

EARTH ORIGIN



ATMOSPHERE: **ABSENT**

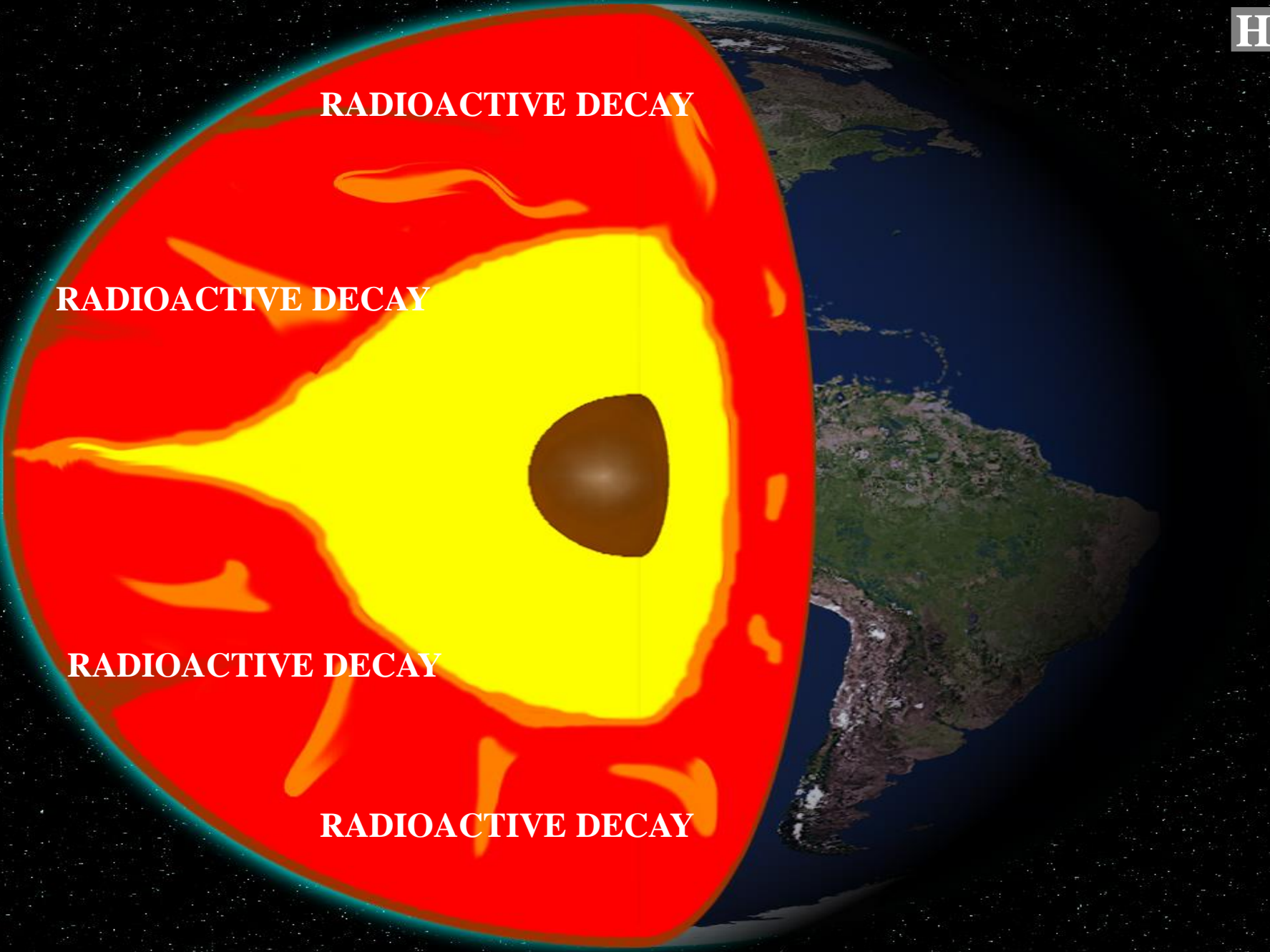
PRIMORDIAL EARTH

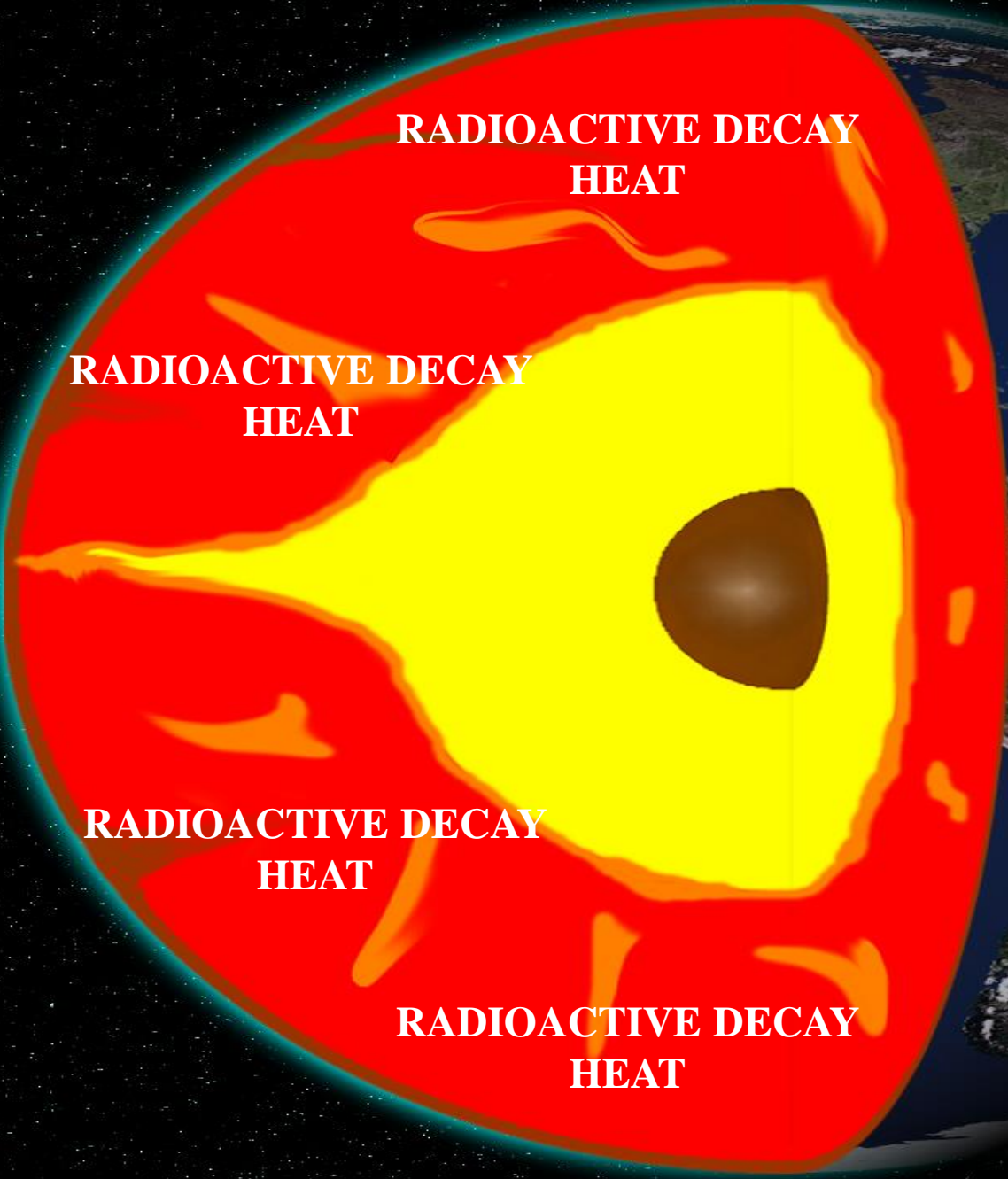
RADIOACTIVE DECAY

RADIOACTIVE DECAY

RADIOACTIVE DECAY

RADIOACTIVE DECAY





**RADIOACTIVE DECAY
HEAT**

**RADIOACTIVE DECAY
HEAT**

**RADIOACTIVE DECAY
HEAT**

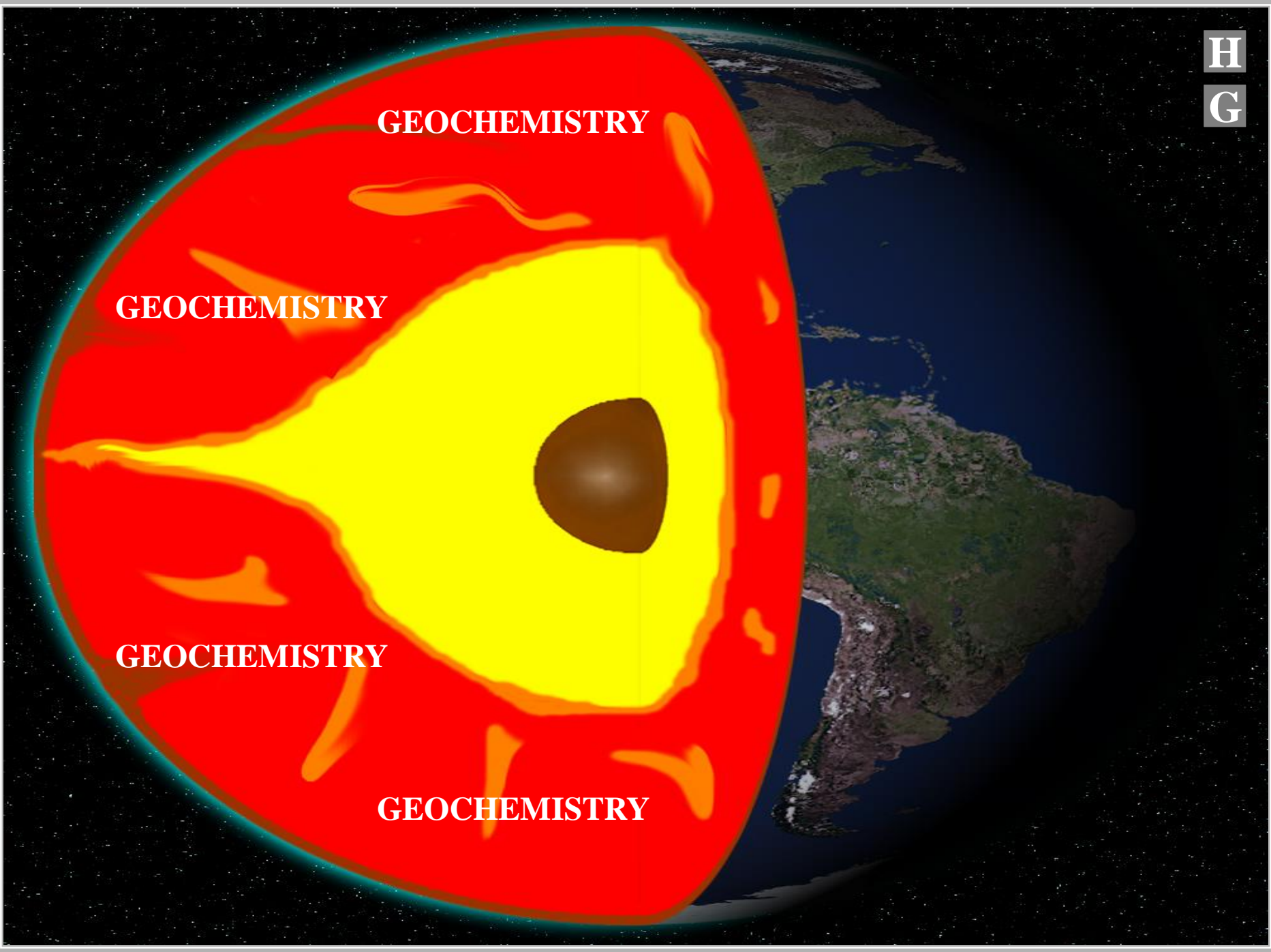
**RADIOACTIVE DECAY
HEAT**

GEOCHEMISTRY

GEOCHEMISTRY

GEOCHEMISTRY

GEOCHEMISTRY





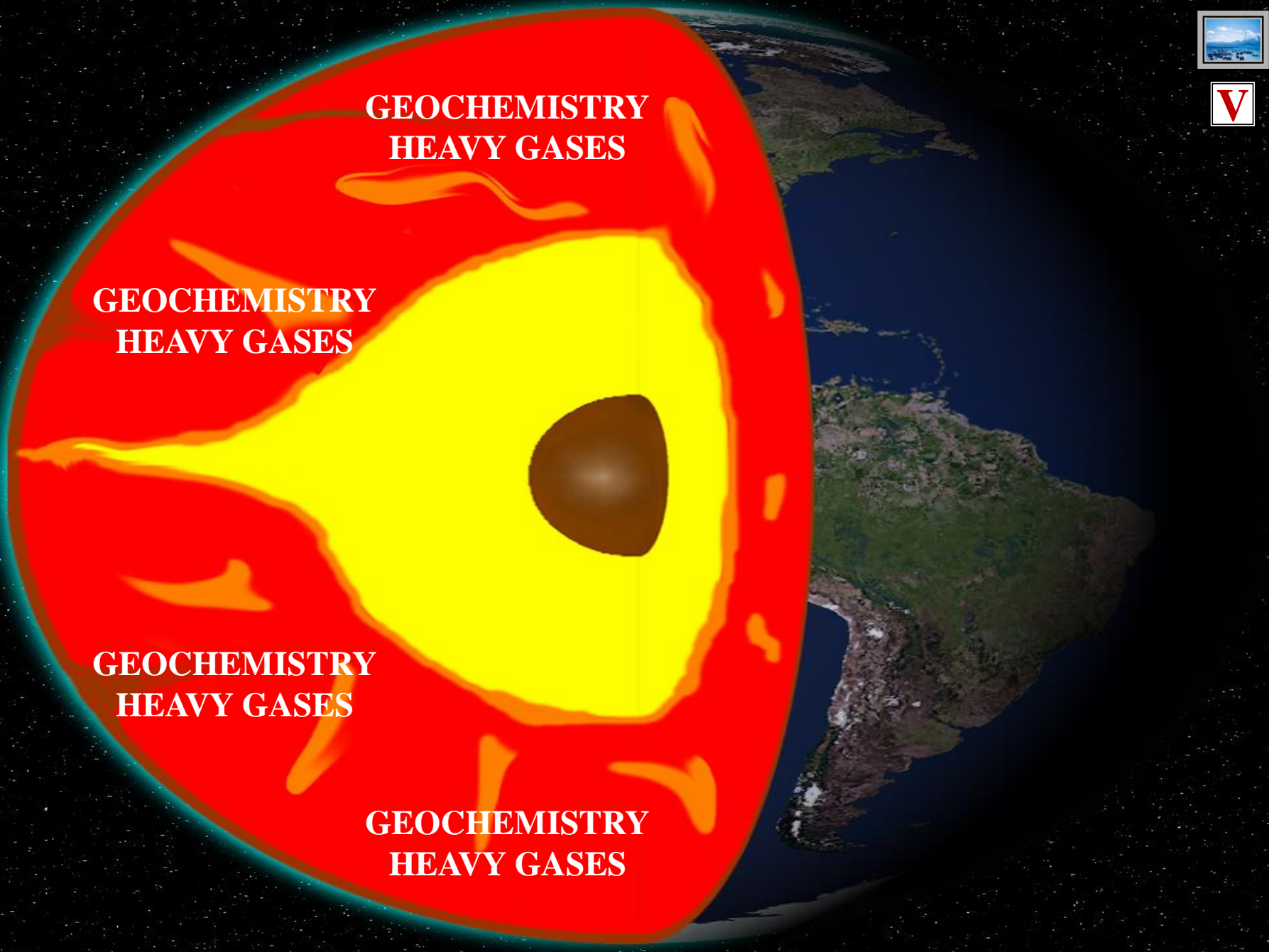
V

**GEOCHEMISTRY
HEAVY GASES**

**GEOCHEMISTRY
HEAVY GASES**

**GEOCHEMISTRY
HEAVY GASES**

**GEOCHEMISTRY
HEAVY GASES**

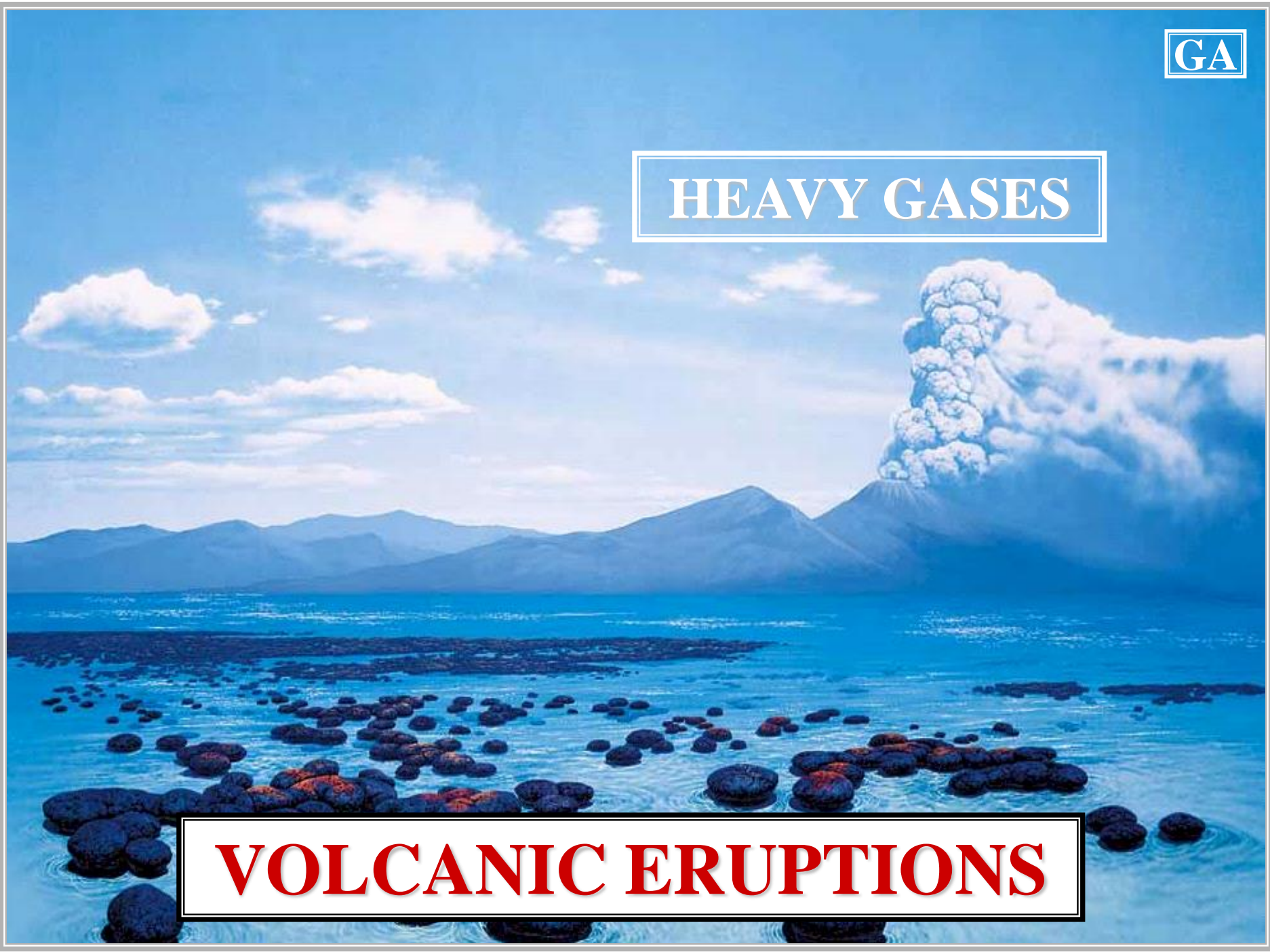




VOLCANIC ERUPTIONS

HEAVY GASES

VOLCANIC ERUPTIONS

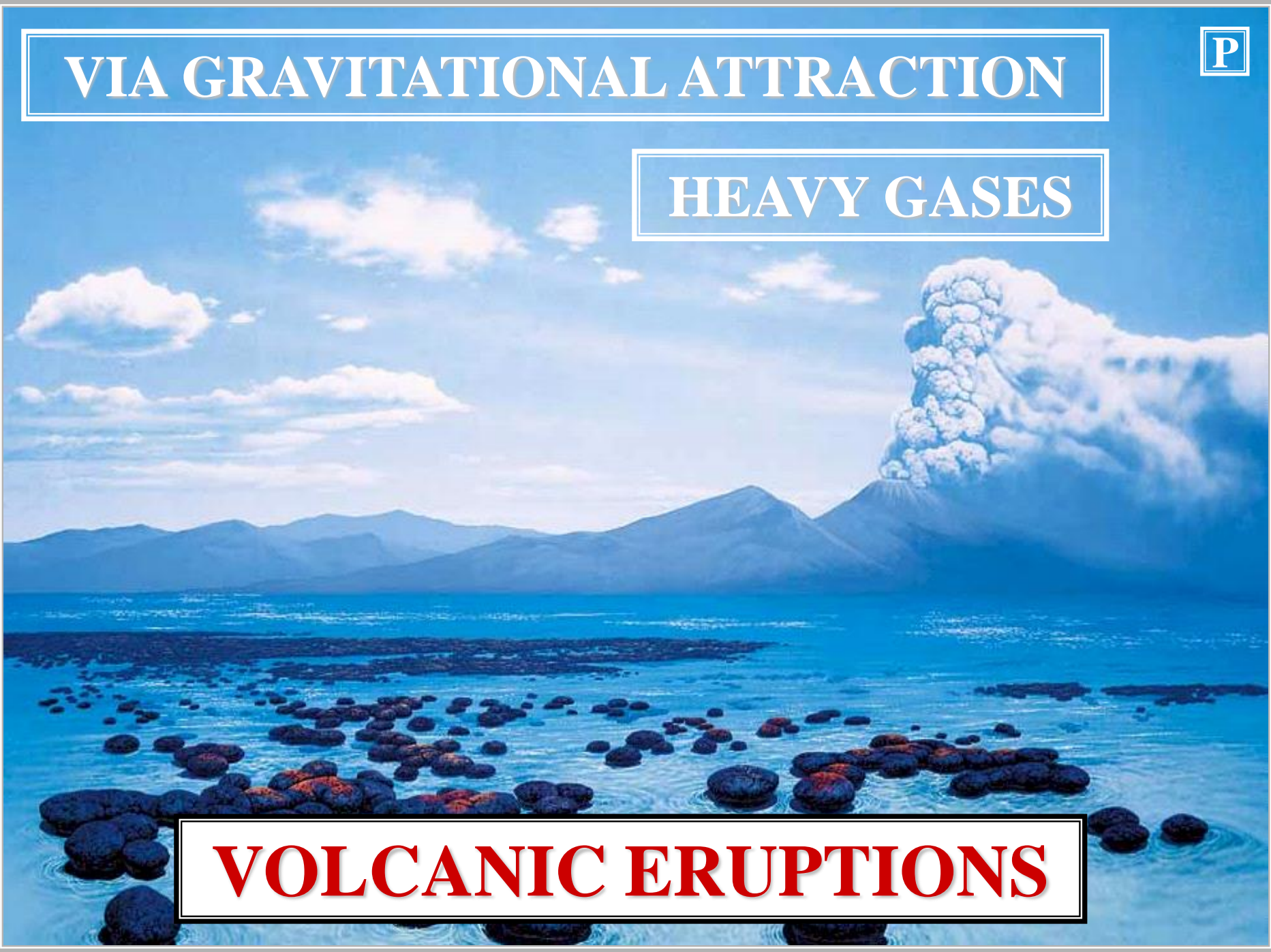


VIA GRAVITATIONAL ATTRACTION

P

HEAVY GASES

VOLCANIC ERUPTIONS



PRIMORDIAL EARTH ATMOSPHERE



HEAVY GASES

