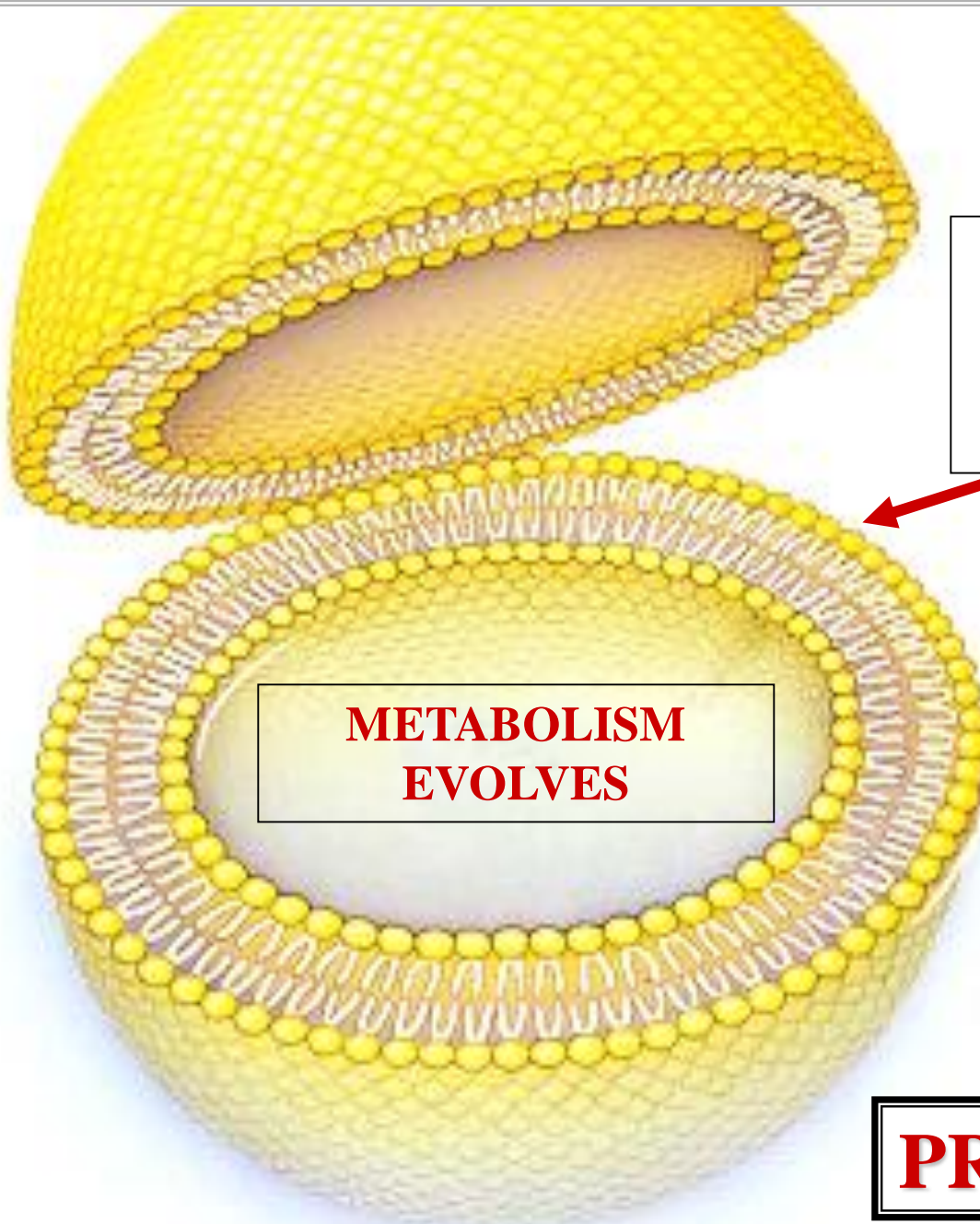
**PRIMITIVE
MEMBRANE
REGULATES
PASSAGE**

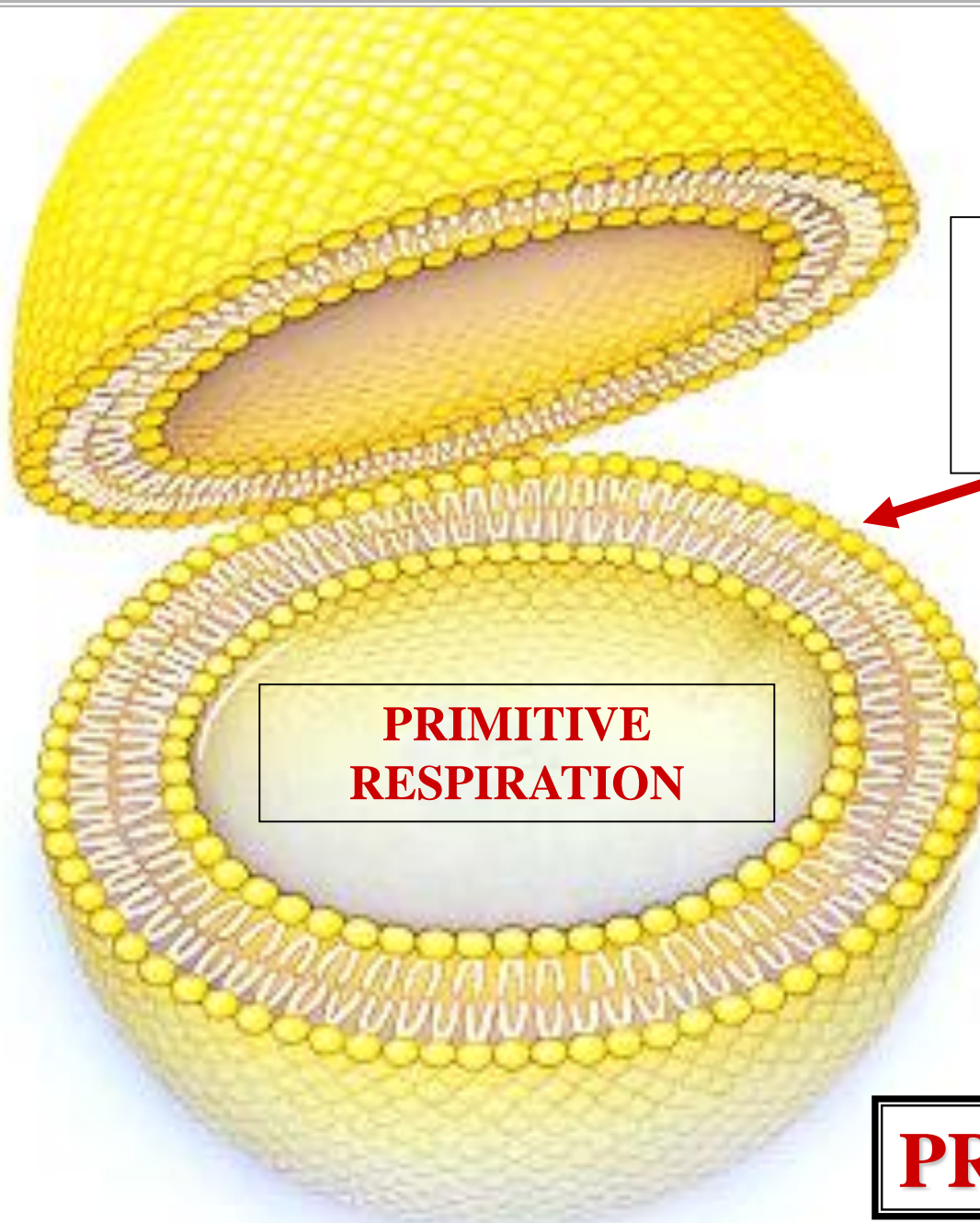
**METABOLISM
EVOLVES**

“PRIMORDIAL SOUP”