A composite image showing a volcanic eruption. In the background, a large volcano is erupting, sending a massive, billowing plume of white ash and steam high into a blue sky with scattered white clouds. The foreground features a rocky beach with numerous dark, rounded volcanic rocks scattered across the sand. The water is a clear, light blue. The overall scene is bright and clear, suggesting a sunny day.

VOLCANIC ERUPTIONS



L

EARTH PRIMORDIAL ATMOSPHERE

PRIMORDIAL EARTH ATMOSPHERE

N

?

A vibrant, stylized illustration of a volcanic landscape. In the foreground, dark, rounded volcanic rocks are scattered across a shallow, turquoise body of water. The middle ground features a range of blue-tinted mountains, with a prominent volcano on the right side emitting a massive, billowing plume of white ash and steam that rises into a clear blue sky with scattered white clouds. The overall scene is bright and clear, suggesting a primordial Earth environment.

VOLCANIC ERUPTIONS

PRIMORDIAL EARTH ATMOSPHERE

C

NITROGEN

A vibrant blue-tinted landscape depicting a volcanic scene. In the foreground, dark, rounded volcanic rocks are scattered across a shallow, rippling body of water. The middle ground shows a range of low mountains and a prominent volcano on the right that is actively erupting, sending a massive, billowing plume of white ash and steam high into the sky. The sky is filled with smaller, scattered white clouds. The overall scene is bright and clear, with a strong blue color cast.

VOLCANIC ERUPTIONS

PRIMORDIAL EARTH ATMOSPHERE



NITROGEN
CARBON DIOXIDE

VOLCANIC ERUPTIONS

PRIMORDIAL EARTH ATMOSPHERE

H

NITROGEN
CARBON DIOXIDE
WATER

A vibrant blue-tinted landscape depicting a volcanic scene. In the foreground, dark, rounded volcanic rocks are scattered across a shallow, rippling body of water. The middle ground shows a range of low, conical mountains. On the right side, a prominent volcano is actively erupting, sending a massive, billowing plume of white ash and steam high into the sky. The sky is filled with scattered white clouds. The overall scene is set against a clear, bright blue sky.

VOLCANIC ERUPTIONS

PRIMORDIAL EARTH ATMOSPHERE



NITROGEN
CARBON DIOXIDE
WATER
HYDROGEN SULFIDE



VOLCANIC ERUPTIONS

PRIMORDIAL EARTH ATMOSPHERE

A

NITROGEN
CARBON DIOXIDE
WATER
HYDROGEN SULFIDE
METHANE

A vibrant blue-toned illustration of a volcanic landscape. In the foreground, dark, rounded volcanic rocks are scattered across a shallow, rippling body of water. In the middle ground, a range of blue mountains stretches across the horizon. On the right side, a large volcano is actively erupting, sending a massive, billowing plume of white and grey ash and smoke high into the sky. The overall scene is bright and clear, with a deep blue sky and water.