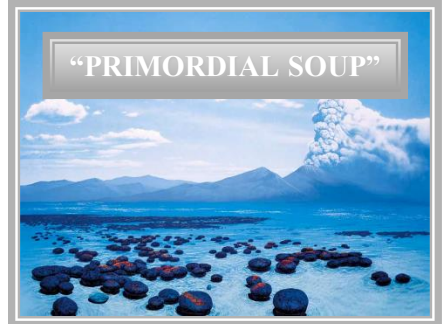
PROTOBIONT





**PRIMITIVE
MEMBRANE
REGULATES
PASSAGE**

**PRIMITIVE
RESPIRATION**



PROTOBIONT

RESPIRATION

GLUCOSE

RESPIRATION

HEXOKINASE

F

ATP

EGY

ADP

GLUCOSE-6-PHOSPHATE

PHOSPHOGLUCOISOMERASE

FRUCTOSE-6-PHOSPHATE

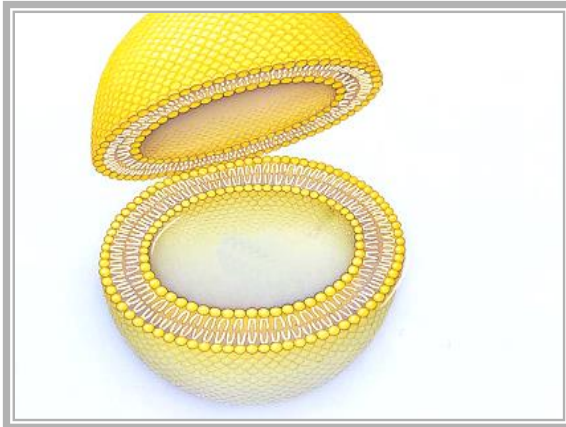
PHOSPHOFRUCTOKINASE

ATP

EGY

ADP

FRUCTOSE-1-6-PHOSPHATE



3-PHOSPHOGLYCERATE - PGA

ENOLASE

3-PHOSPHOENOLPYRUVATE

PYRUVATE KINASE



PYRUVATE

3-PHOSPHOGLYCERATE - PGA

ENOLASE

3-PHOSPHOENOLPYRUVATE

PYRUVATE KINASE



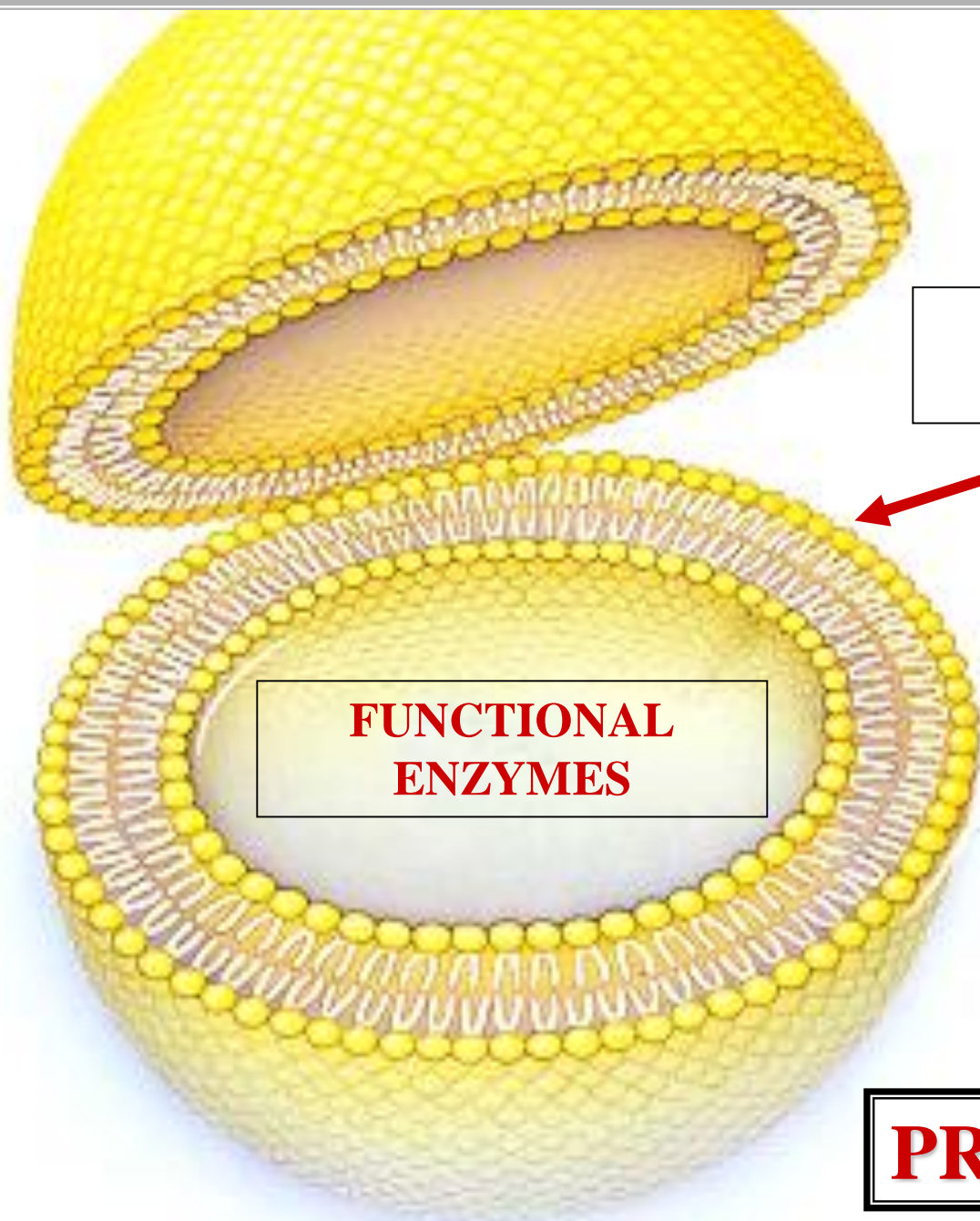
PYRUVATE

+



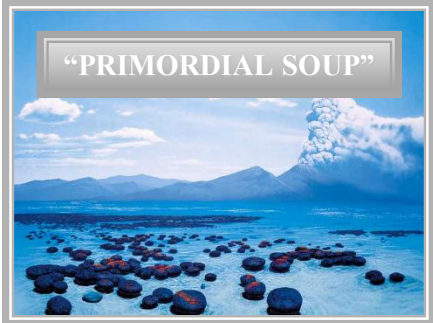
ATP = BIOLOGICAL ENERGY MOLECULE

FUNCTIONAL ENZYMES



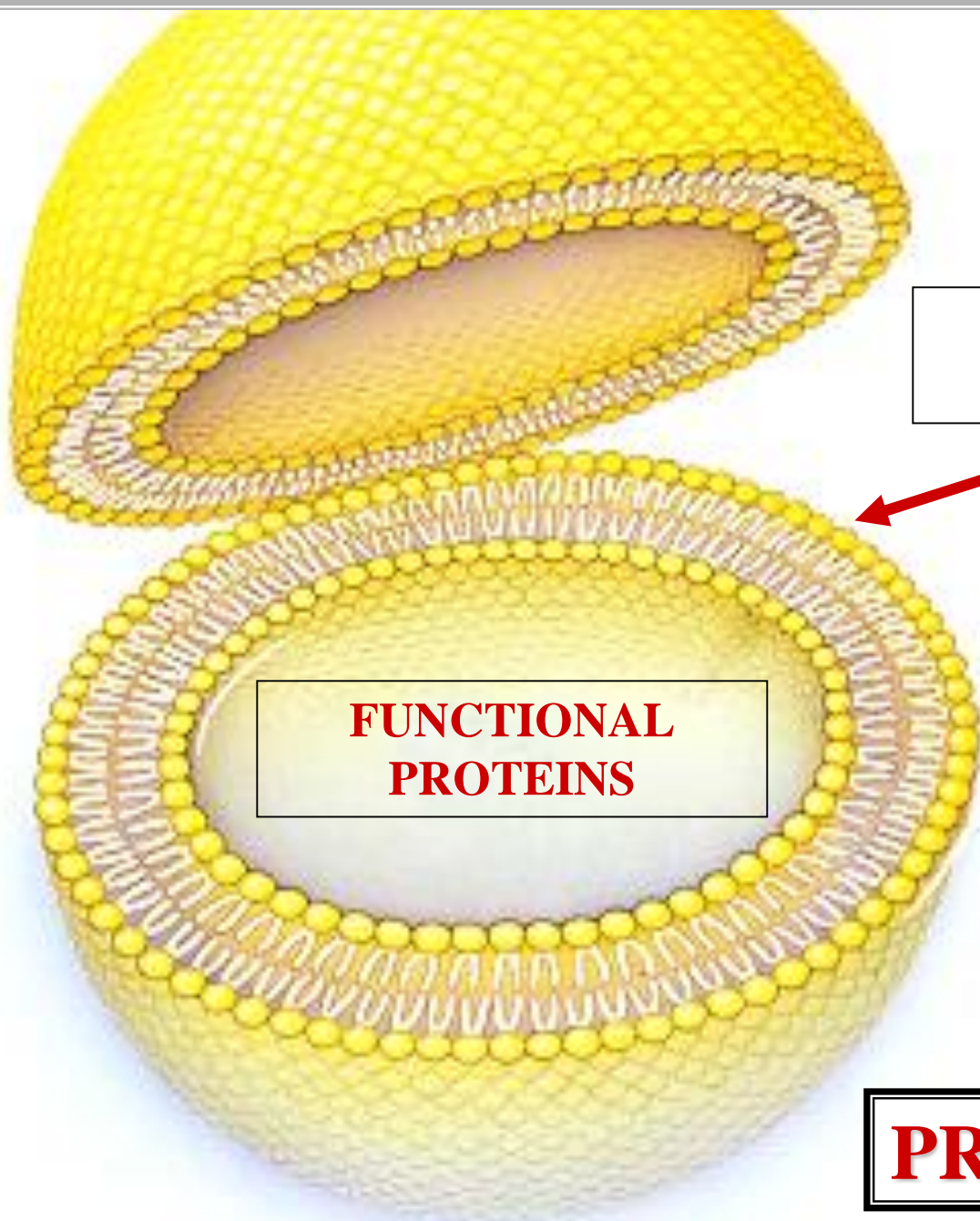
**PRIMITIVE
MEMBRANE**

**FUNCTIONAL
ENZYMES**



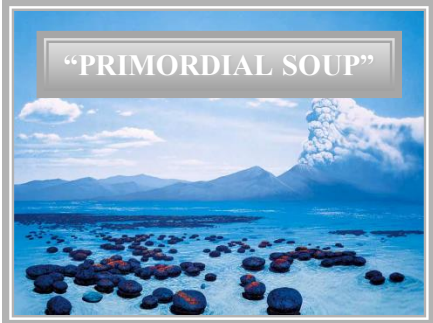
PROTOBIONT

PS

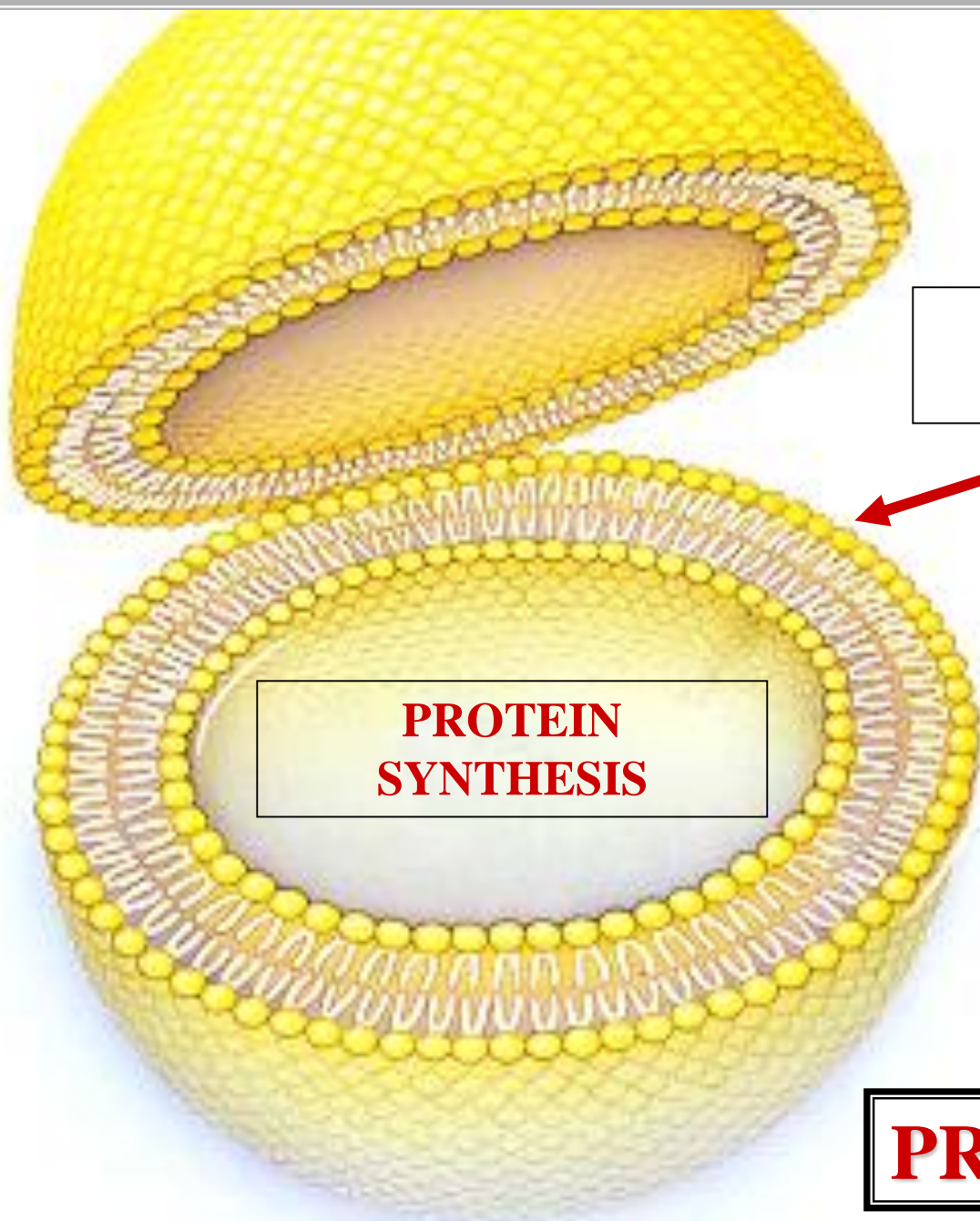


**PRIMITIVE
MEMBRANE**

**FUNCTIONAL
PROTEINS**

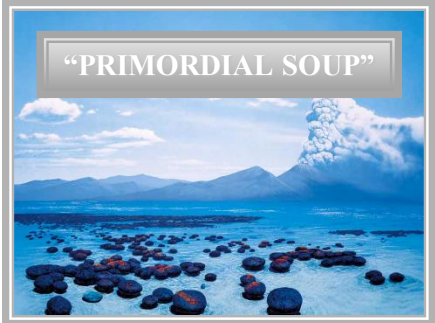


PROTOBIONT



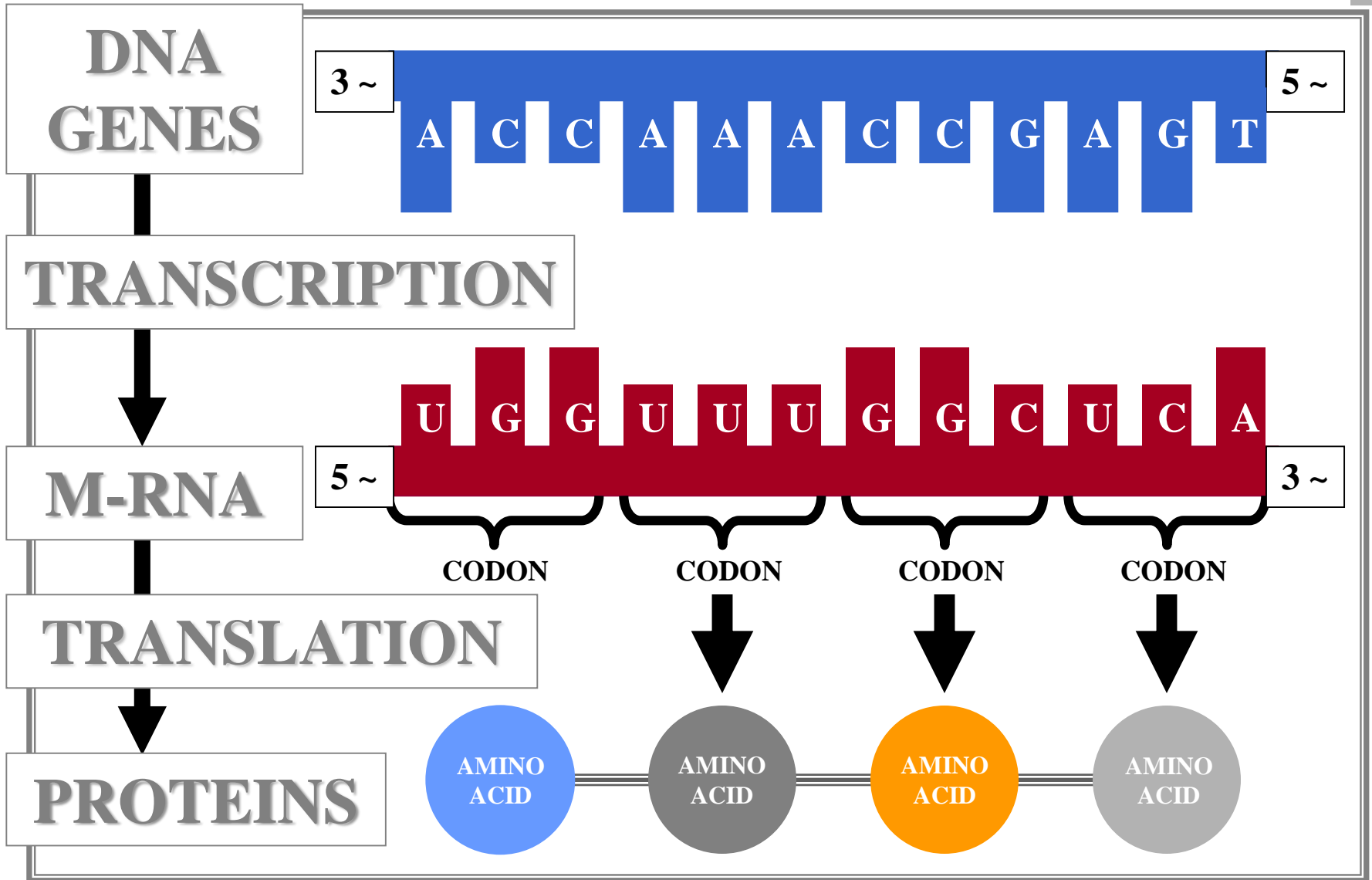
**PRIMITIVE
MEMBRANE**

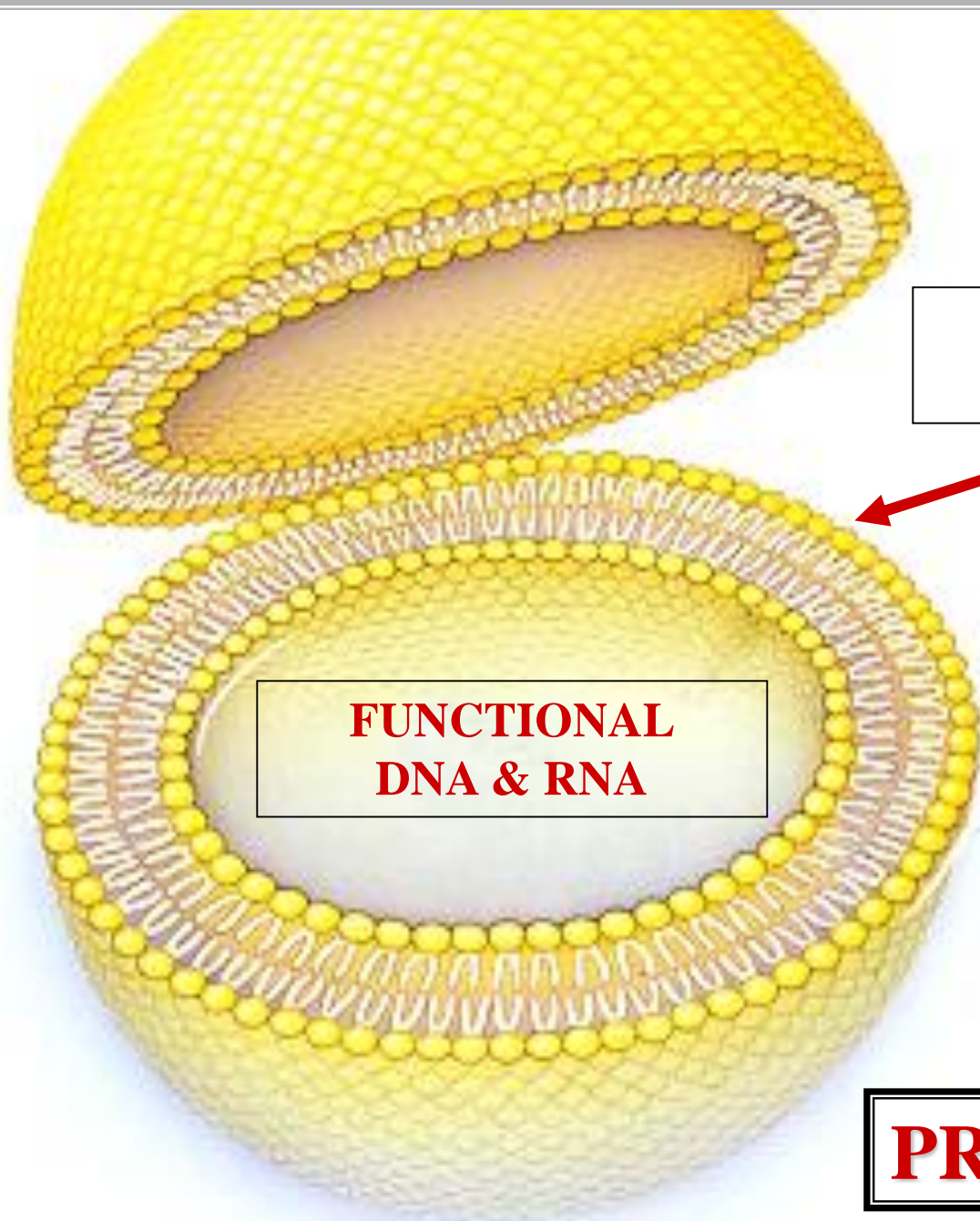
**PROTEIN
SYNTHESIS**



PROTOBIONT

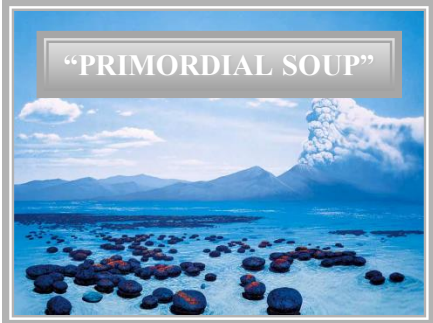
PROTEIN SYNTHESIS





**PRIMITIVE
MEMBRANE**

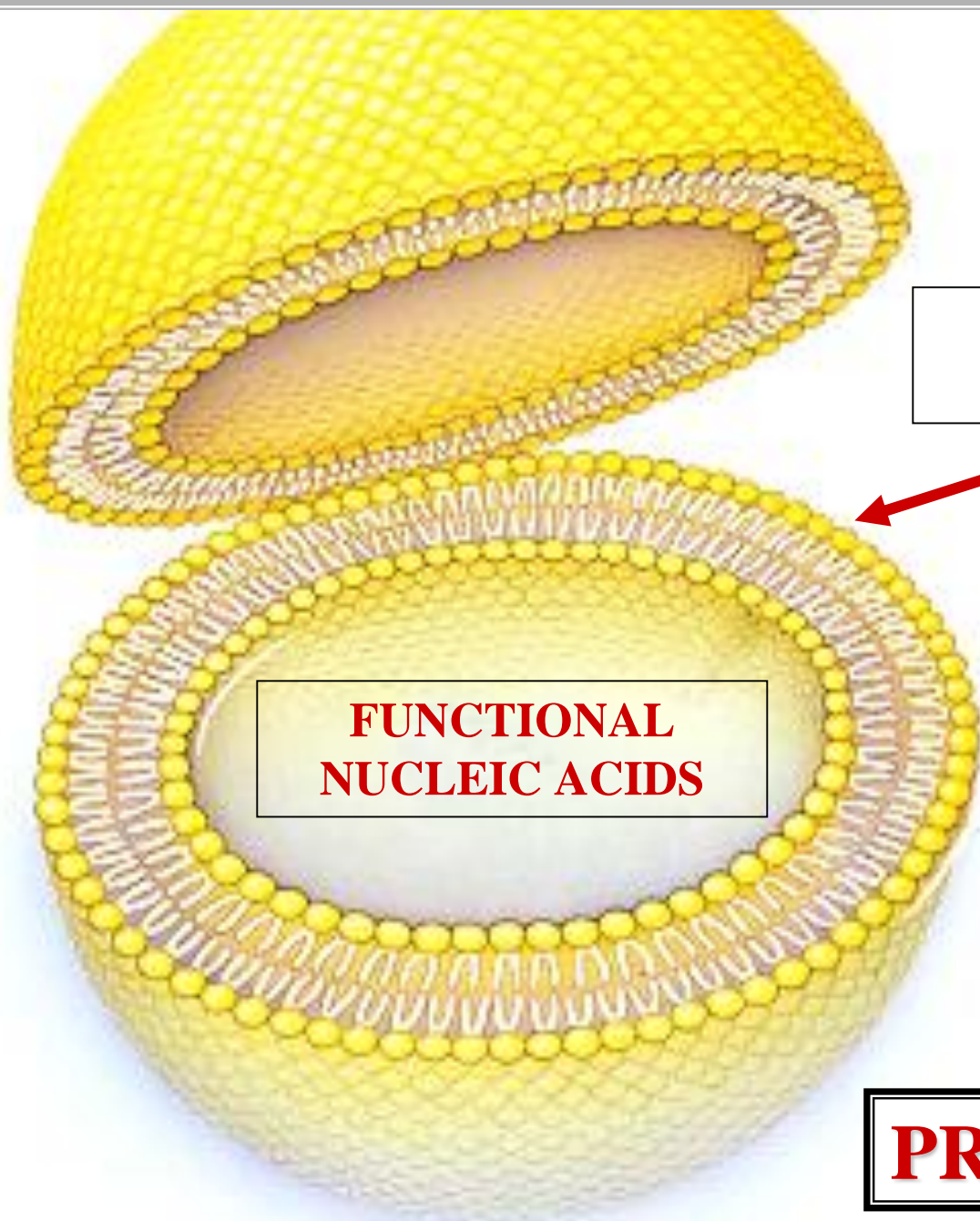
**FUNCTIONAL
DNA & RNA**



PROTOBIONT

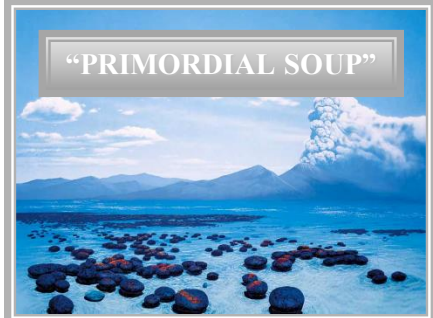
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LO



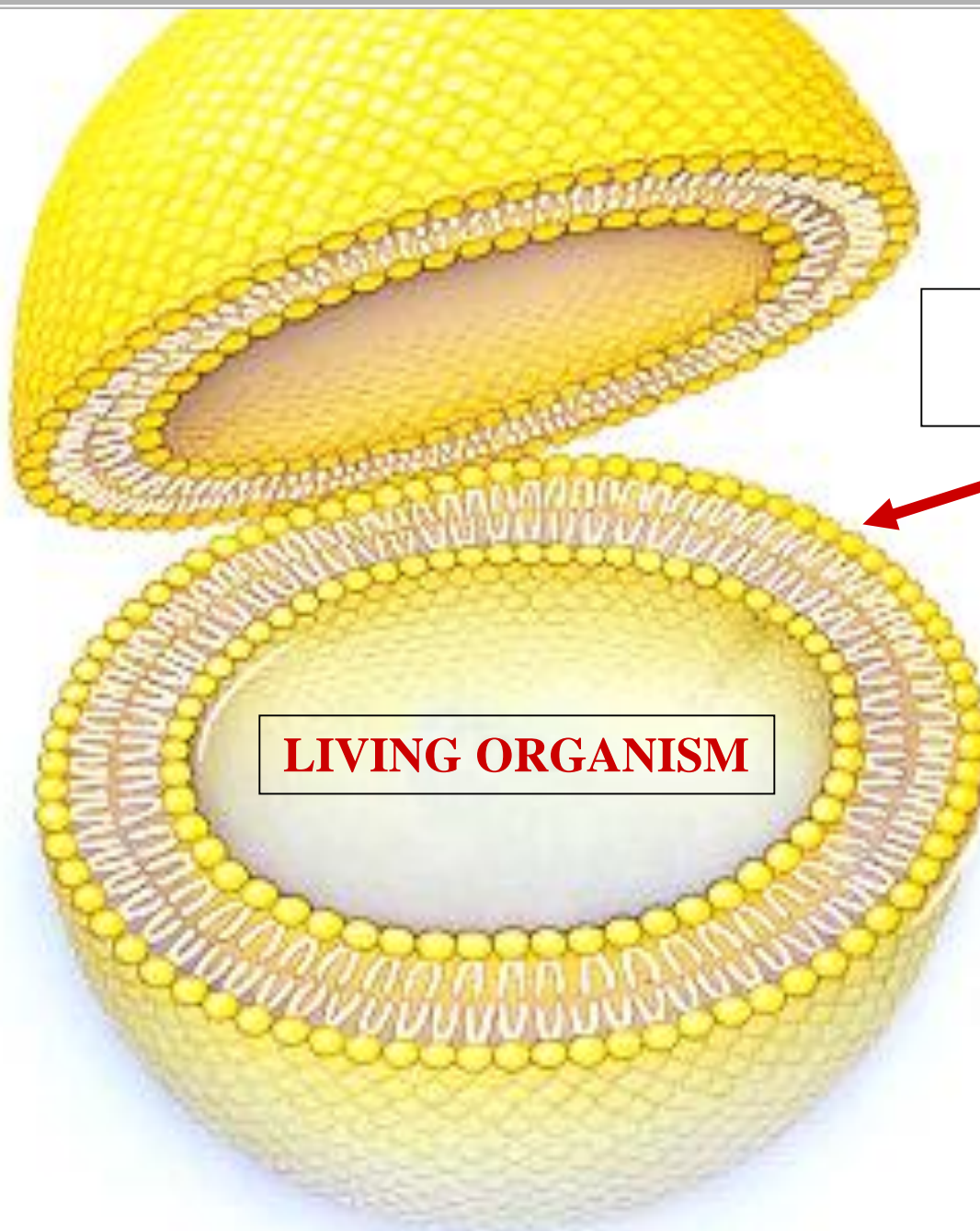
**PRIMITIVE
MEMBRANE**

**FUNCTIONAL
NUCLEIC ACIDS**



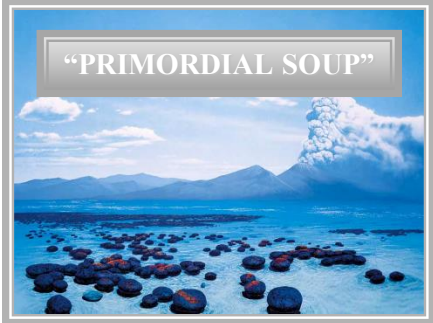
PROTOBIONT

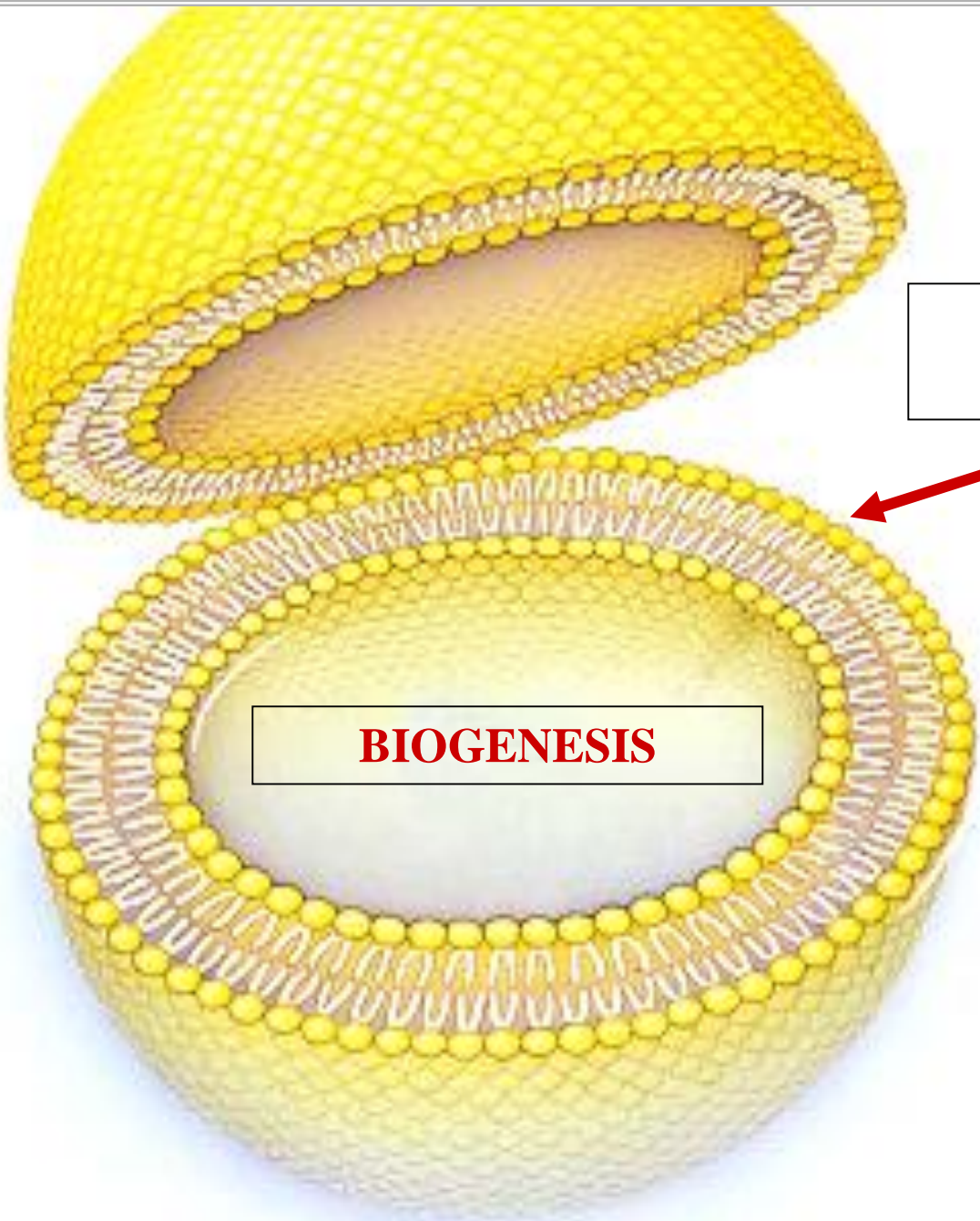
B



**PRIMITIVE
MEMBRANE**

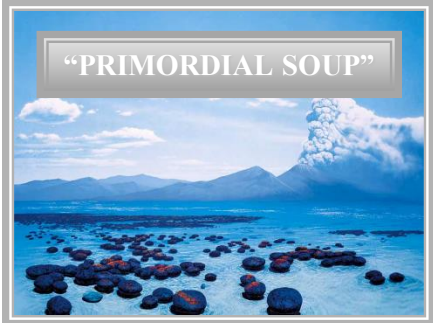
LIVING ORGANISM



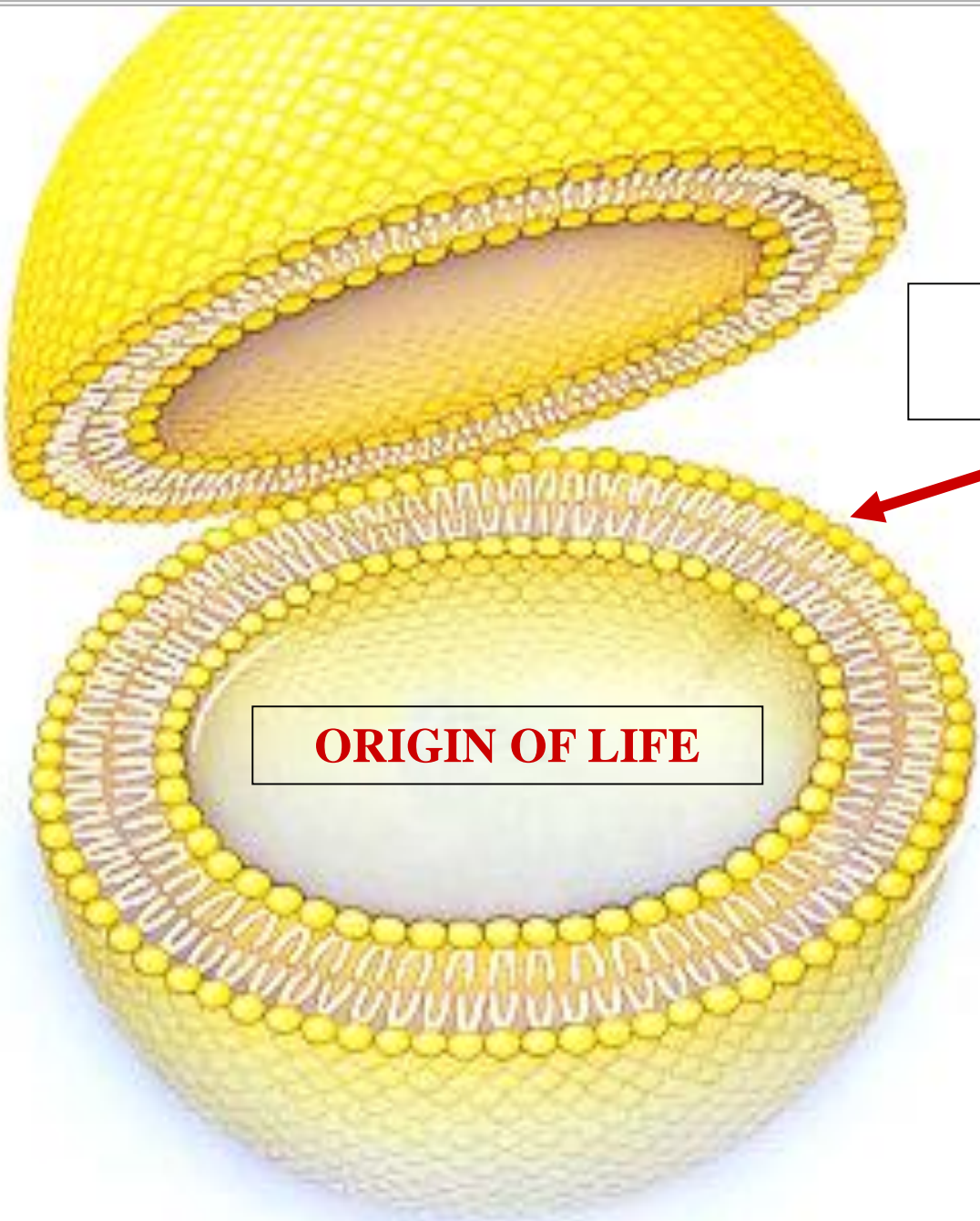


**PRIMITIVE
MEMBRANE**

BIOGENESIS

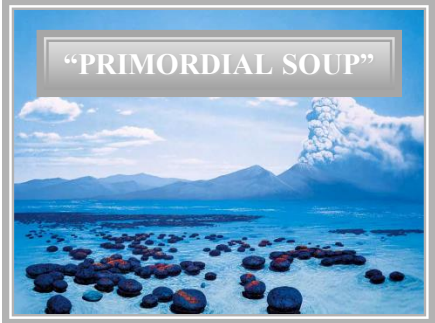


"PRIMORDIAL SOUP"



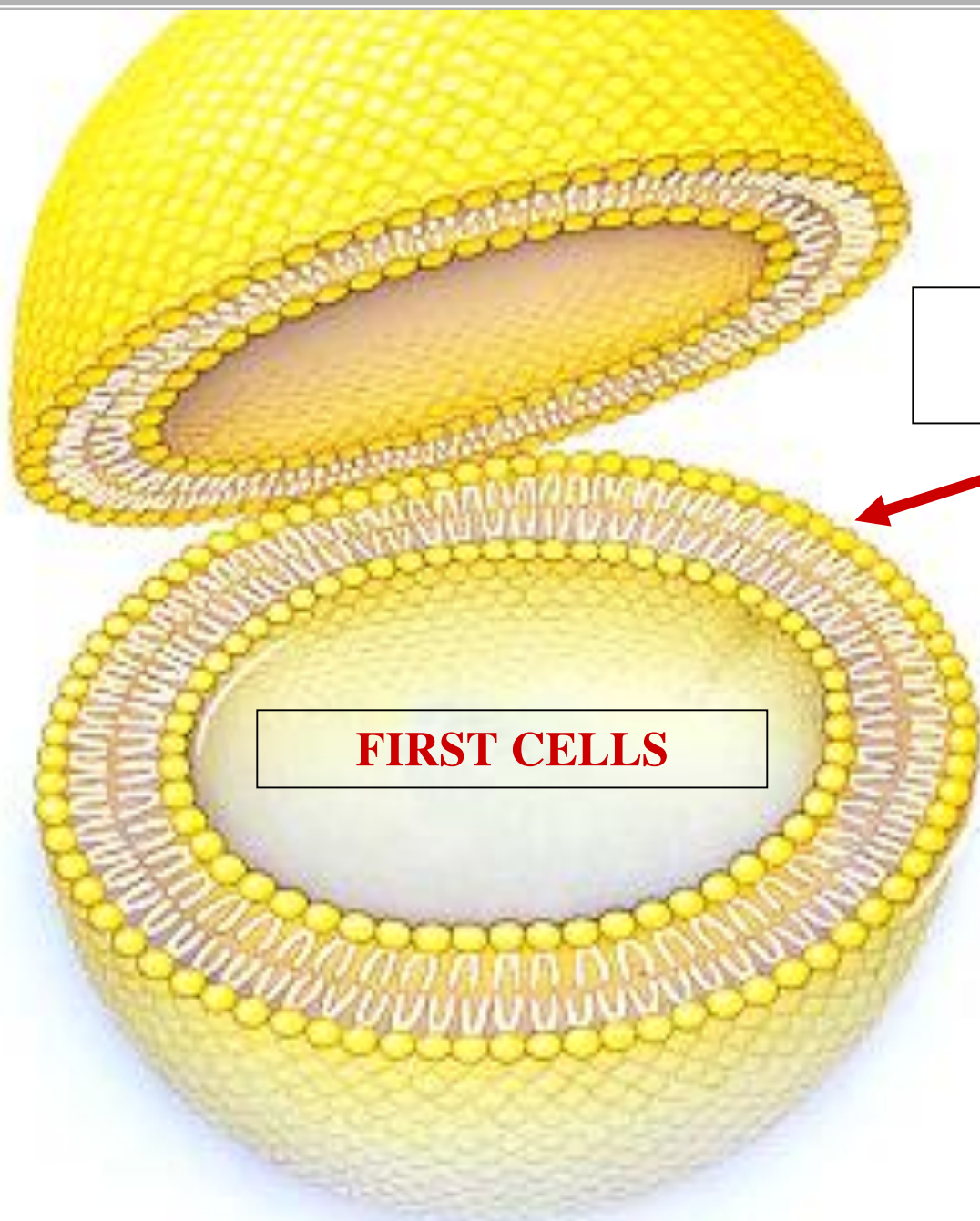
**PRIMITIVE
MEMBRANE**

ORIGIN OF LIFE



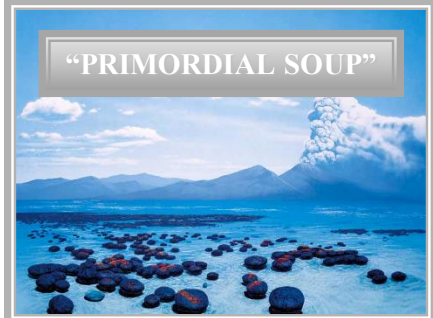
“PRIMORDIAL SOUP”

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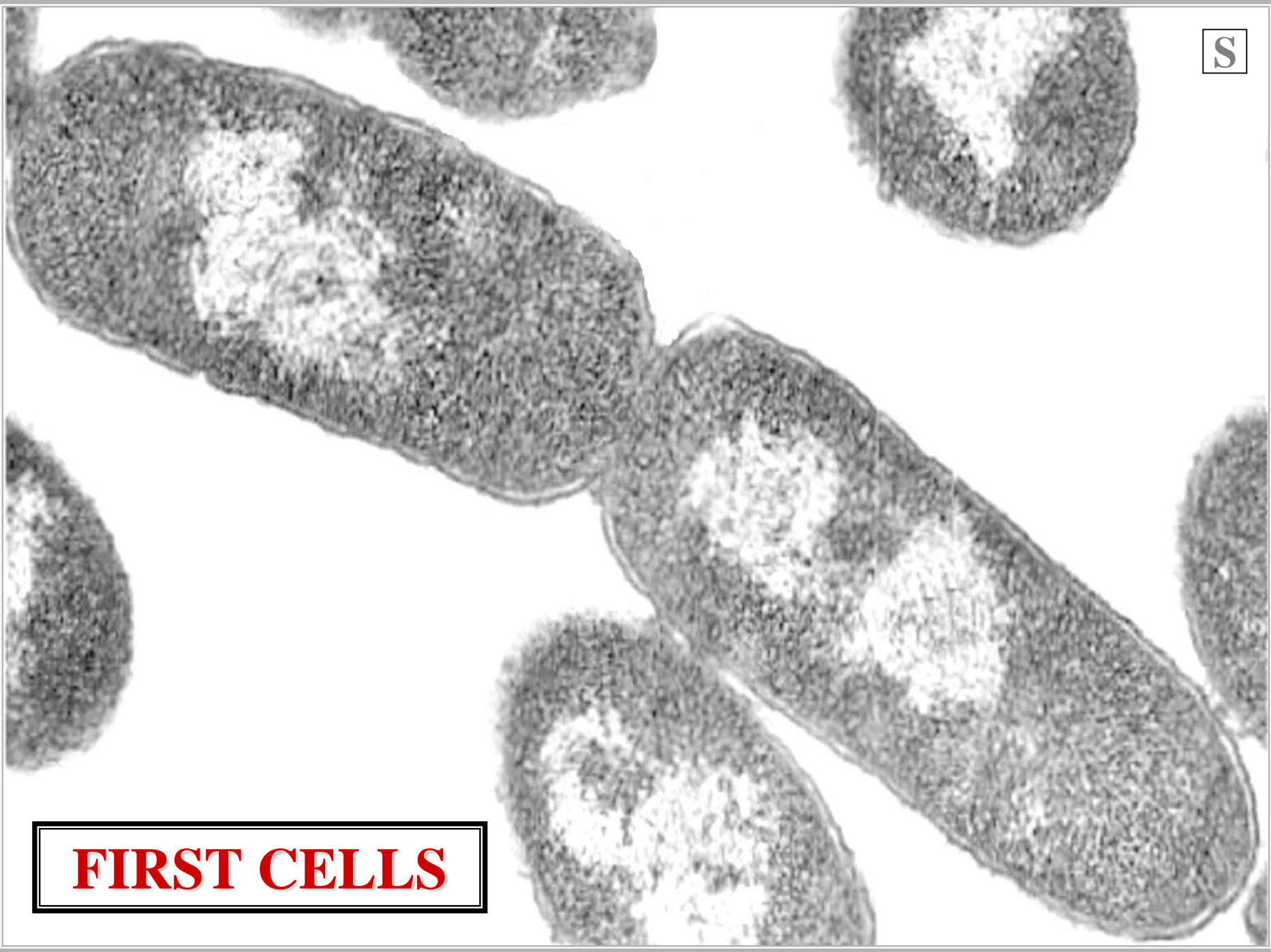
**PRIMITIVE
MEMBRANE**

FIRST CELLS



S

FIRST CELLS

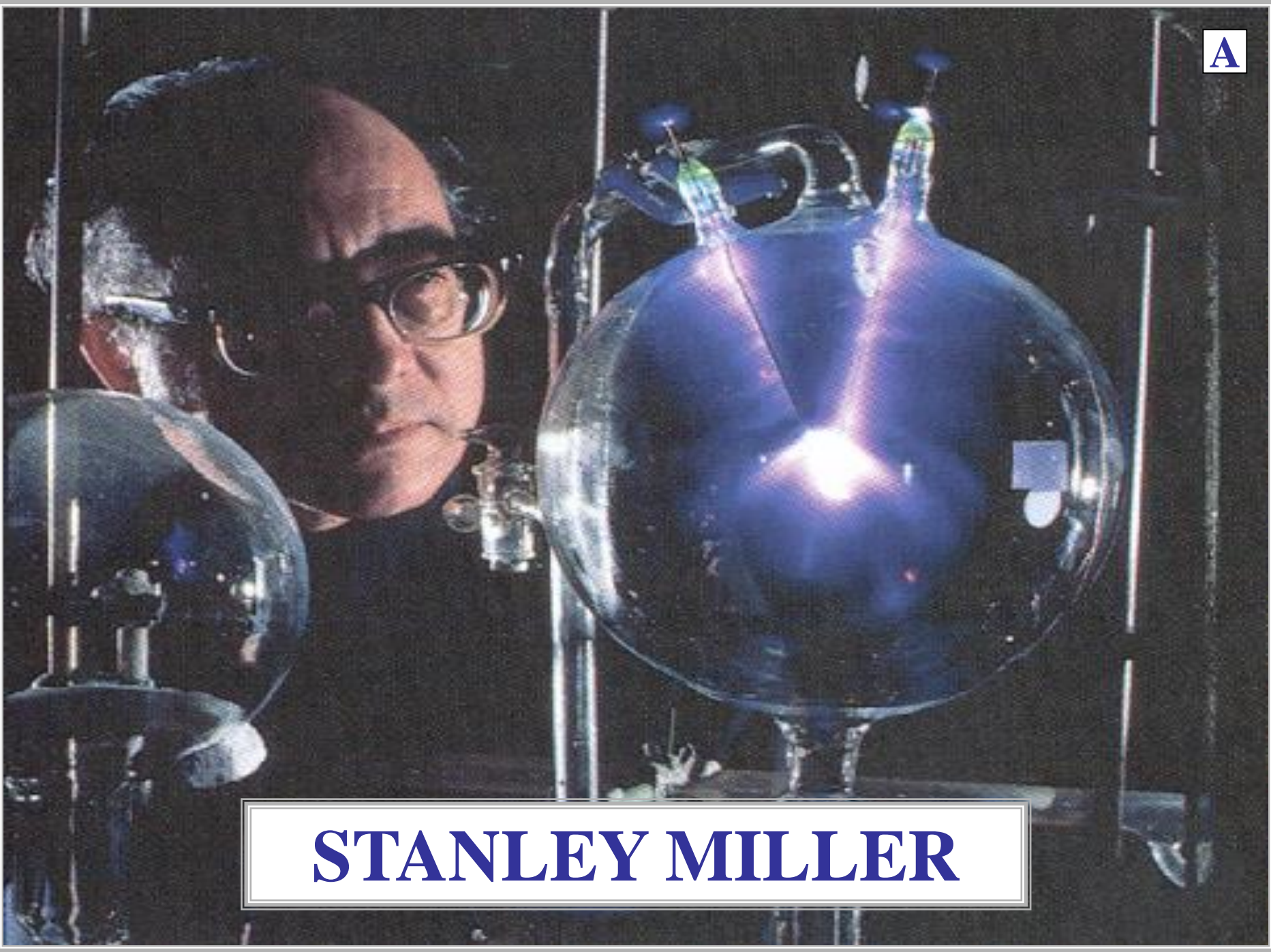




SUPPORTING EVIDENCE



STANLEY MILLER EXPERIMENTS



STANLEY MILLER

AMERICAN BIOCHEMIST

STANLEY MILLER

A photograph of Stanley Miller in his laboratory. He is wearing glasses and looking towards the camera. To his right is a large, glowing Miller-Urey apparatus, which is a glass flask containing a mixture of gases that is being heated and electrically discharged. The apparatus is illuminated with a bright blue light, creating a glowing effect. The background is dark, and the overall scene is set in a laboratory environment.

TESTED OPARIN THEORY

STANLEY MILLER

SIMULATED PRIMITIVE EARTH

STANLEY MILLER

A photograph of Stanley Miller in his laboratory. He is wearing glasses and looking towards a large, glowing glass apparatus. The apparatus is a complex setup of glass tubes and flasks, with a bright light source inside, creating a purple and blue glow. The background is dark, and the overall scene is dimly lit, focusing attention on the glowing apparatus and Miller's face.