VOLCANIC ERUPTIONS

PRIMORDIAL EARTH ATMOSPHERE



NITROGEN
CARBON DIOXIDE
WATER
HYDROGEN SULFIDE
METHANE
AMMONIA



VOLCANIC ERUPTIONS

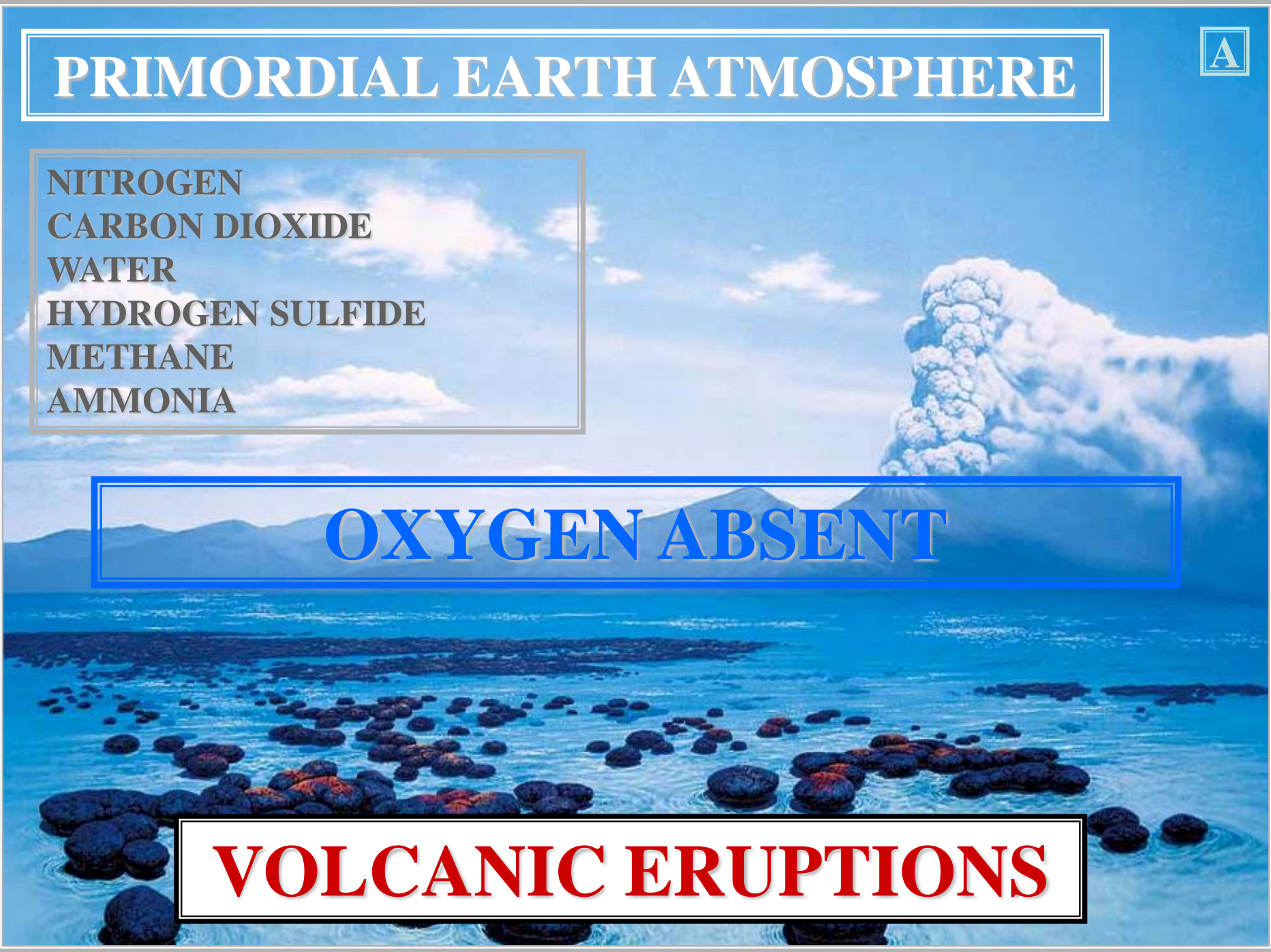
PRIMORDIAL EARTH ATMOSPHERE

A

NITROGEN
CARBON DIOXIDE
WATER
HYDROGEN SULFIDE
METHANE
AMMONIA

OXYGEN ABSENT

VOLCANIC ERUPTIONS

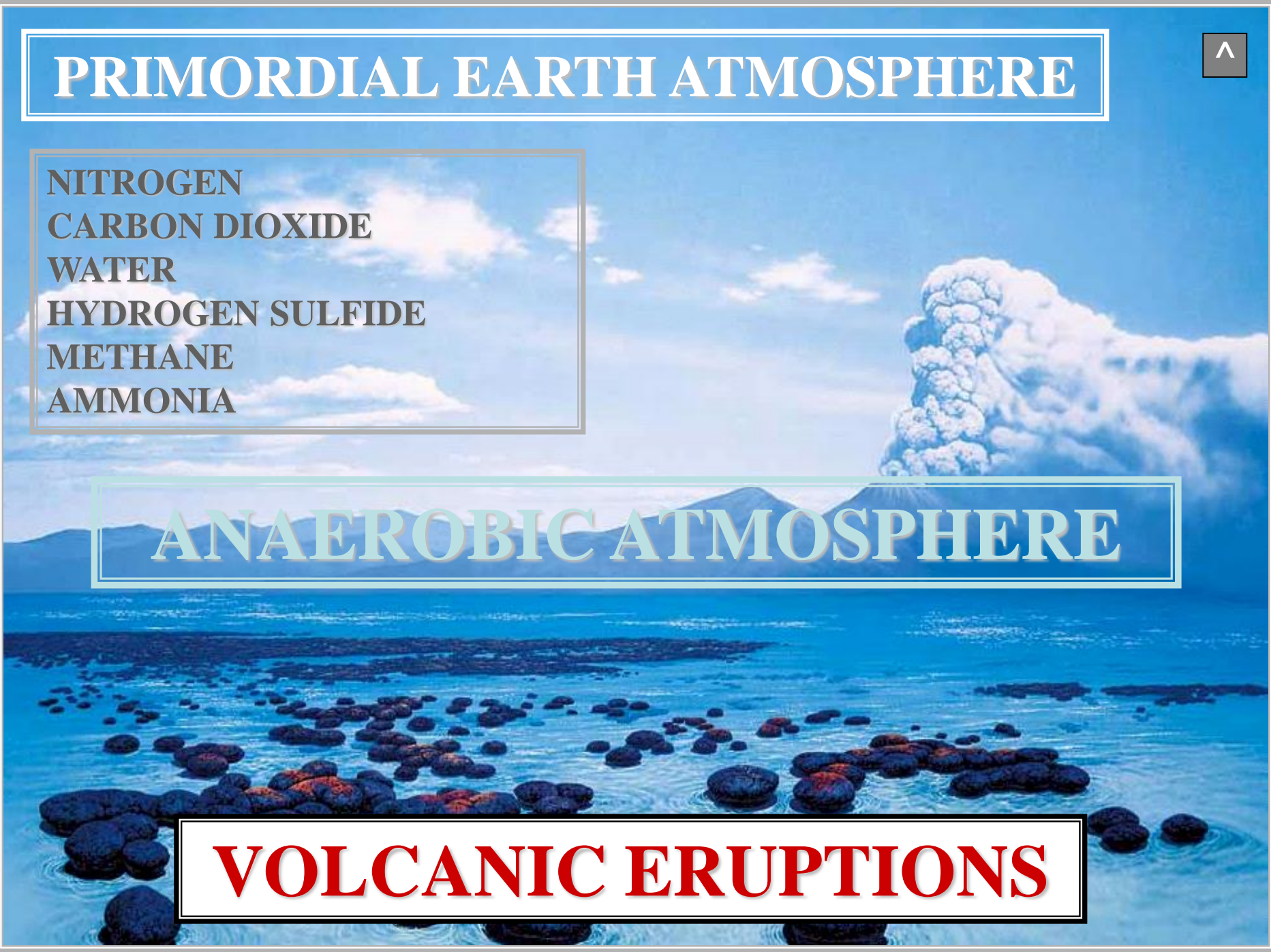


PRIMORDIAL EARTH ATMOSPHERE

NITROGEN
CARBON DIOXIDE
WATER
HYDROGEN SULFIDE
METHANE
AMMONIA

ANAEROBIC ATMOSPHERE

VOLCANIC ERUPTIONS



CHEMICAL EVOLUTION

CHEMICAL EVOLUTION



CHEMICAL EVOLUTION

CONVERSION
ATMOSPHERIC GASES
TO COMPLEX ORGANIC
COMPOUNDS

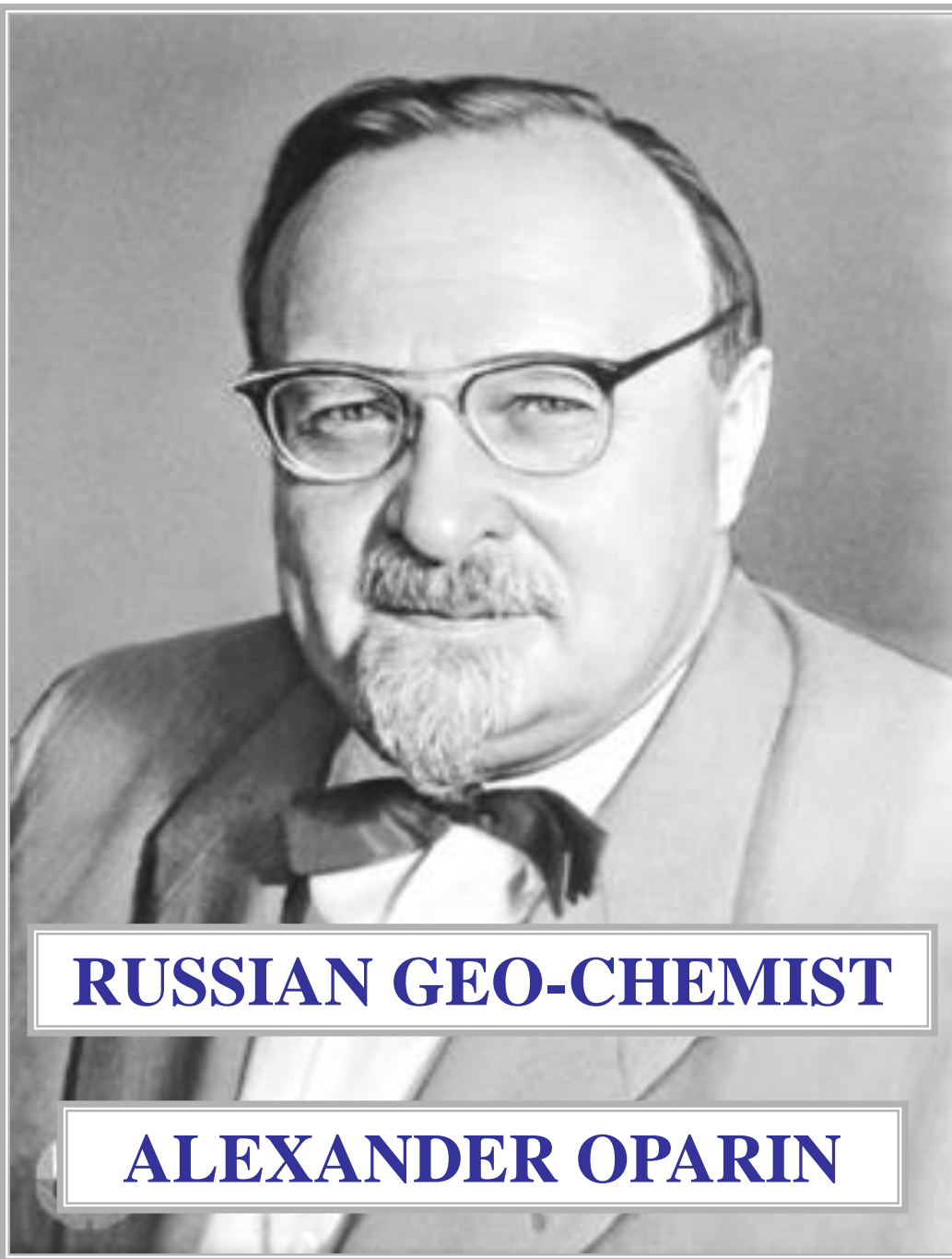
CHEMICAL EVOLUTION



OPARIN THEORY

+

EX

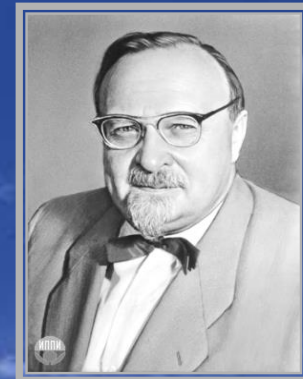


RUSSIAN GEO-CHEMIST

ALEXANDER OPARIN



N_2 CO_2 H_2O
 H_2S CH_4 NH_3

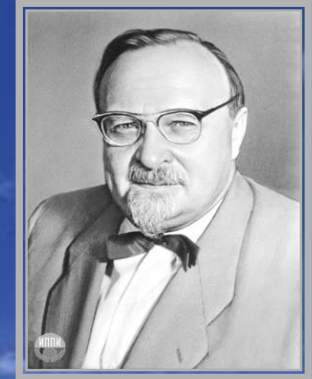


**OPARIN THEORY
EXPLAINS
CONVERSION ATMOSPHERIC