DERIVE ORGANIC CMPS

STANLEY MILLER



AMINO ACIDS - NUCLEOTIDES

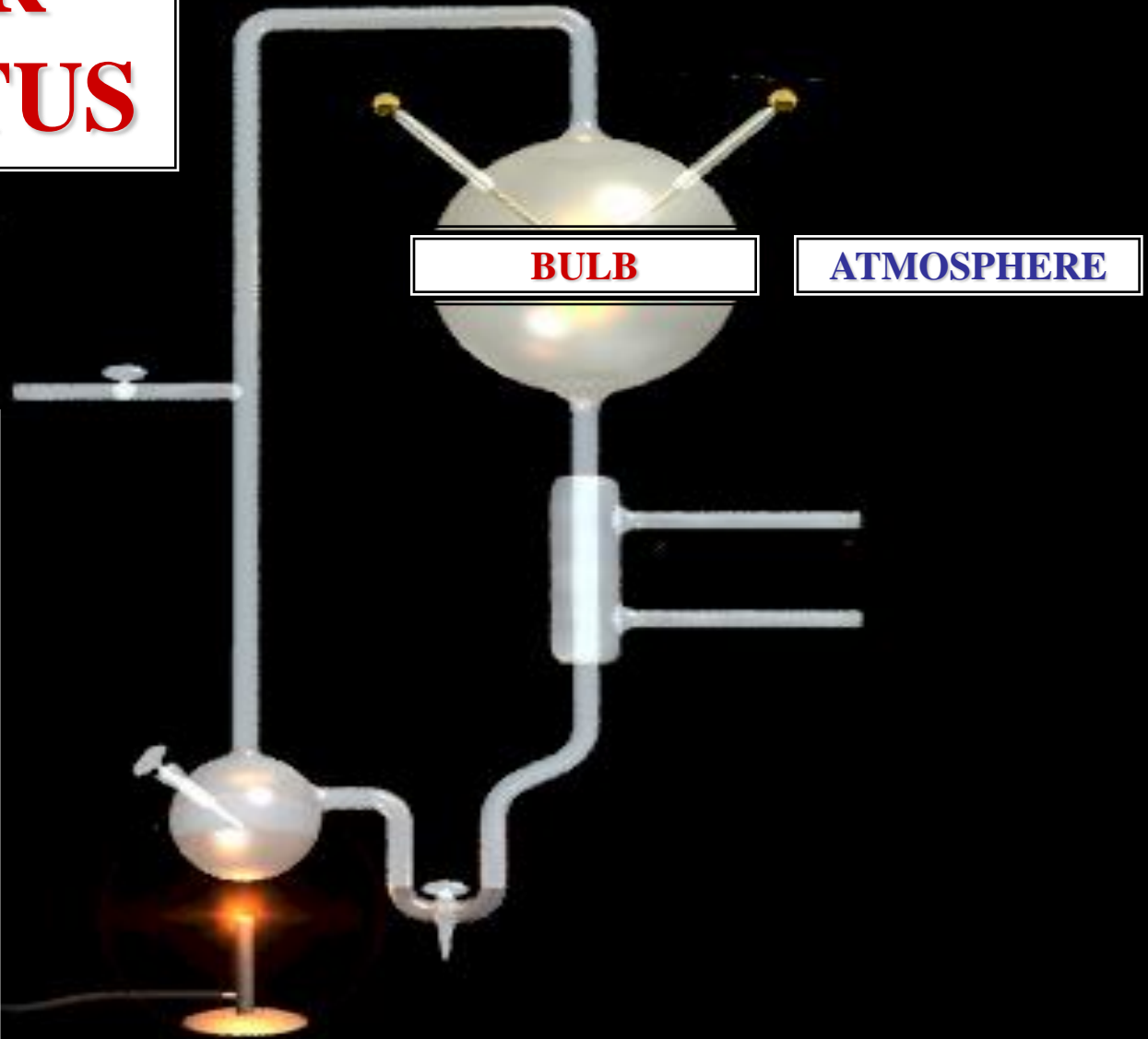
STANLEY MILLER

MILLER APPARATUS



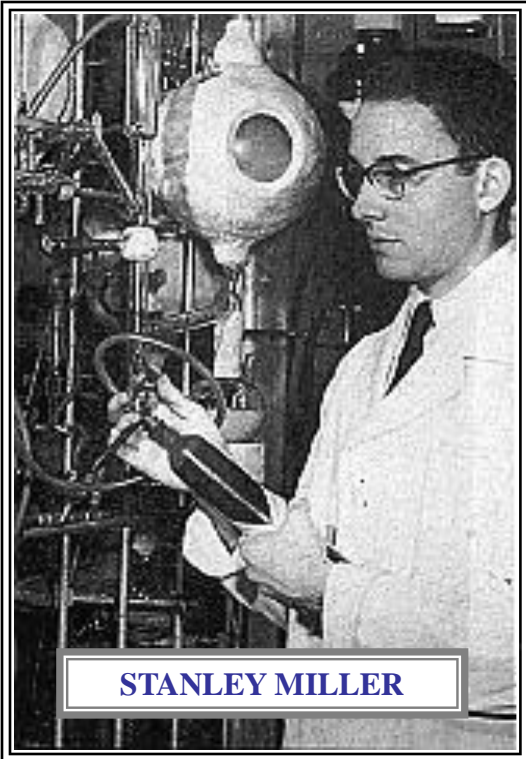
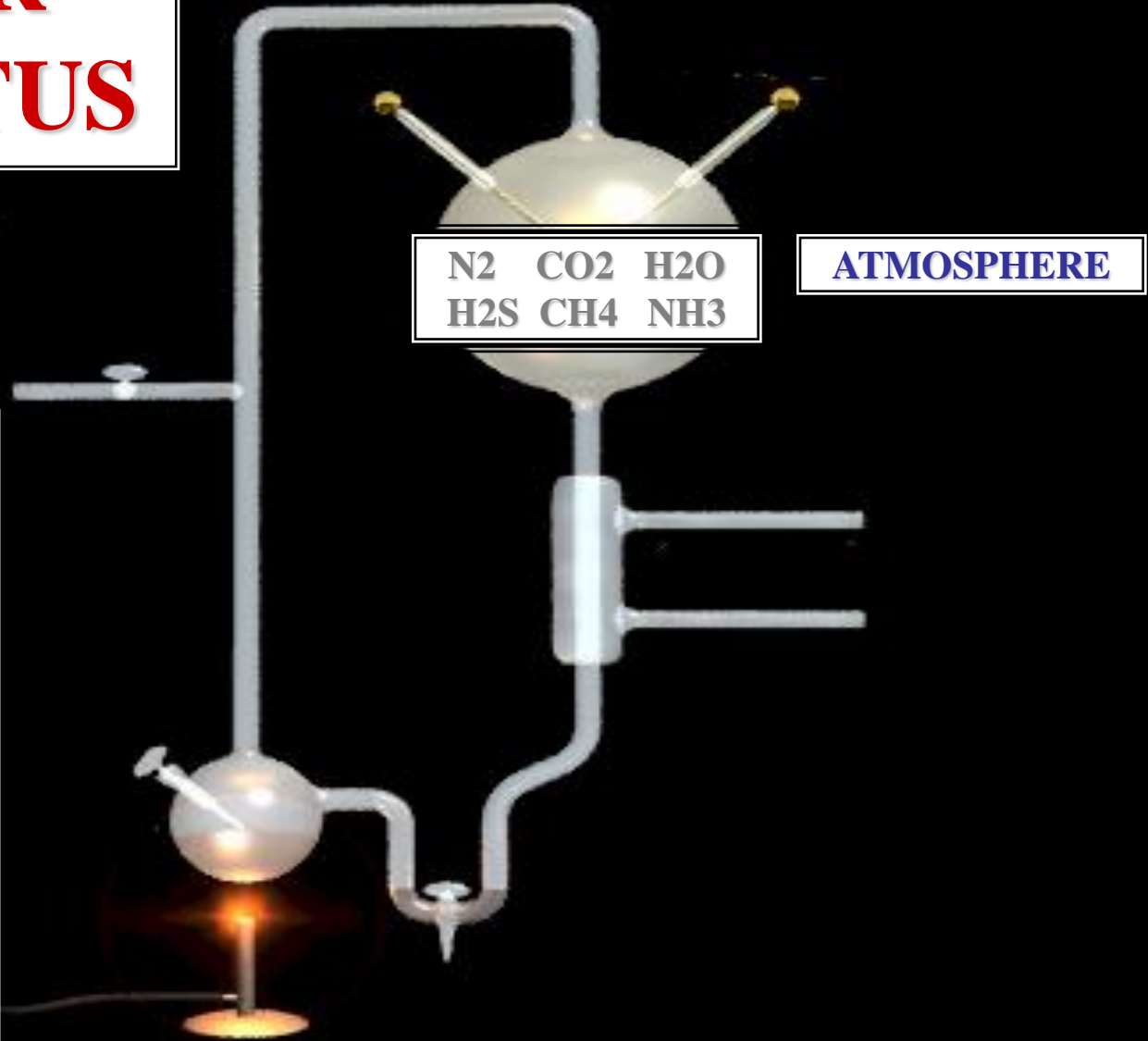
STANLEY MILLER

MILLER APPARATUS



STANLEY MILLER

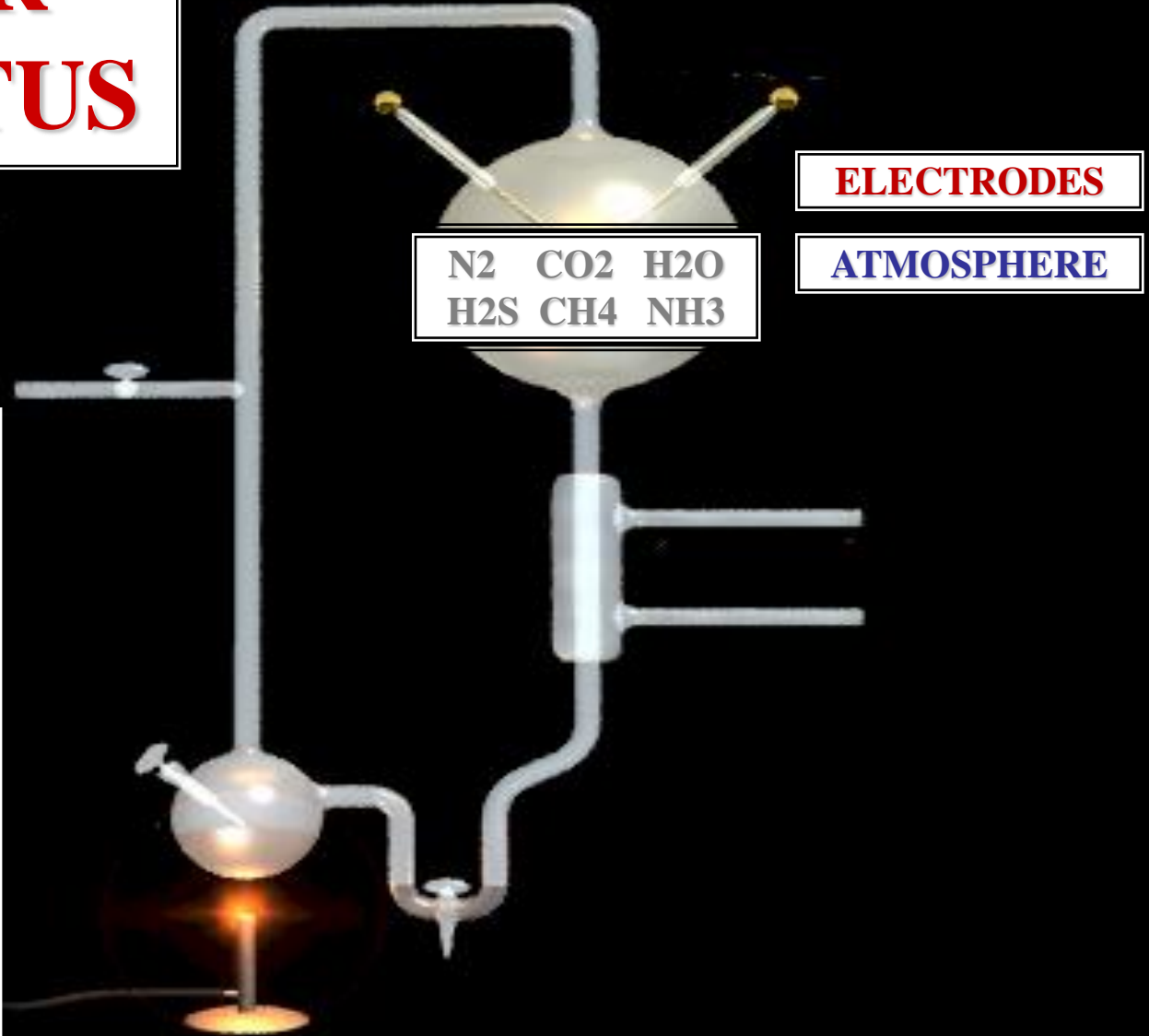
MILLER APPARATUS



STANLEY MILLER

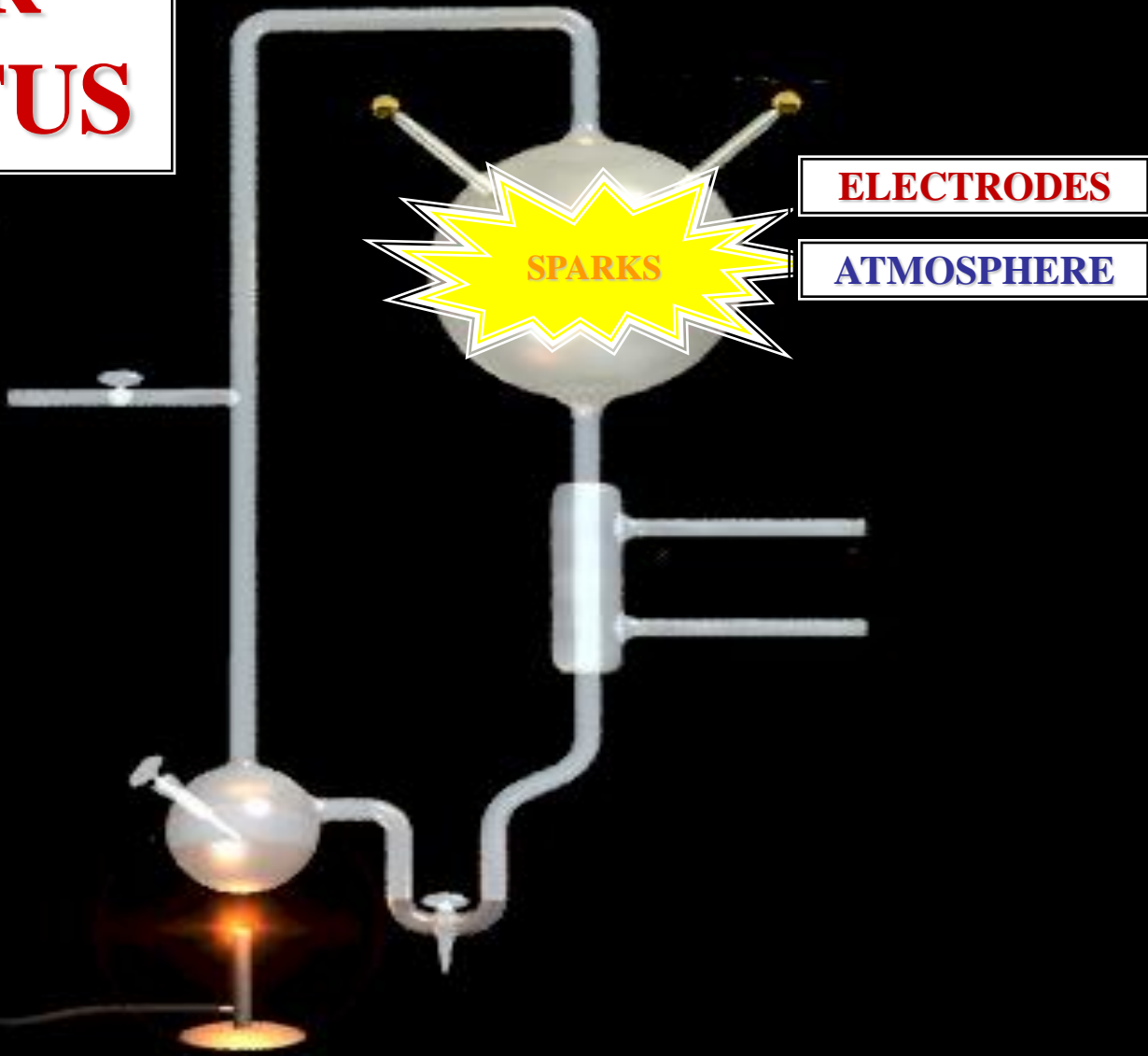


MILLER APPARATUS



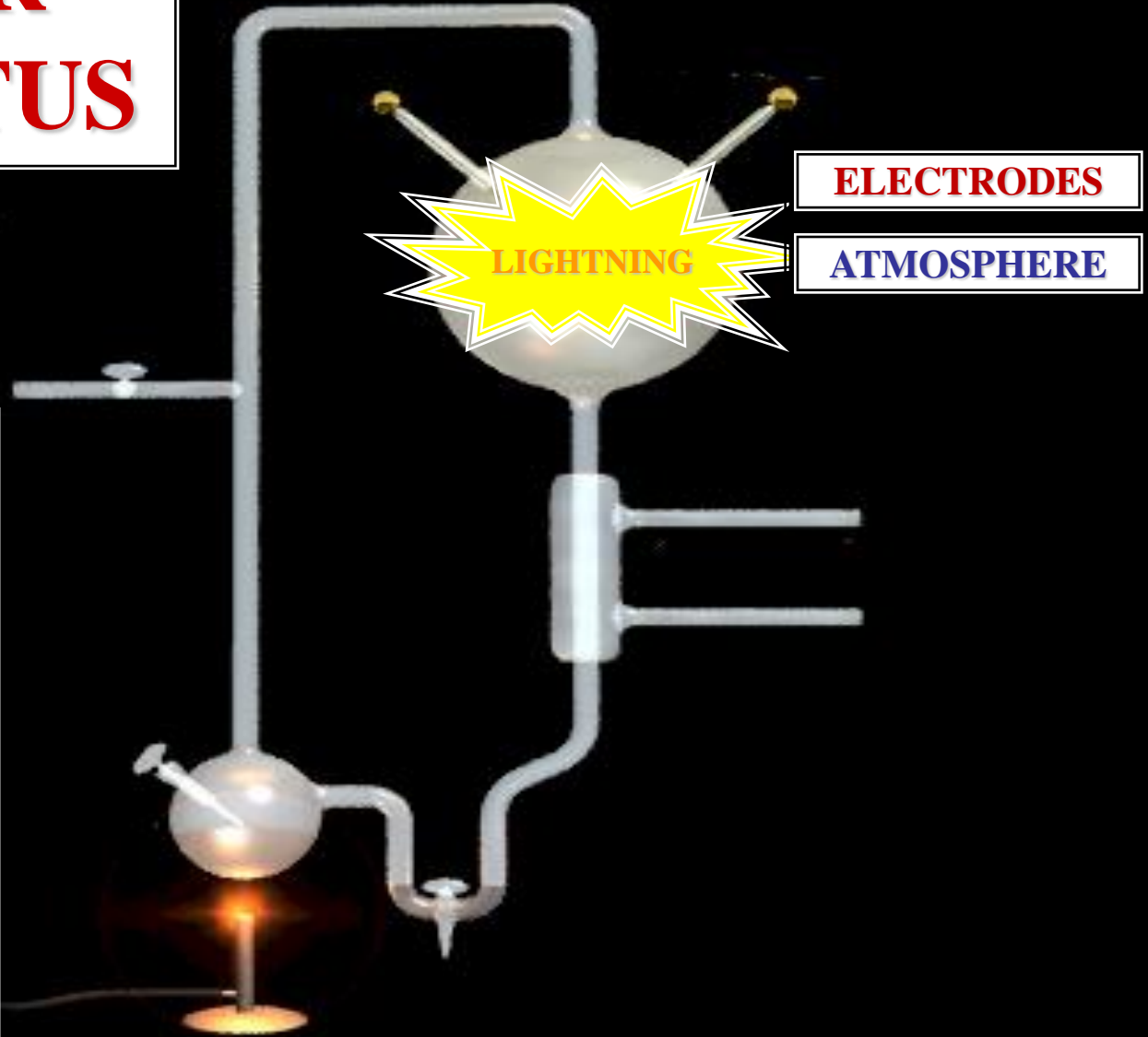
STANLEY MILLER

MILLER APPARATUS



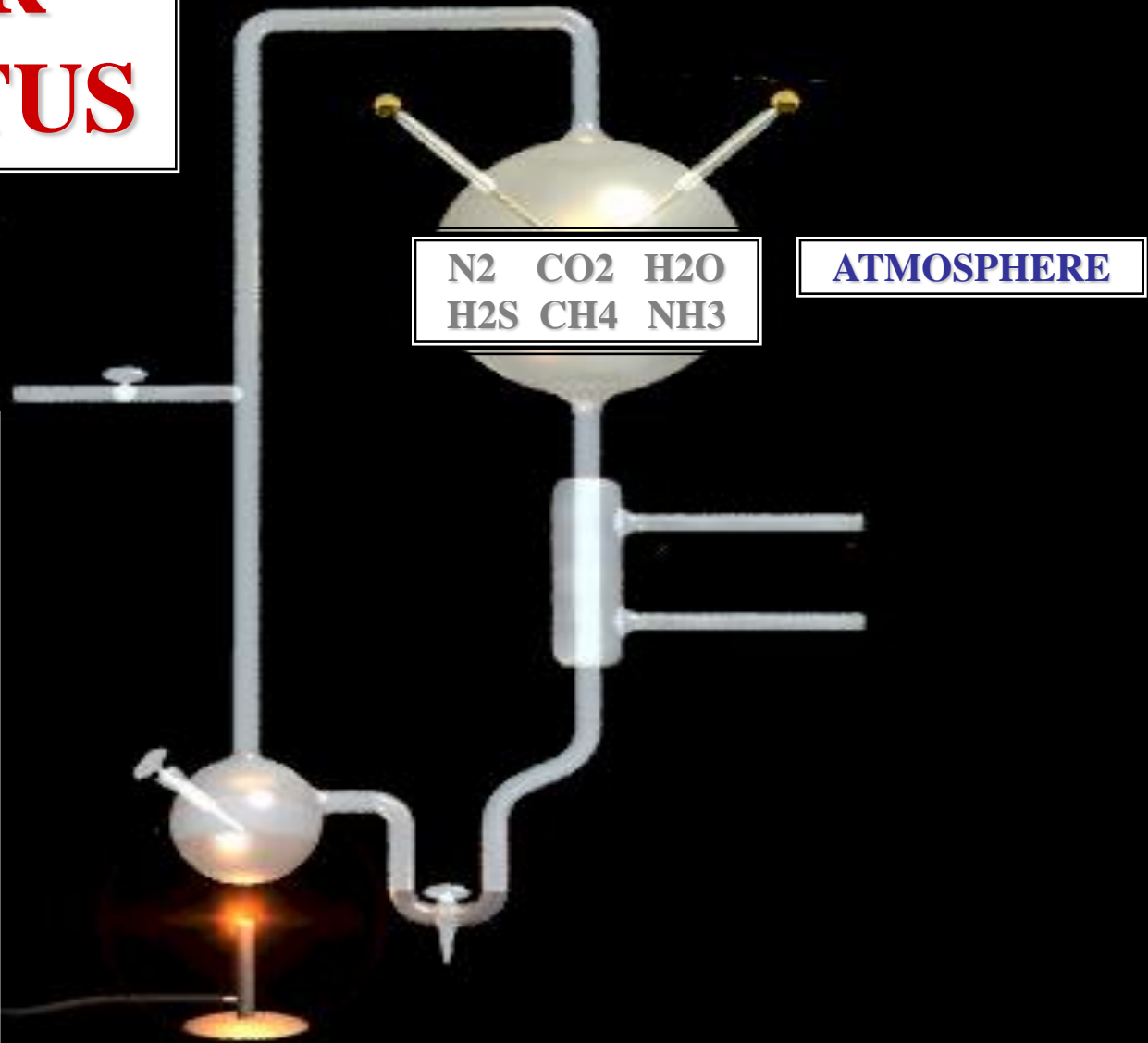
STANLEY MILLER

MILLER APPARATUS



STANLEY MILLER

MILLER APPARATUS

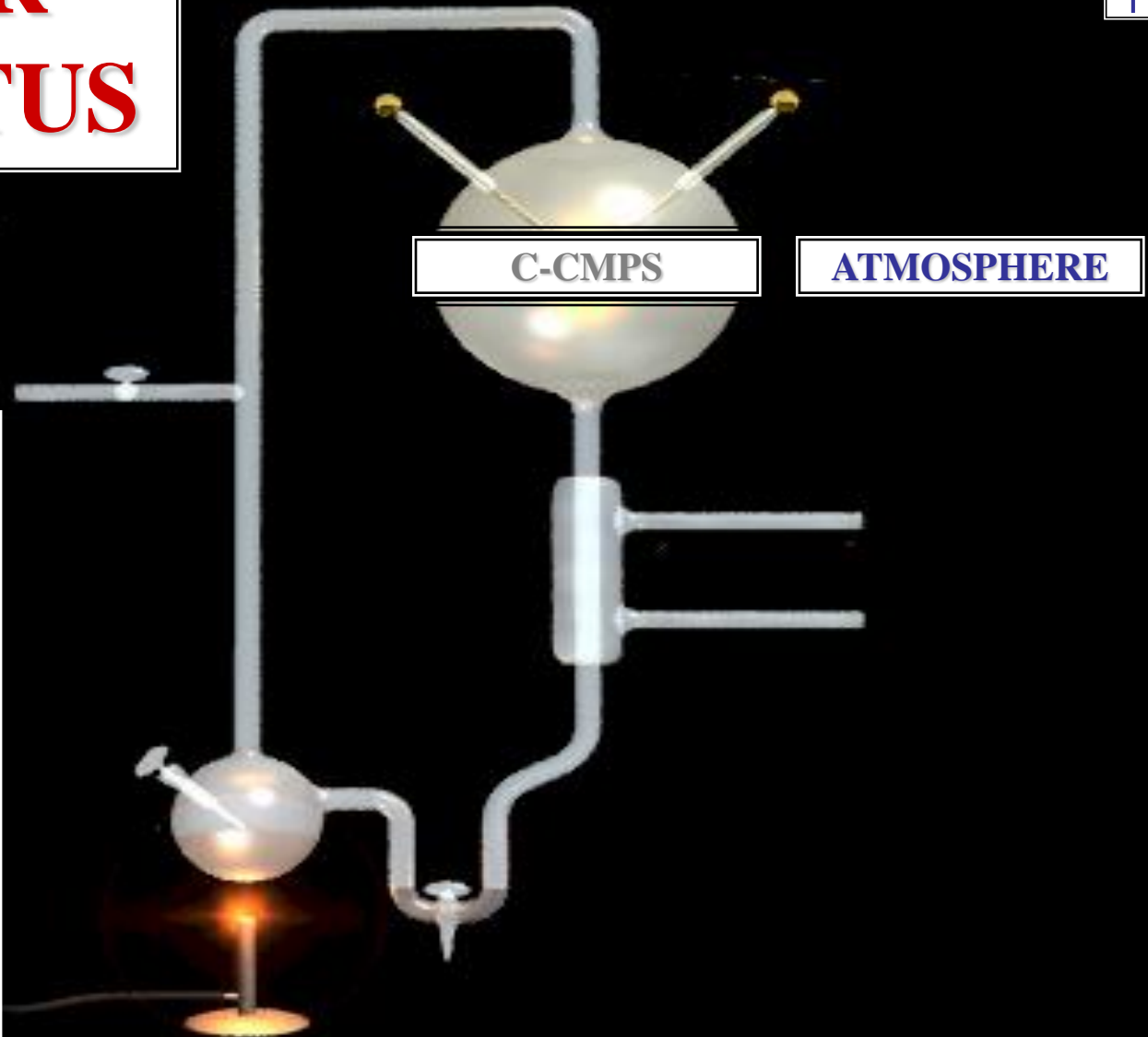


STANLEY MILLER

MILLER APPARATUS

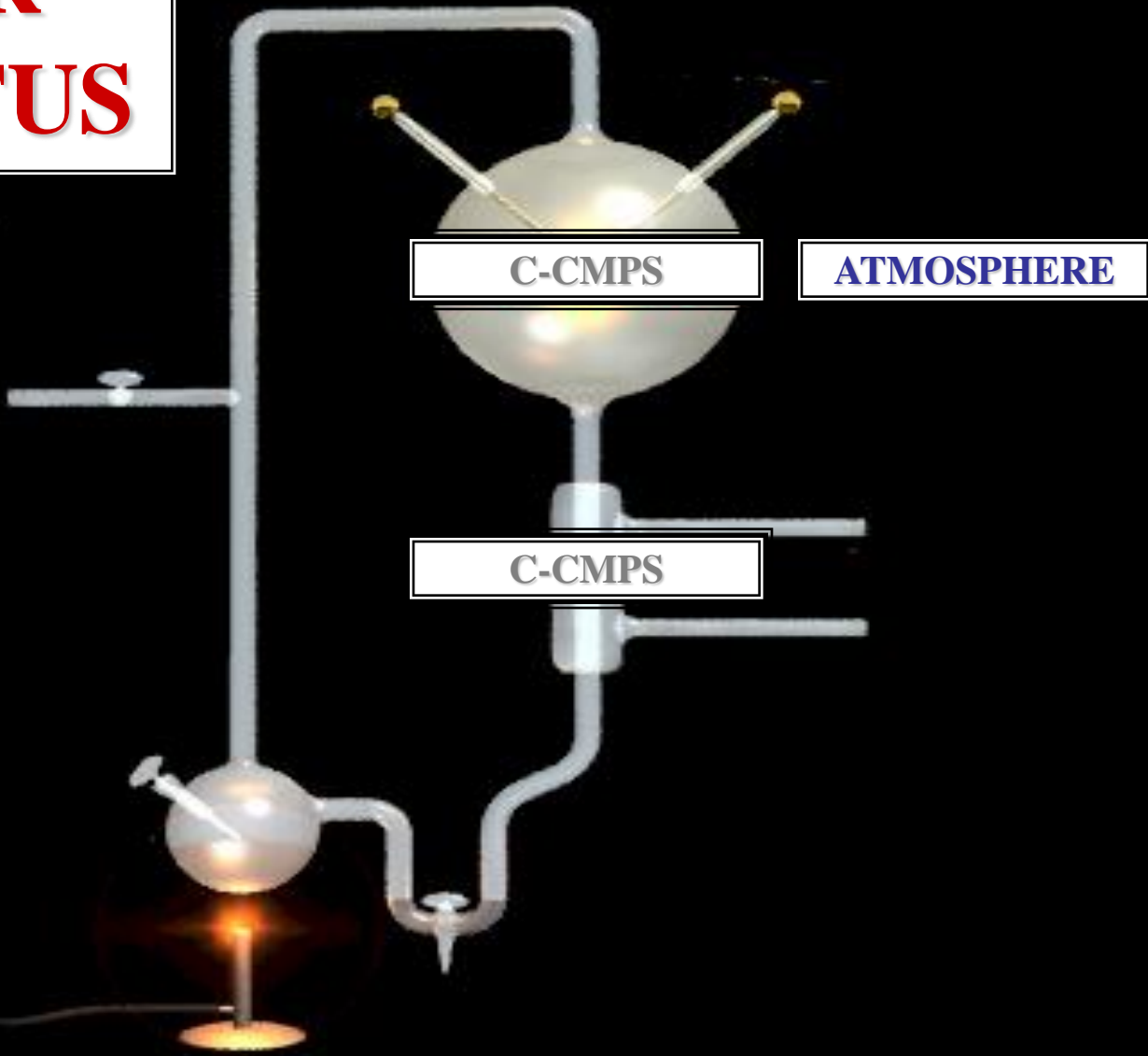
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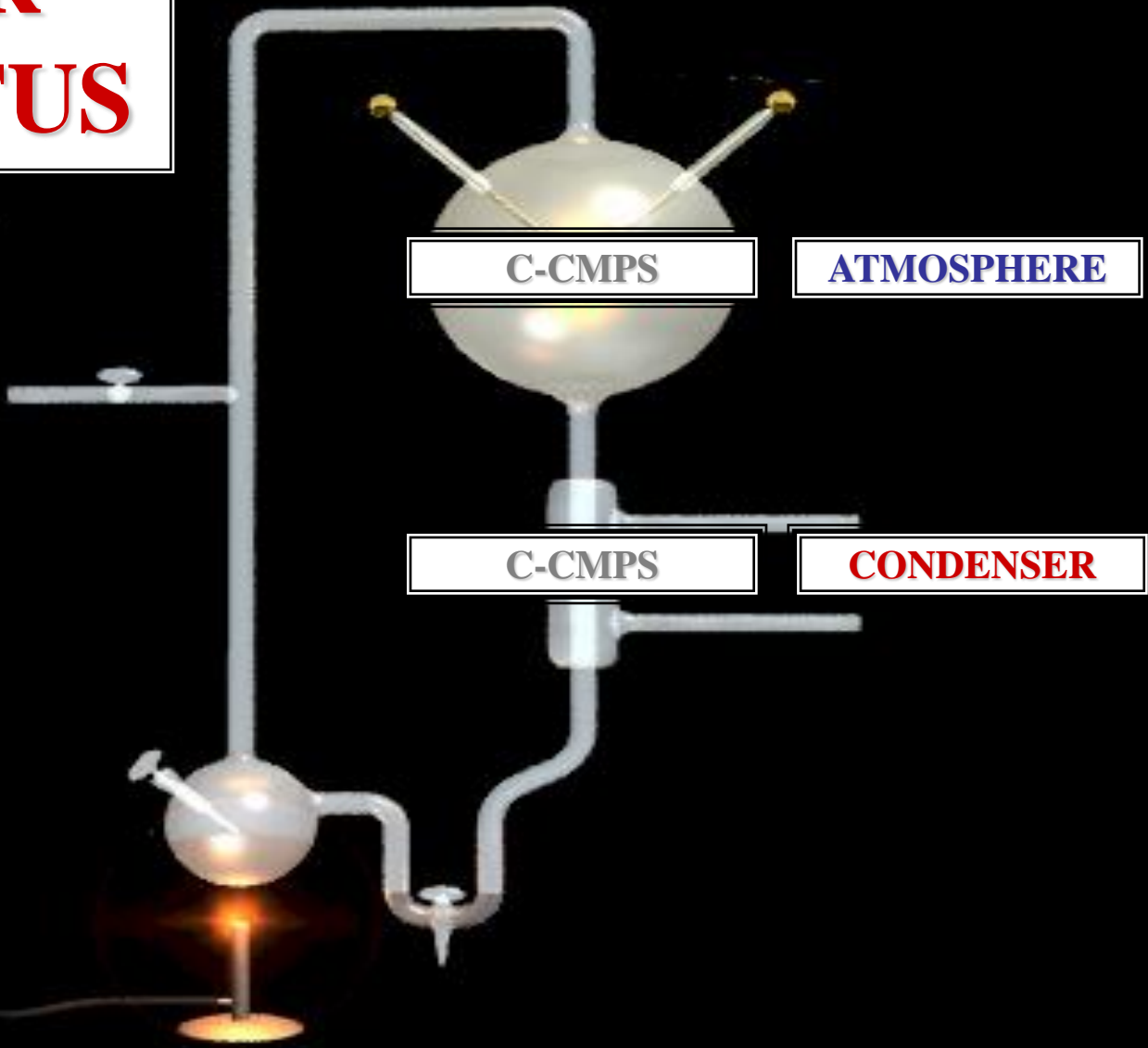
STANLEY MILLER

MILLER APPARATUS



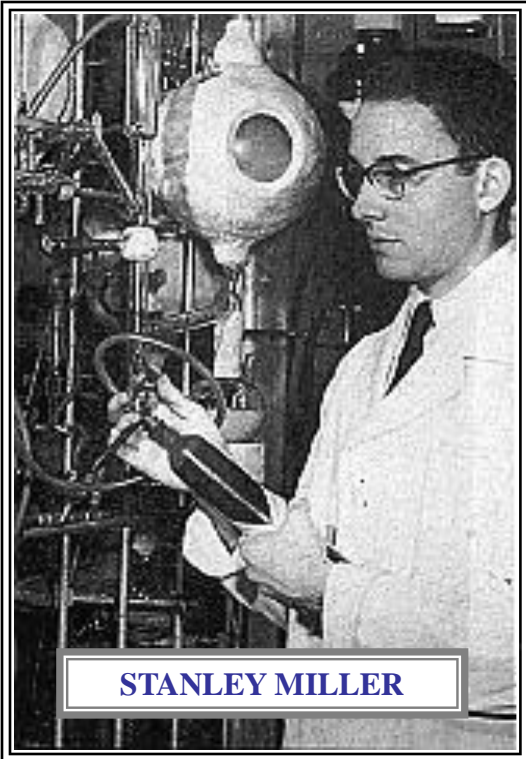
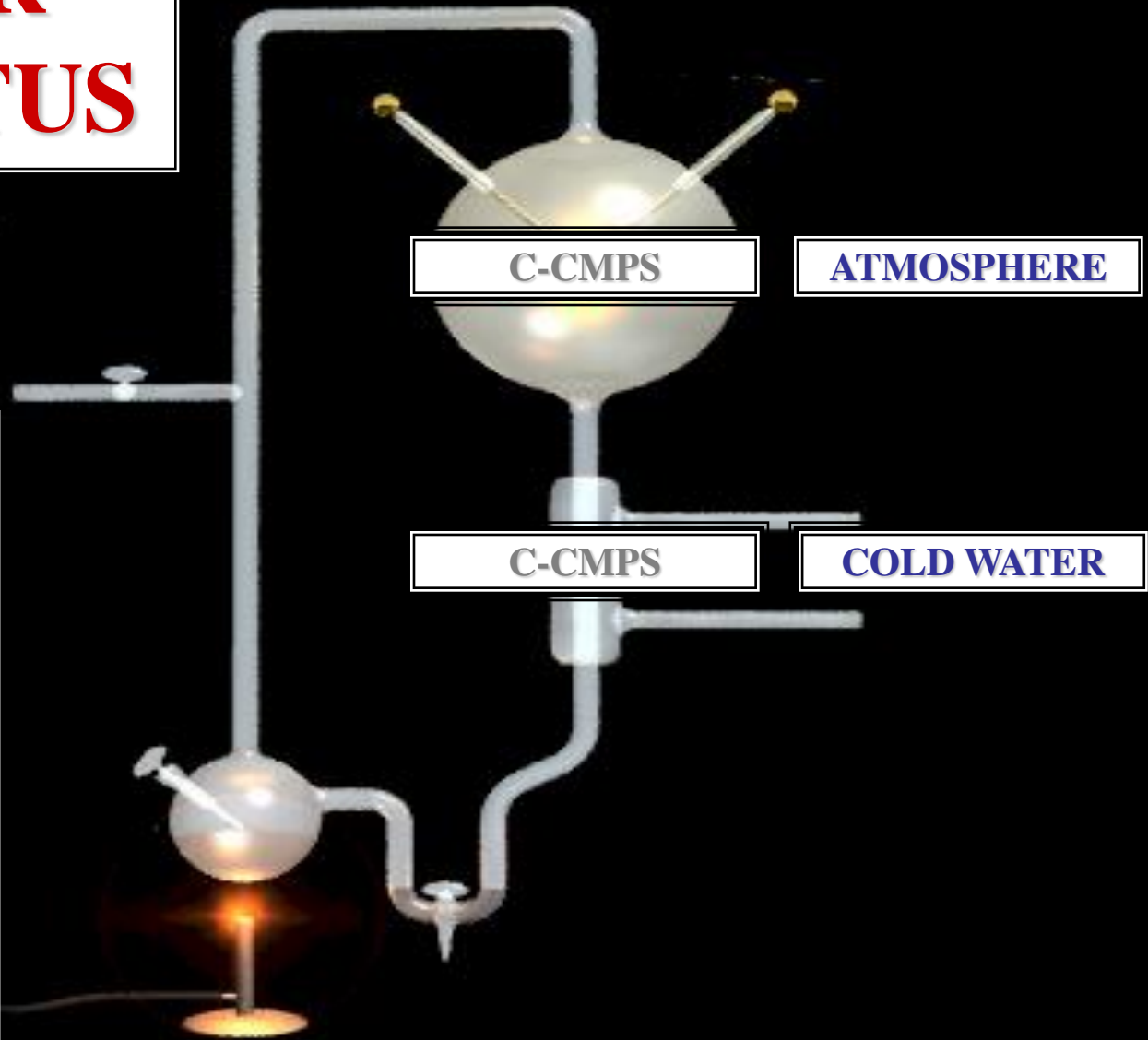
STANLEY MILLER