GASES TO COMPLEX
ORGANIC COMPOUNDS**

PRIMORDIAL ATMOSPHERE



N_2 CO_2 H_2O
 H_2S CH_4 NH_3



CONVERSION ENERGY SOURCES

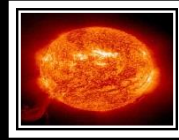
PRIMORDIAL ATMOSPHERE



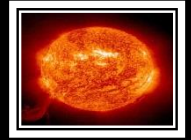
ATMOSPHERIC LIGHTNING

CONVERSION ENERGY SOURCES

PRIMORDIAL ATMOSPHERE



SOLAR RADIATION



CONVERSION ENERGY SOURCES

U

PRIMORDIAL ATMOSPHERE



**ULTRA-VIOLET
RADIATION**



CONVERSION ENERGY SOURCES



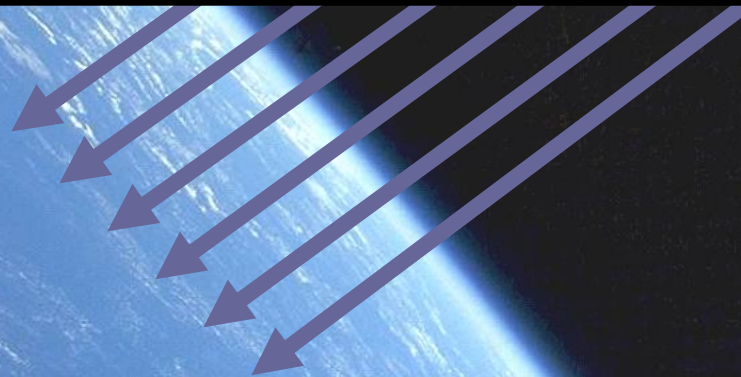
PRIMORDIAL ATMOSPHERE



**ULTRA-VIOLET
RADIATION**



CONVERSION ENERGY SOURCES



N

OZONE LAYER: ABSENT

PRIMORDIAL ATMOSPHERE

NITROGEN
CARBON DIOXIDE
WATER
HYDROGEN
SULFIDE
METHANE
AMMONIA

PRIMORDIAL ATMOSPHERE

C-CMP

C-CMP

C-CMP

C-CMP



R

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 = COMPLEX ORGANIC COMPOUNDS

AMINO ACIDS & NUCLEOTIDES

C
+

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

RAIN

RAIN

RAIN

RAIN

C-CMP PRECIPITATED INTO OCEANS



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

RAIN

RAIN

RAIN

RAIN

C-CMP

C-CMP

C-CMP

C-CMP

OCEANS HIGH ORGANIC CONTENT

“P”



SHALLOW COAST

OCEANS HIGH ORGANIC CONTENT

“PRIMORDIAL SOUP”



SHALLOW COAST

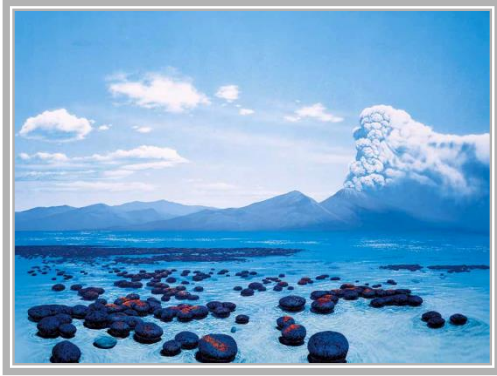
OCEANS HIGH ORGANIC CONTENT

“PRIMORDIAL SOUP”

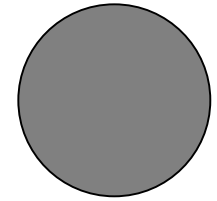
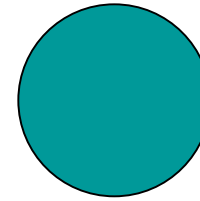
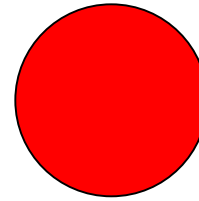
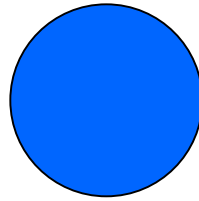
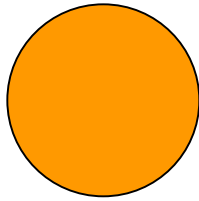
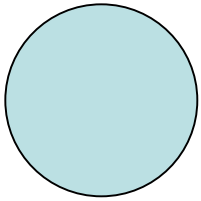
ORGANIC CMPS
ASSOCIATE & ORGANIZE

SHALLOW COAST





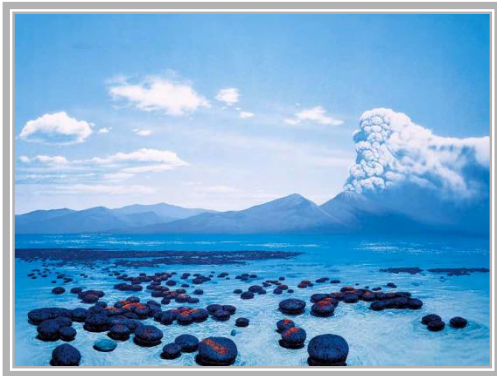
ORGANIC COMPOUNDS



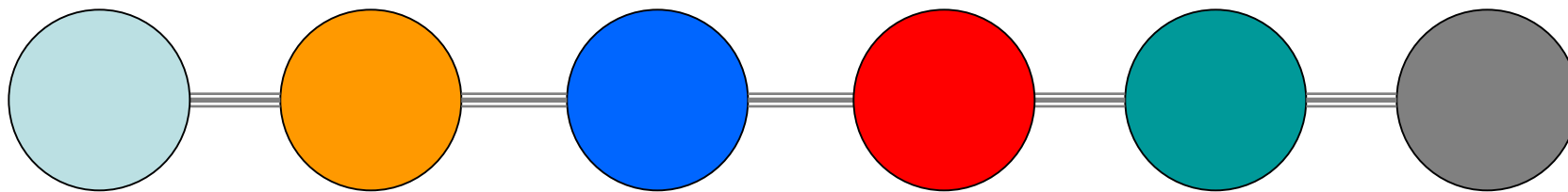
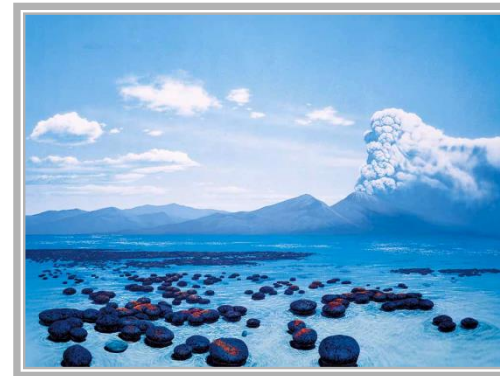
MONOMER

**ORGANIC CMPS
ASSOCIATE & ORGANIZE**

“PRIMORDIAL SOUP”