MILLER APPARATUS



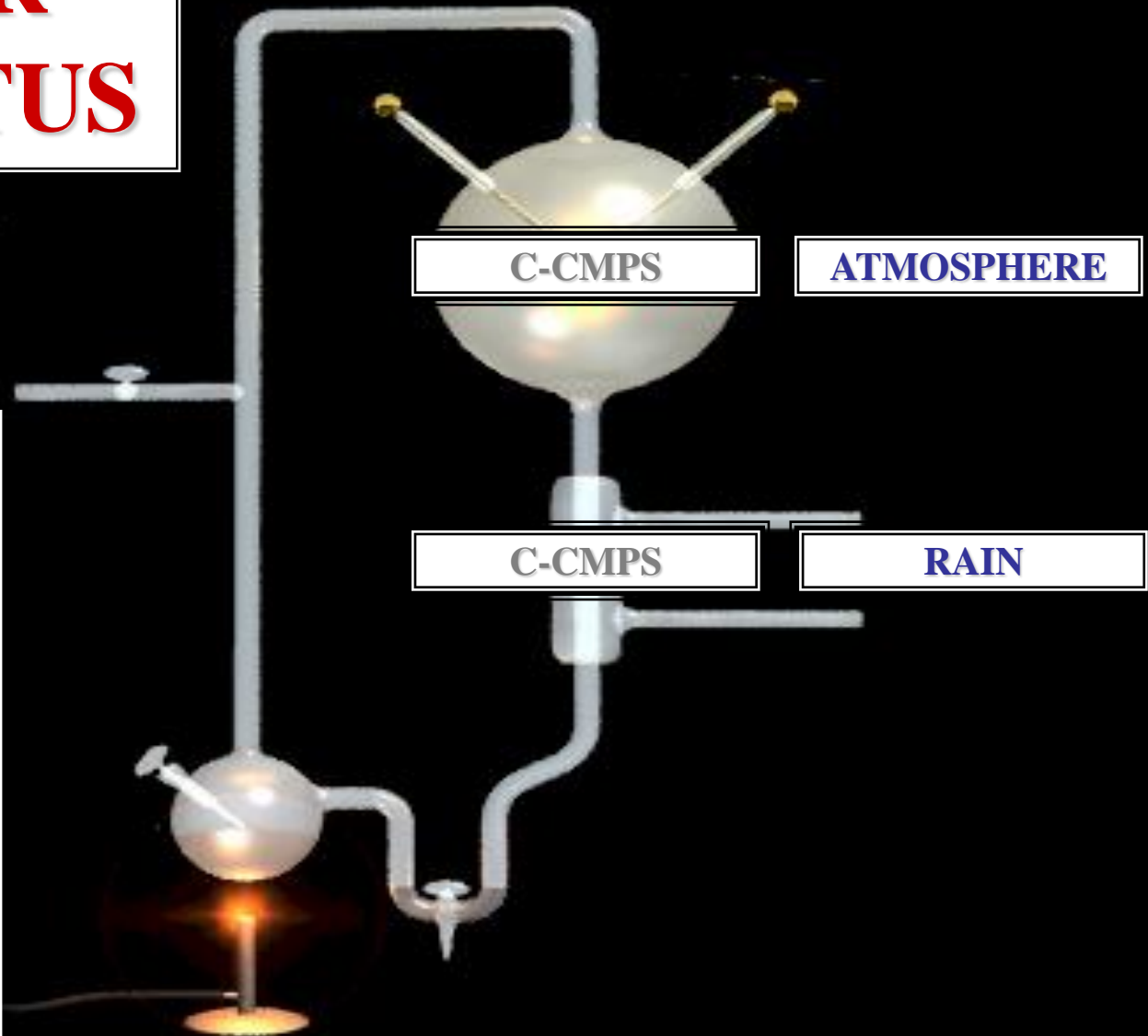
STANLEY MILLER

MILLER APPARATUS



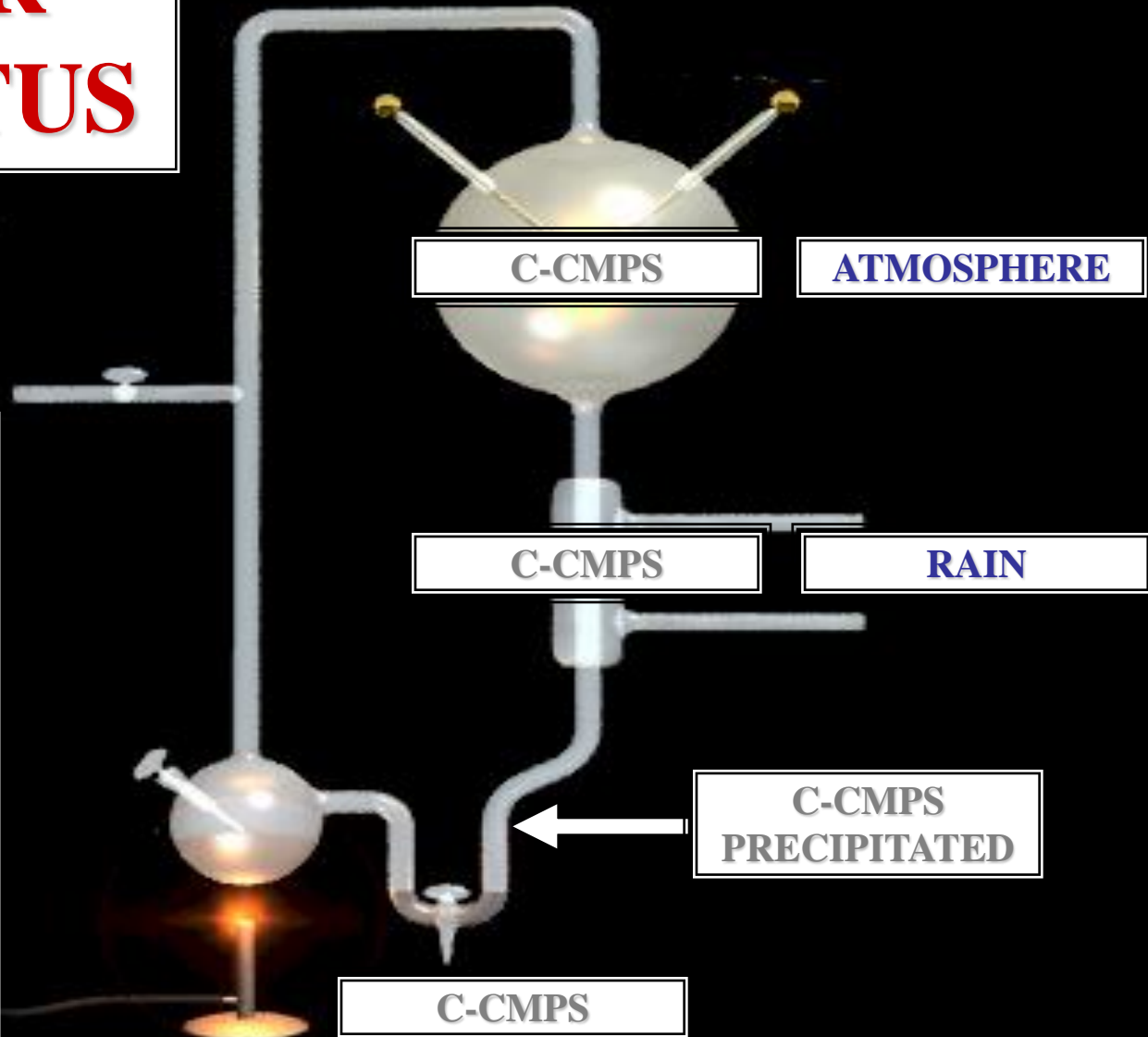
STANLEY MILLER

MILLER APPARATUS



STANLEY MILLER

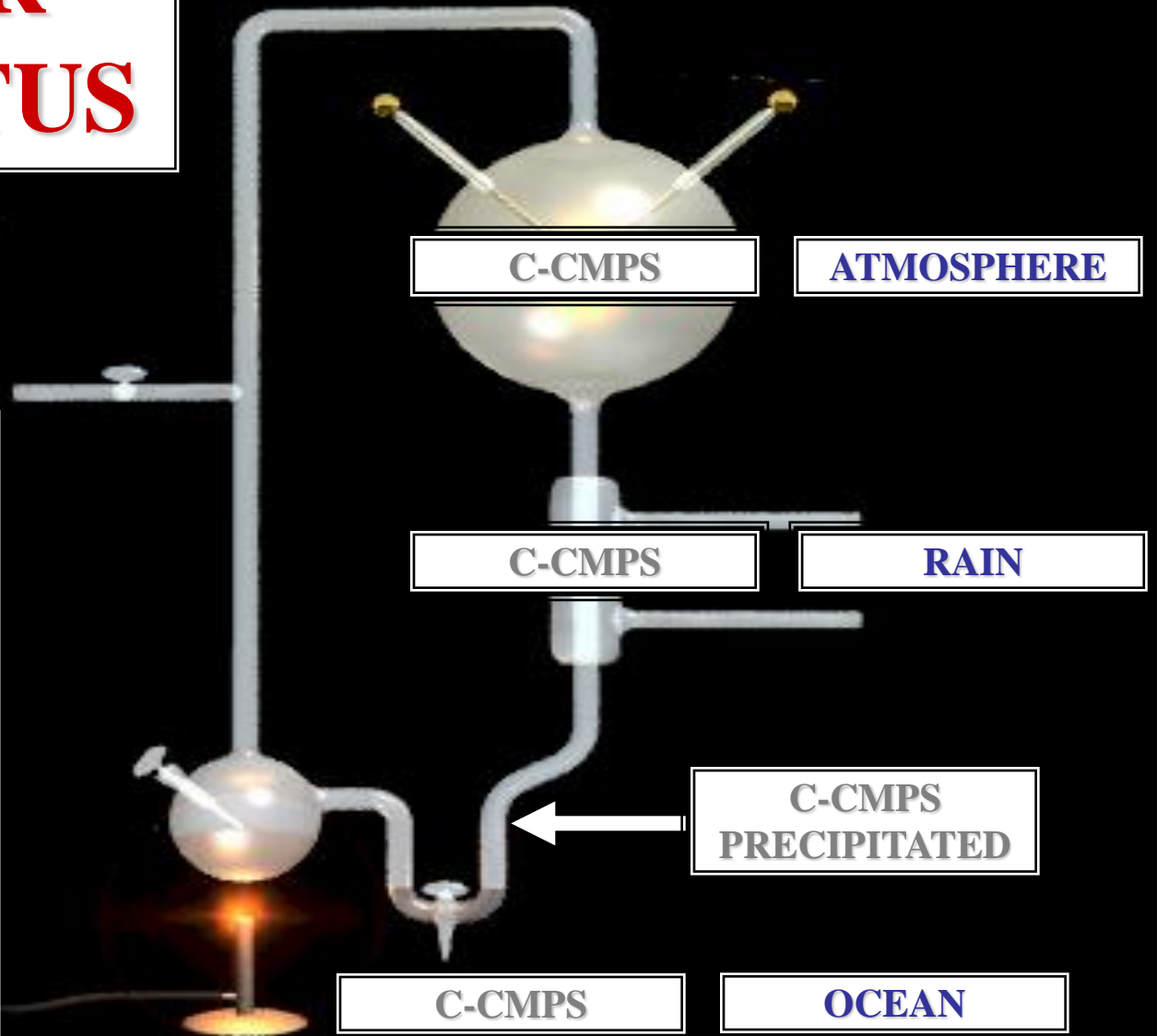
MILLER APPARATUS



STANLEY MILLER

MILLER APPARATUS

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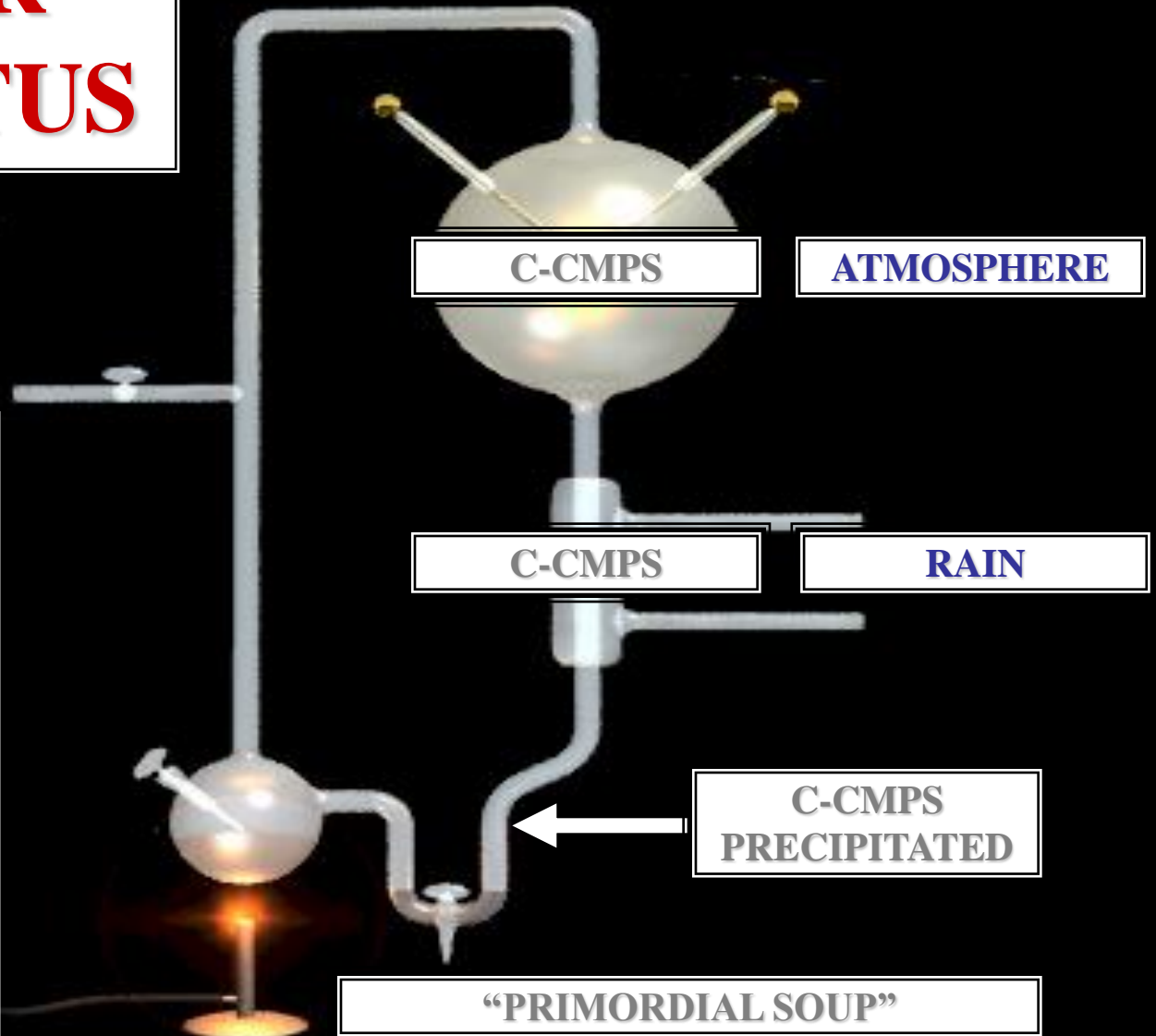


STANLEY MILLER

MILLER APPARATUS

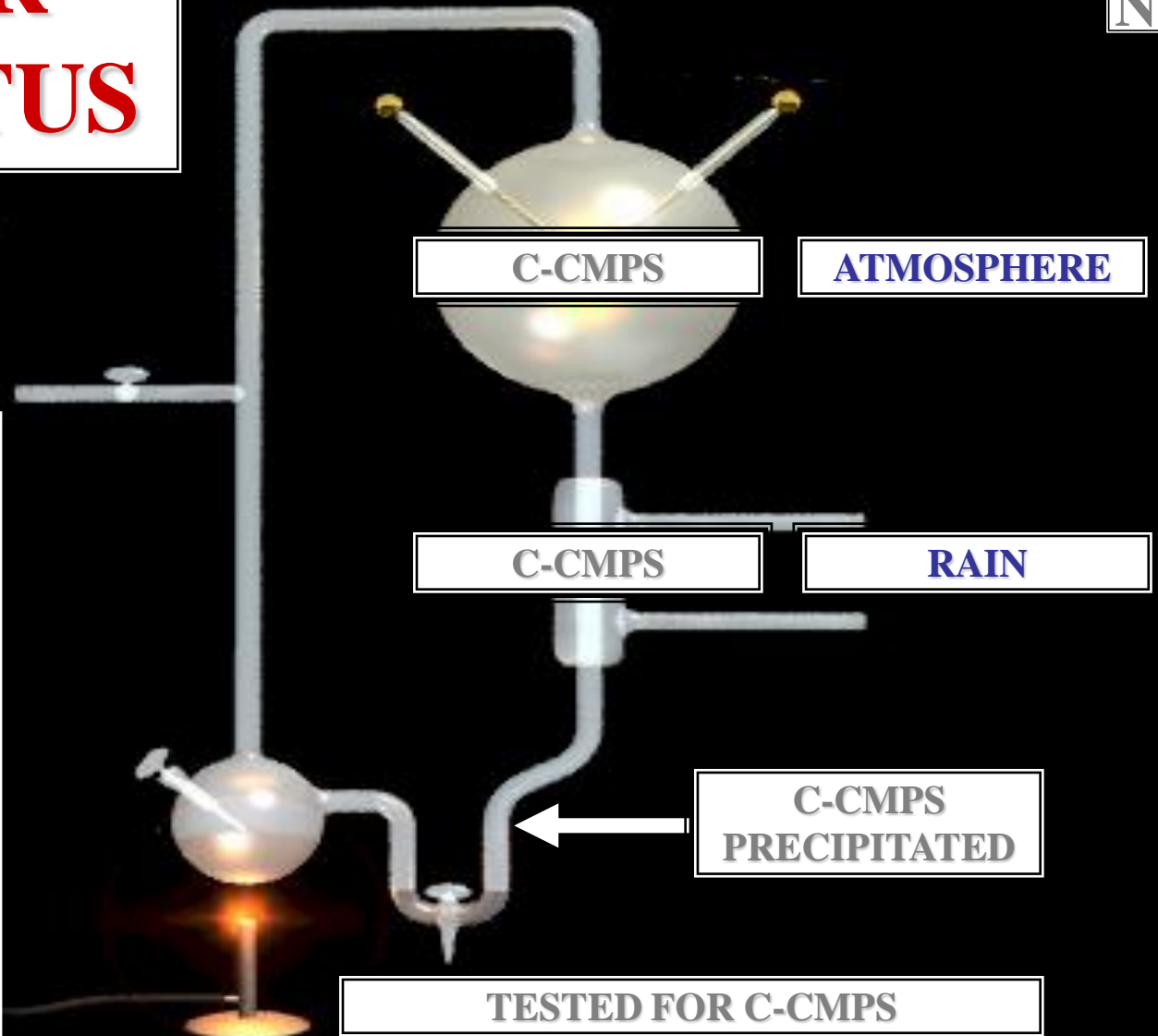


STANLEY MILLER



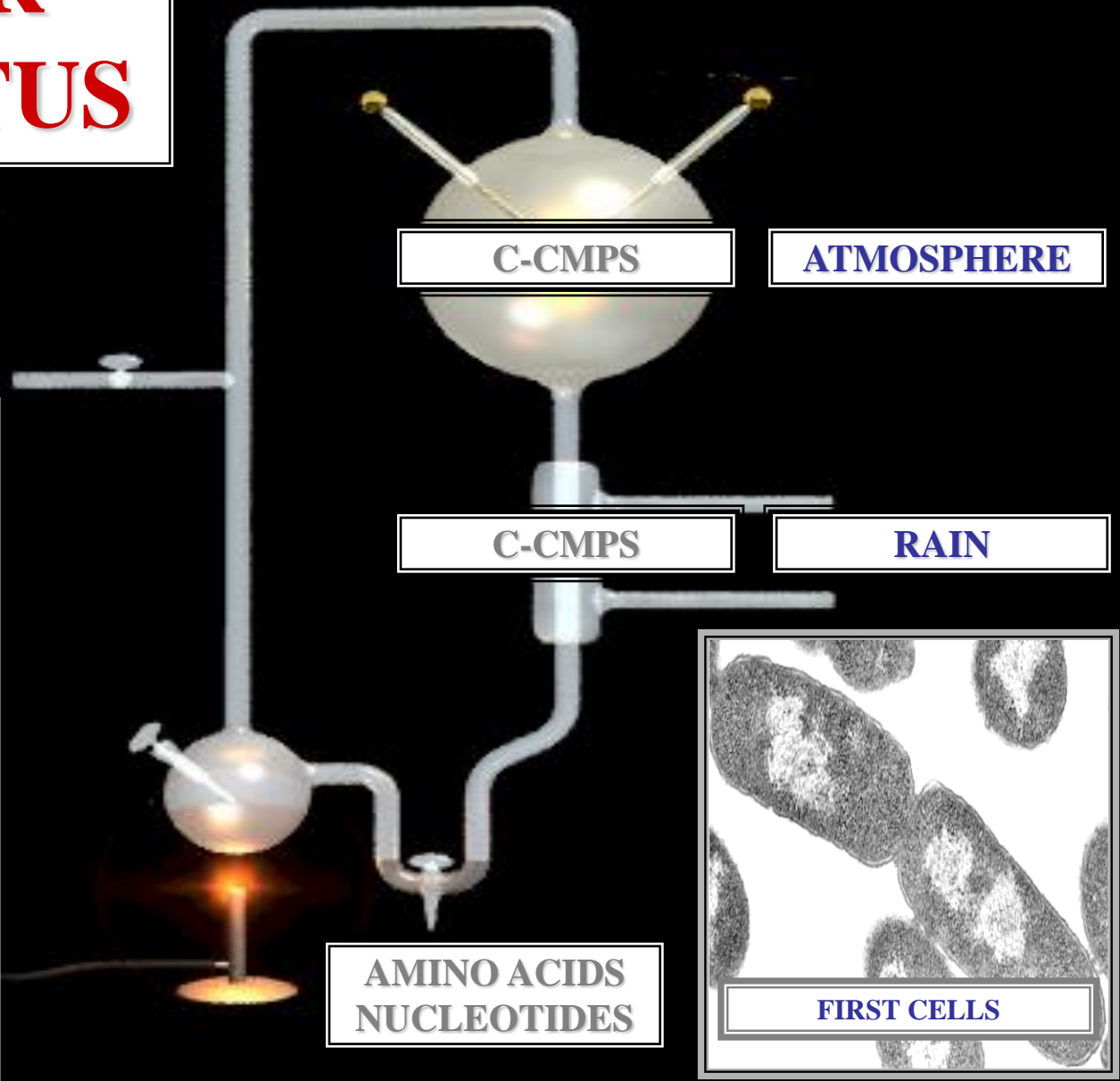
MILLER APPARATUS

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N



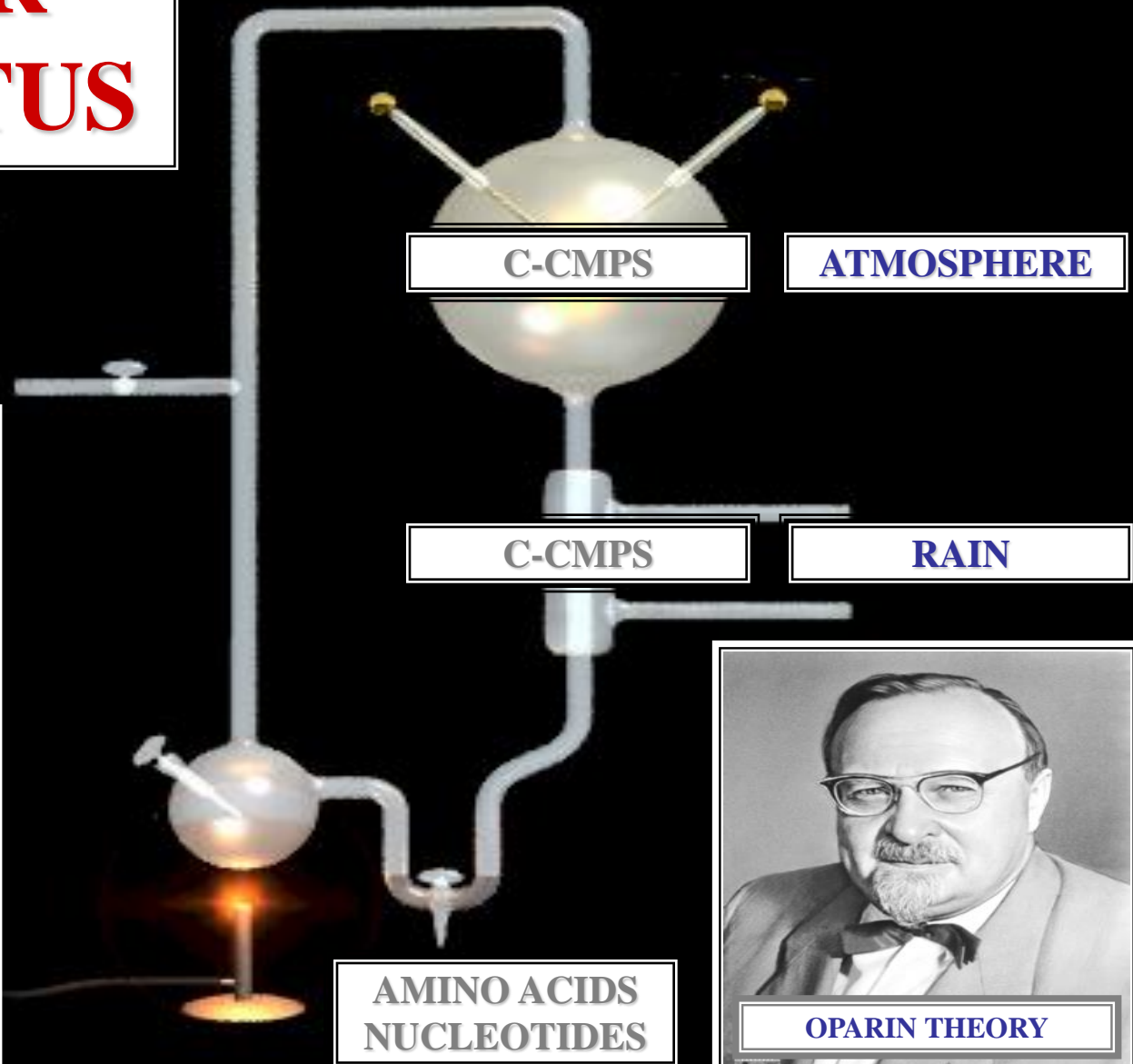
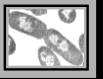
STANLEY MILLER

MILLER APPARATUS

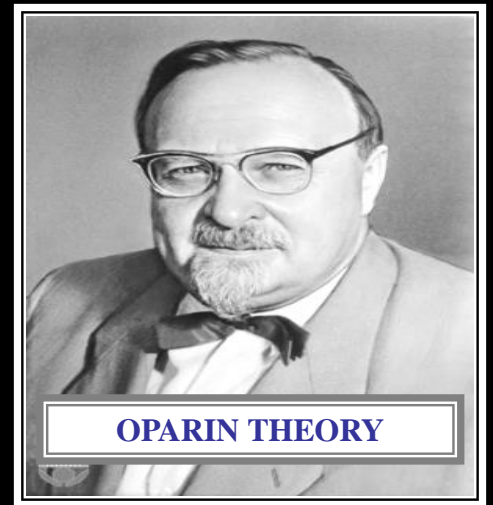


STANLEY MILLER

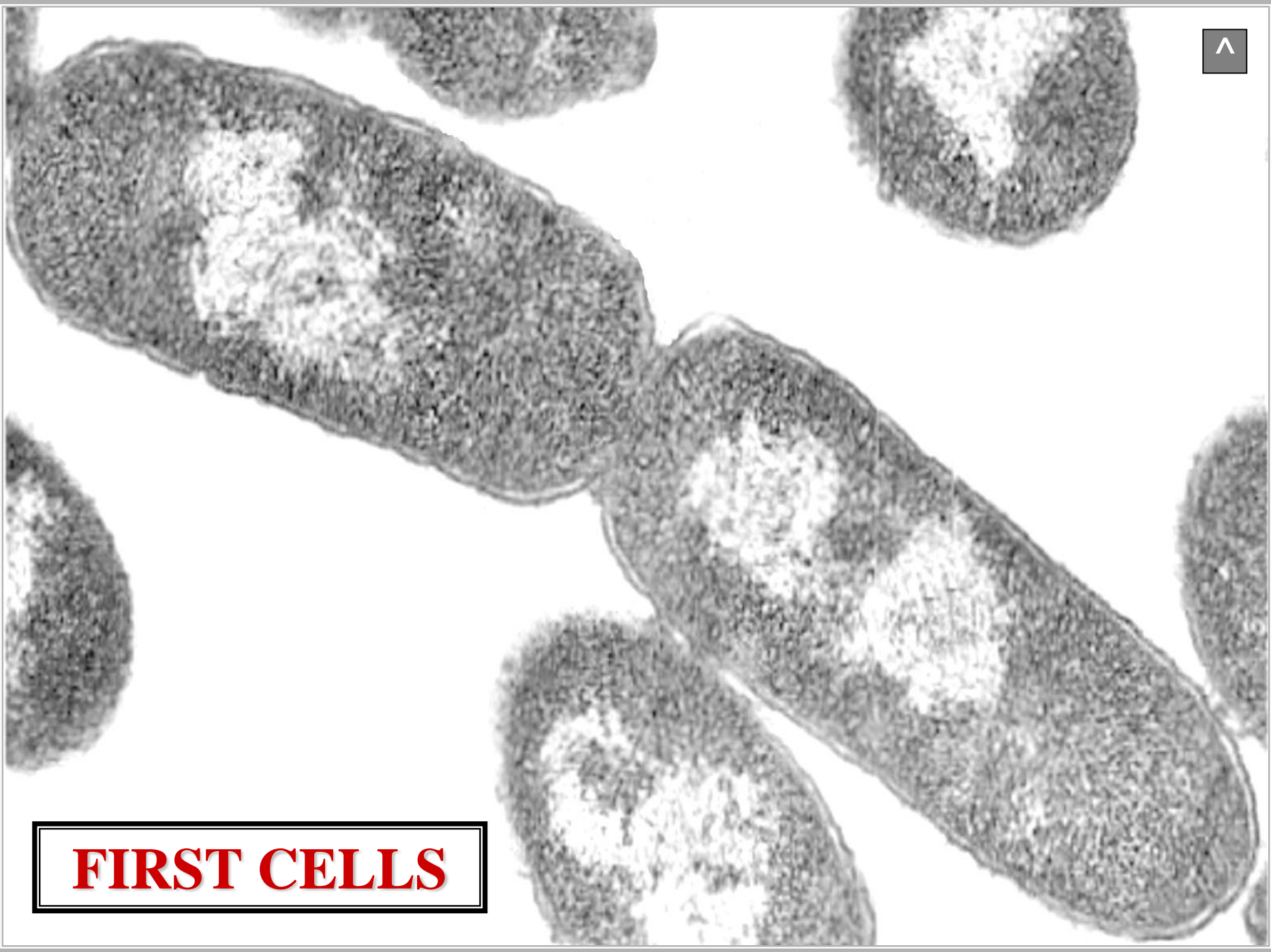
MILLER APPARATUS



STANLEY MILLER



OPARIN THEORY



FIRST CELLS

BIOLOGICAL EVOLUTION

BIOLOGICAL EVOLUTION



BIOLOGICAL EVOLUTION

BIO-DIVERSITY

VIA

BIOLOGICAL EVOLUTION



BIOLOGICAL EVOLUTION

BIO-DIVERSITY

VIA

MUTATION

BIOLOGICAL EVOLUTION



BIOLOGICAL EVOLUTION

BIO-DIVERSITY

VIA

MUTATION

NATURAL SELECTION

BIOLOGICAL EVOLUTION



BIOLOGICAL EVOLUTION

BIO-DIVERSITY

VIA

MUTATION

NATURAL SELECTION

SPECIATION

BIOLOGICAL EVOLUTION

QUESTION

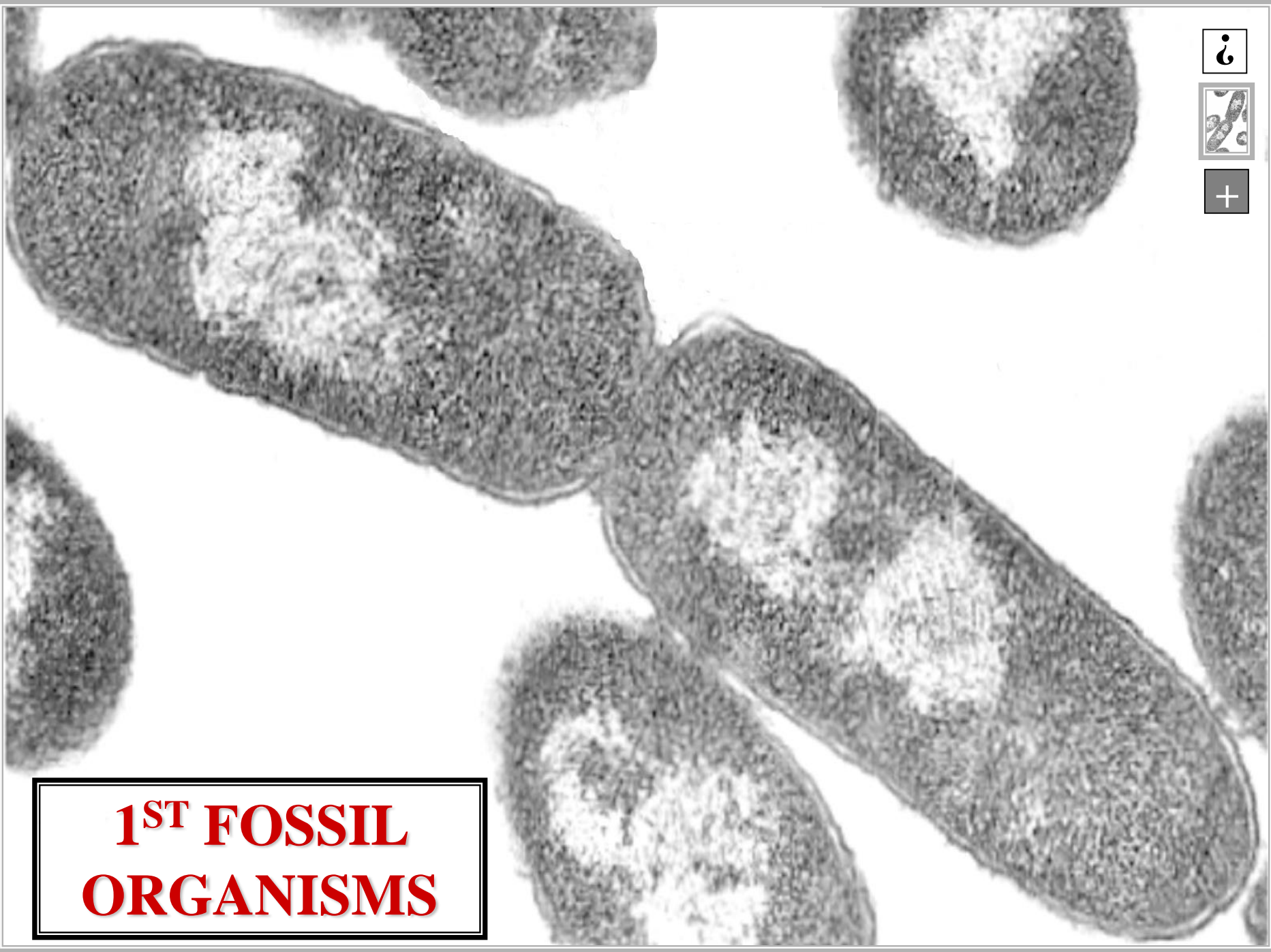
HOW OLD IS LIFE?

QUESTION

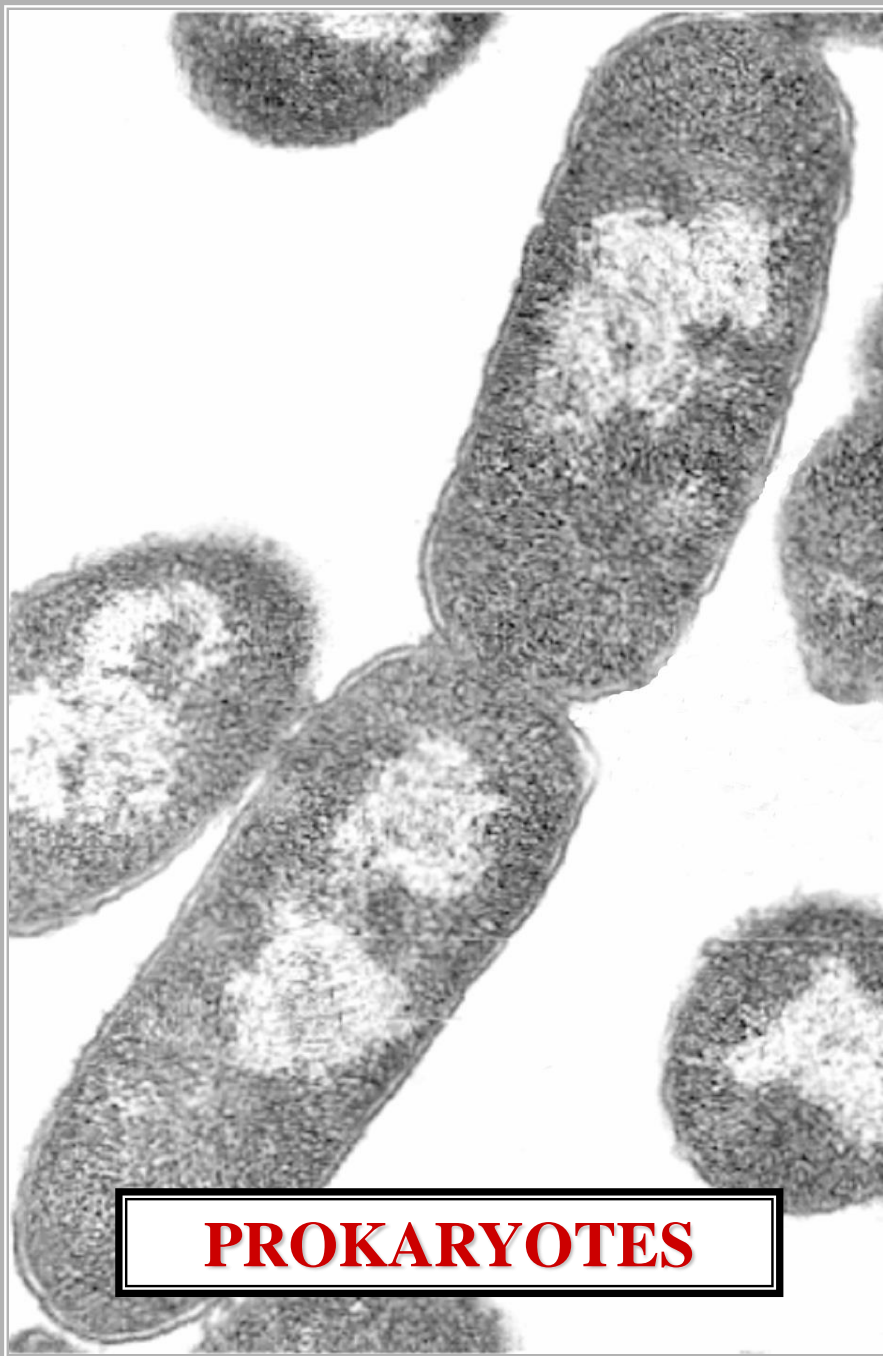


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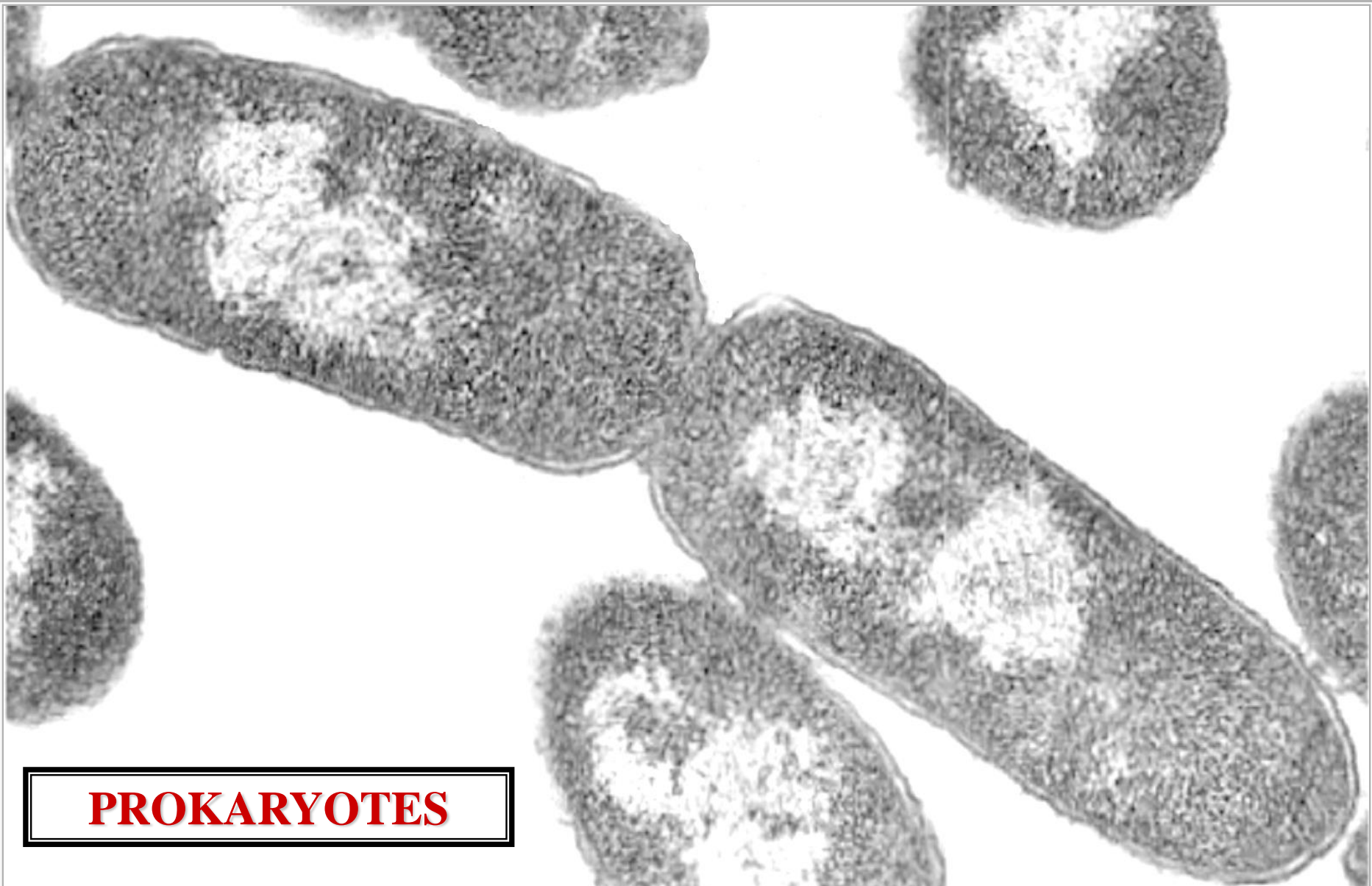
~3.5
BILLION YEARS



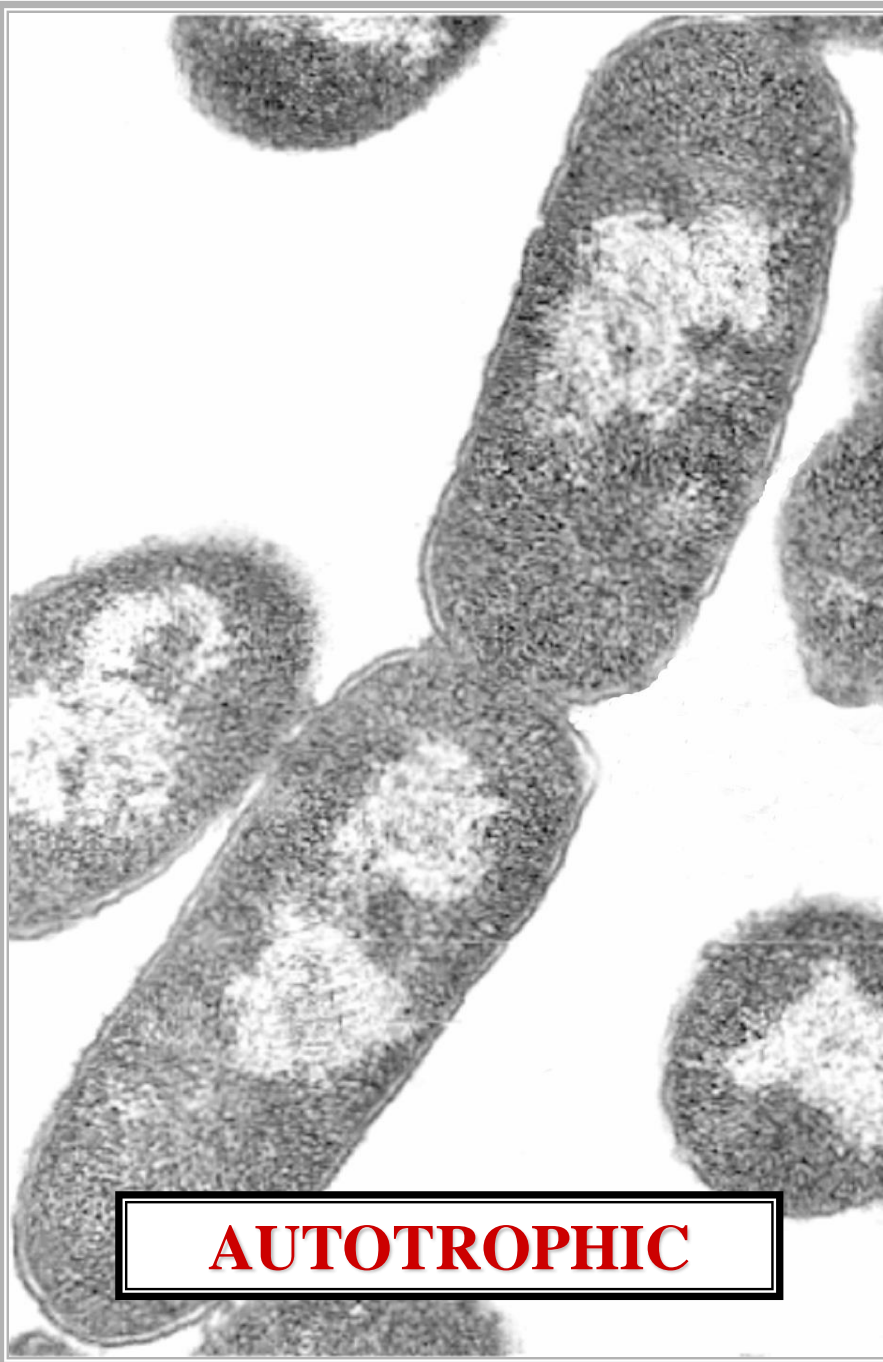
**1ST FOSSIL
ORGANISMS**



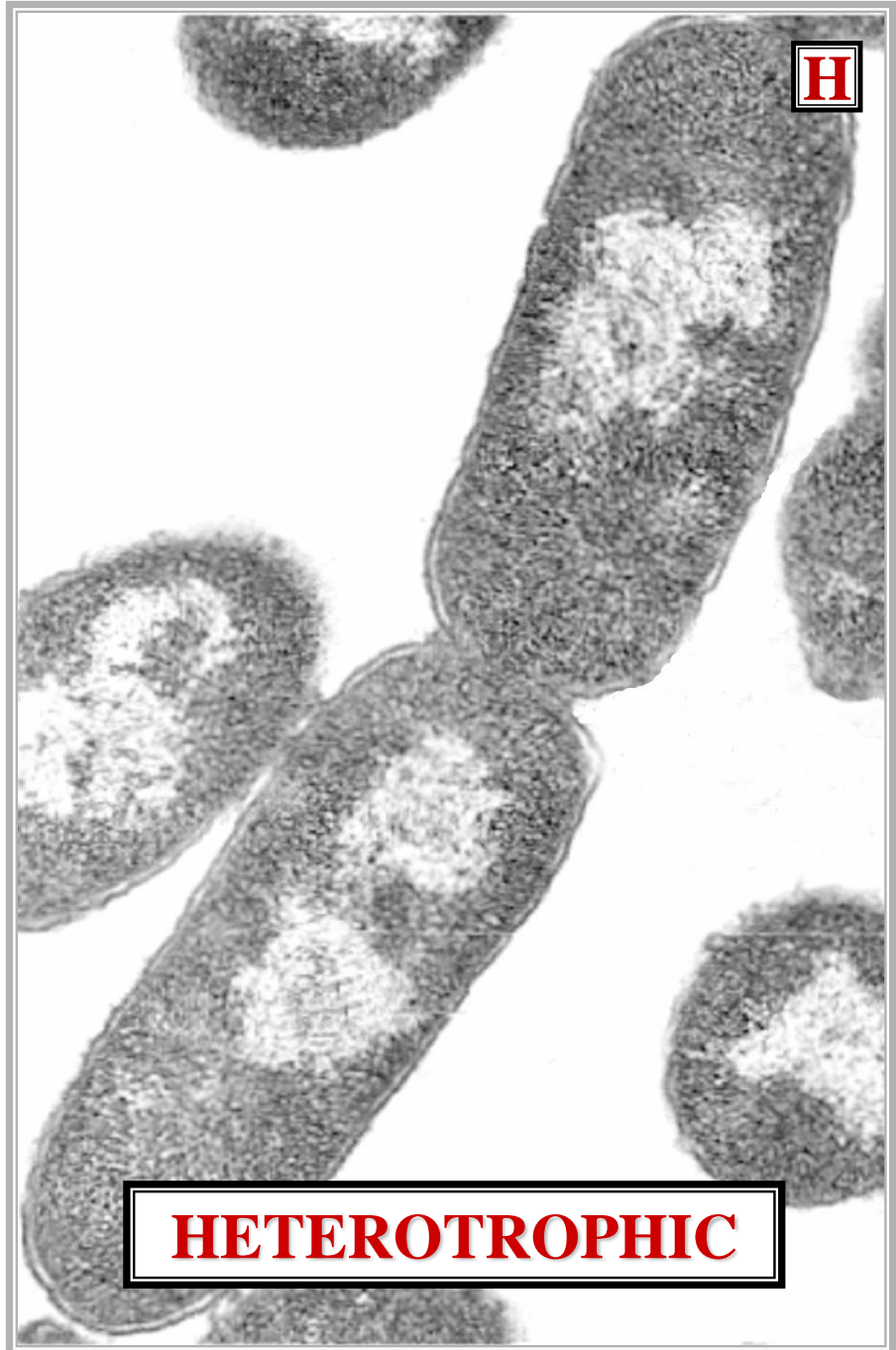
PROKARYOTES



PROKARYOTES

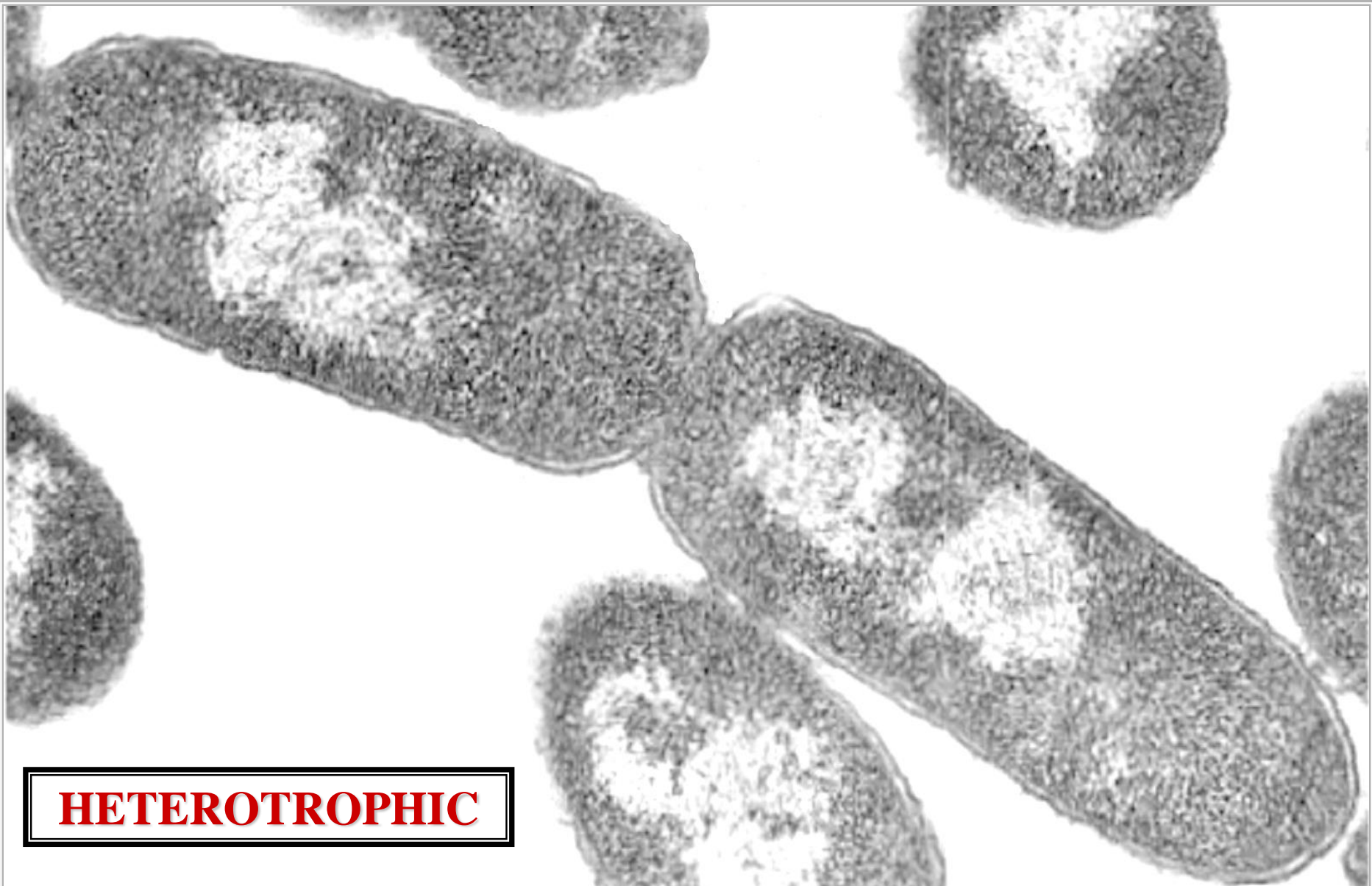


AUTOTROPHIC



HETEROTROPHIC

PROKARYOTES



HETEROTROPHIC

PRIMORDIAL EARTH OCEANS



“PRIMORDIAL SOUP”

C-CMP

C-CMP

C-CMP

C-CMP

C-CMP

C-CMP

C-CMP

C-CMP

C-CMP

C-CMP

C-CMP

C-CMP

C-CMP

C-CMP

C-CMP

C-CMP

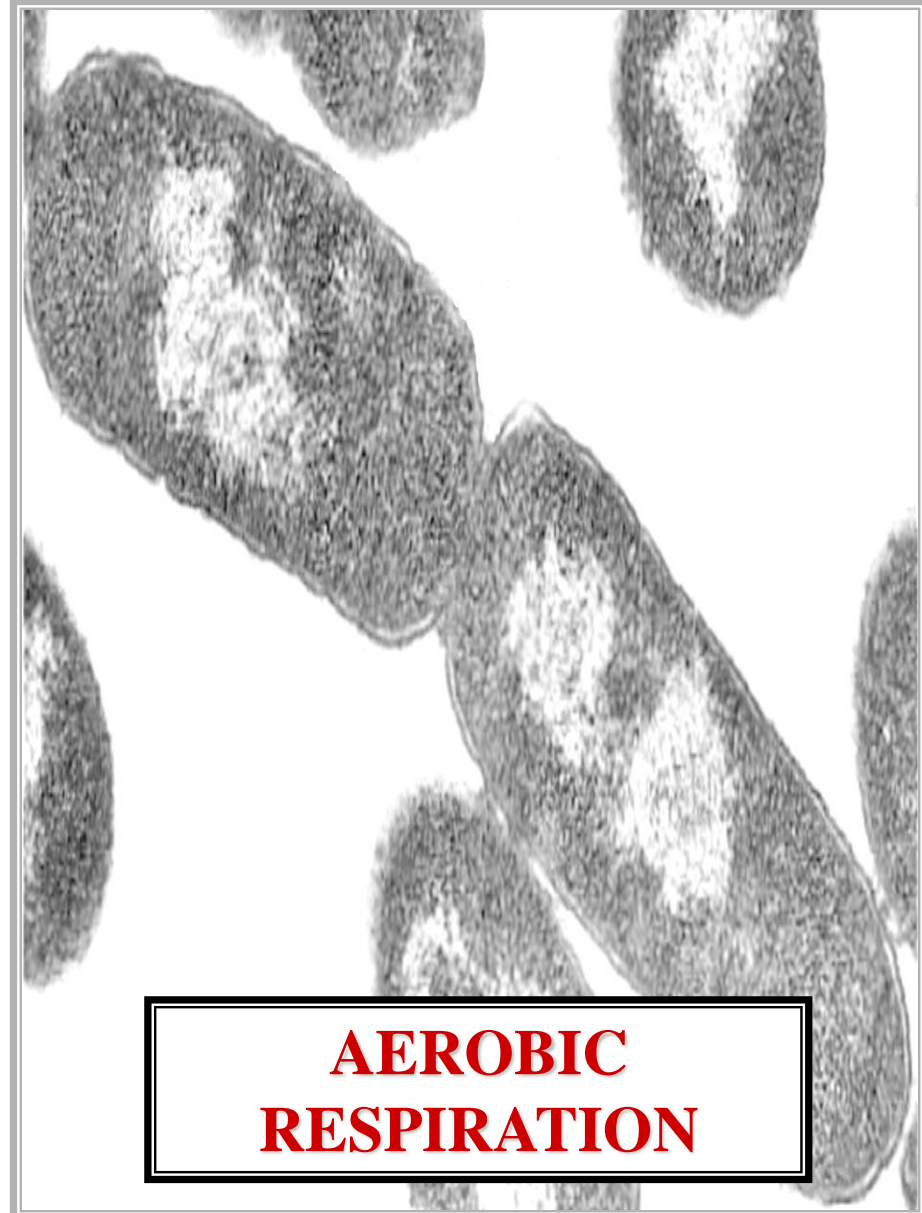
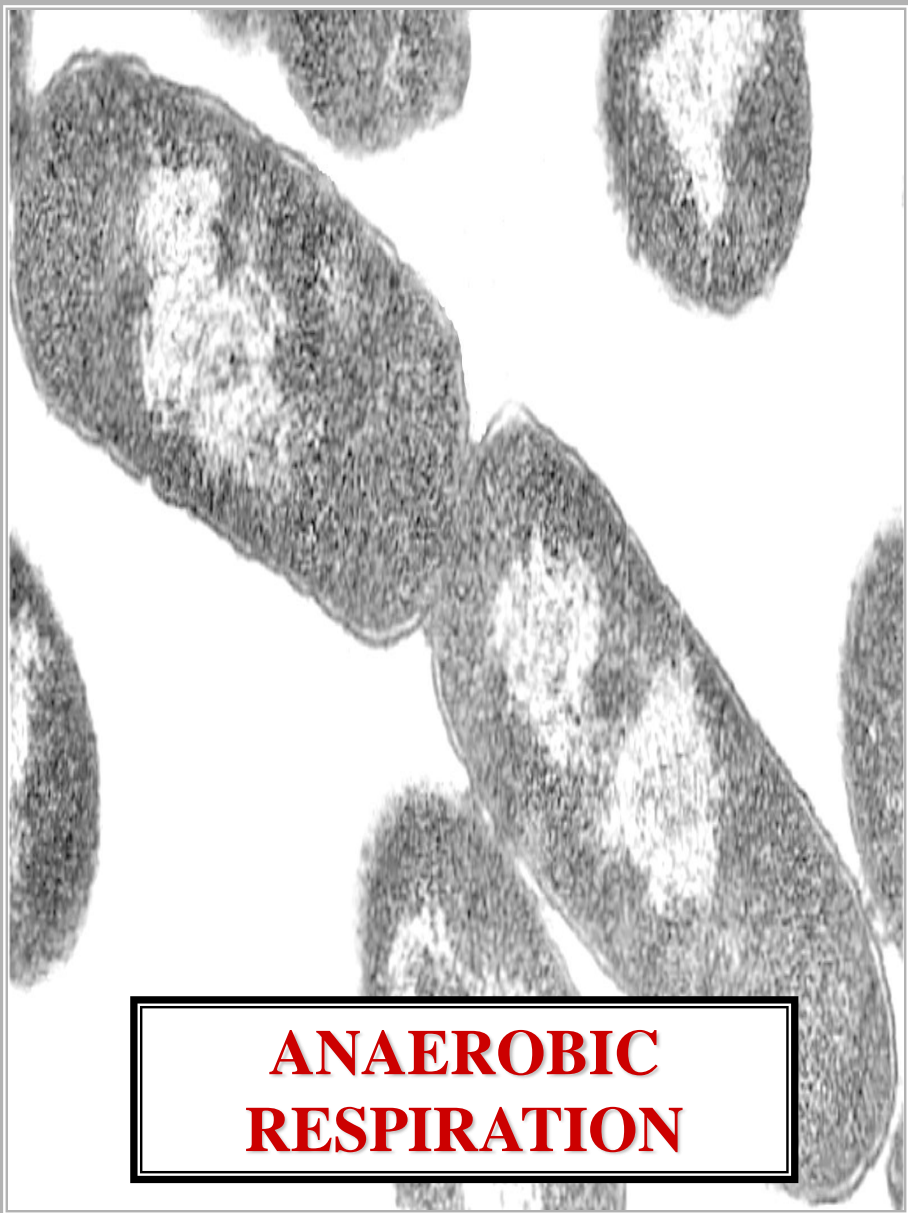
C-CMP

C-CMP

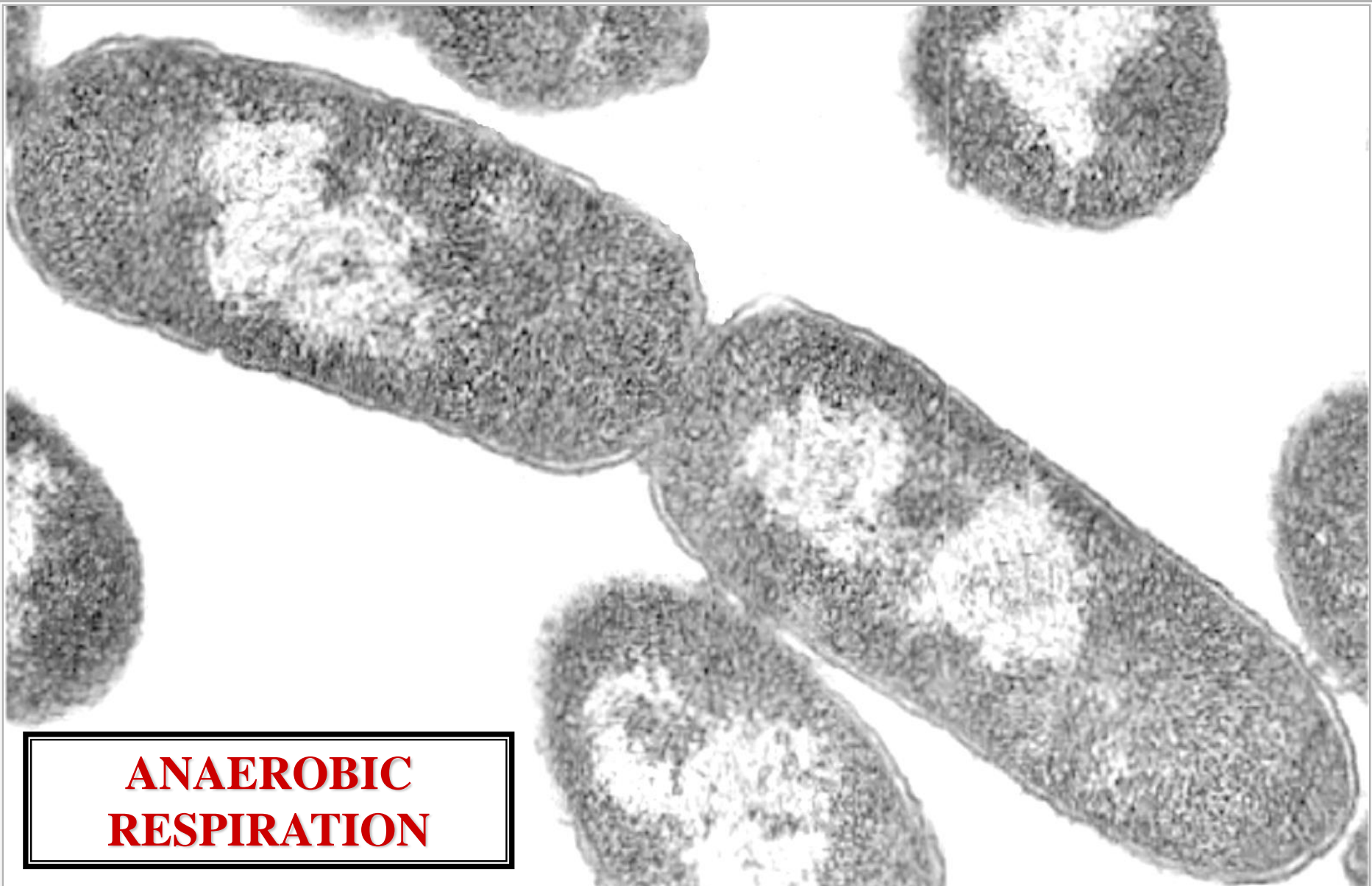
C-CMP

C-CMP

PROKARYOTES



PROKARYOTES



**ANAEROBIC
RESPIRATION**

?

ENVIRONMENT

PRIMORDIAL EARTH



**ANAEROBIC
ENVIRONMENT**

?

A

OXYGEN ABSENT

PRIMORDIAL EARTH

PROKARYOTES

A grayscale electron micrograph showing several rod-shaped prokaryotic cells. The cells have a thick, textured outer layer and a granular internal structure. The text is overlaid on this image.

**ANAEROBIC
RESPIRATION
ATP NET**

? ATP

**ANAEROBIC
RESPIRATION**

PROKARYOTES

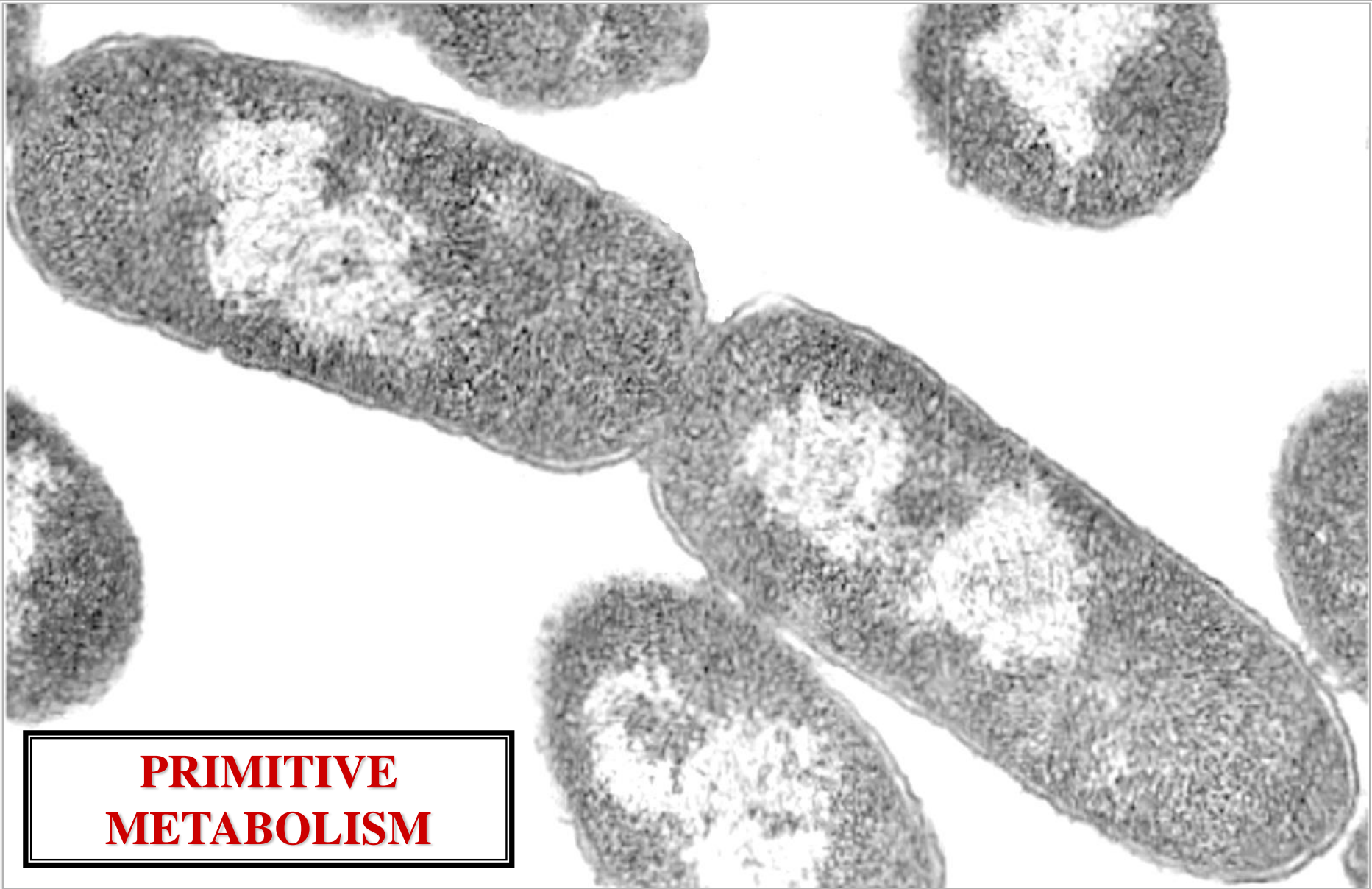
ANAEROBIC RESPIRATION ATP NET

2 ATP

**ANAEROBIC
RESPIRATION**

PROKARYOTES

S



**PRIMITIVE
METABOLISM**



SUPPORTING EVIDENCE



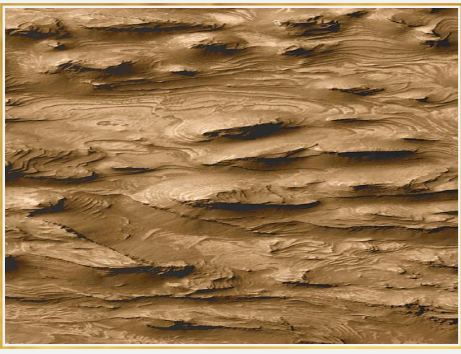
SEDIMENTARY ROCK ~3.5 BYA

SCANNING ELECTRON MICROSCOPE



SEDIMENTARY ROCK ~3.5 BYA

H



SEDIMENTARY ROCK ~3.5 BYA

HIGH ORGANIC
CONTENT

F