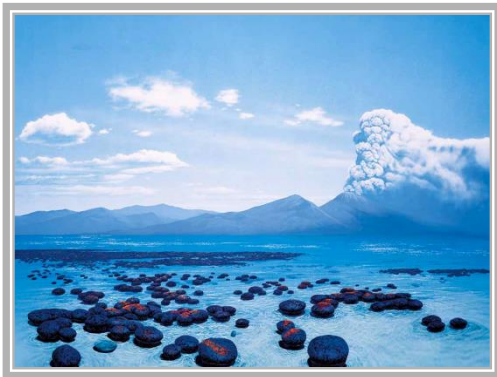
ORGANIC COMPOUNDS



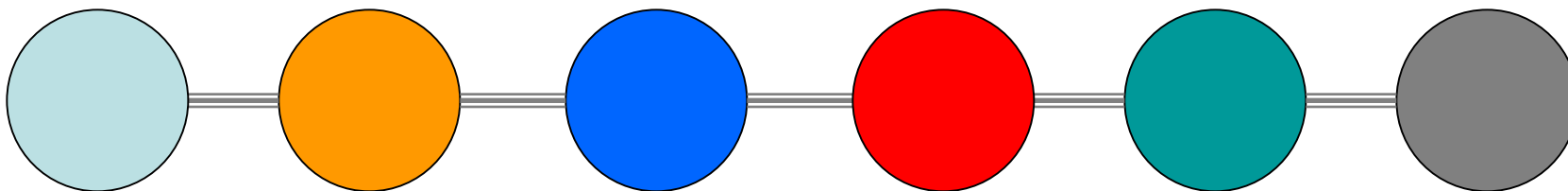
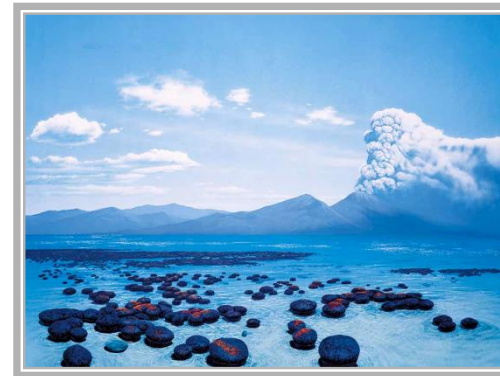
MONOMER

== = BOND

“PRIMORDIAL SOUP”

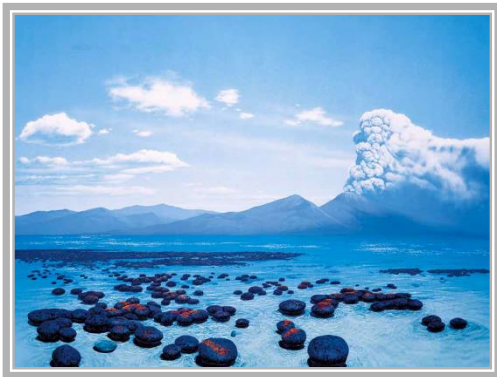


ORGANIC COMPOUNDS

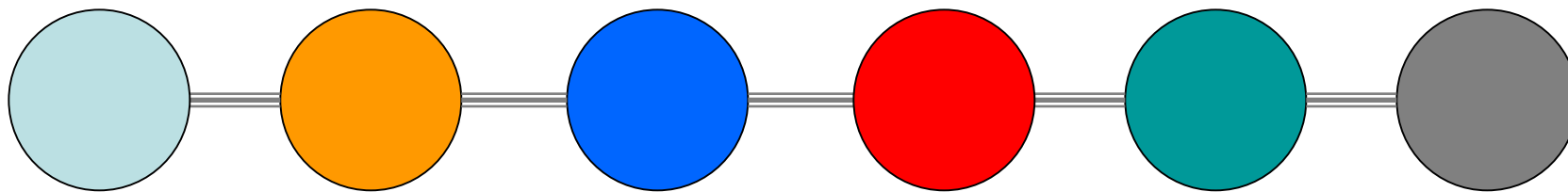
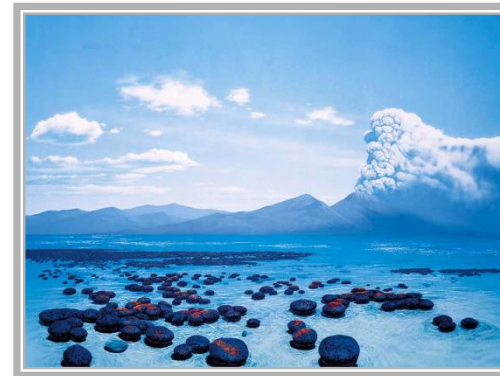


MONOMER **== = BOND**

?

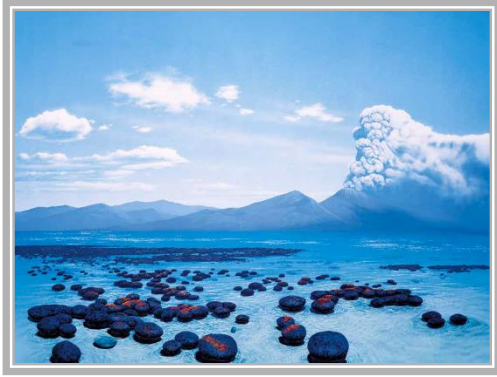


ORGANIC COMPOUNDS

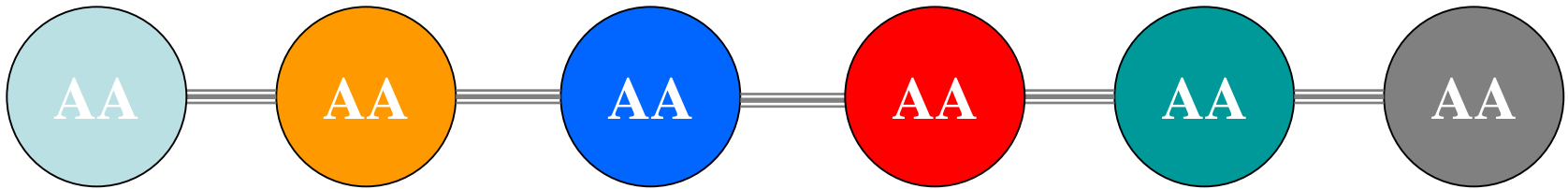


MONOMER **== = BOND**

POLYMER

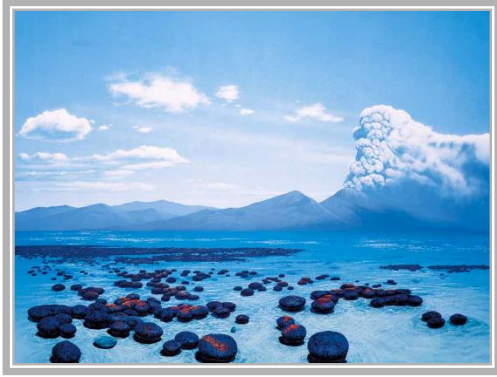


ORGANIC COMPOUNDS

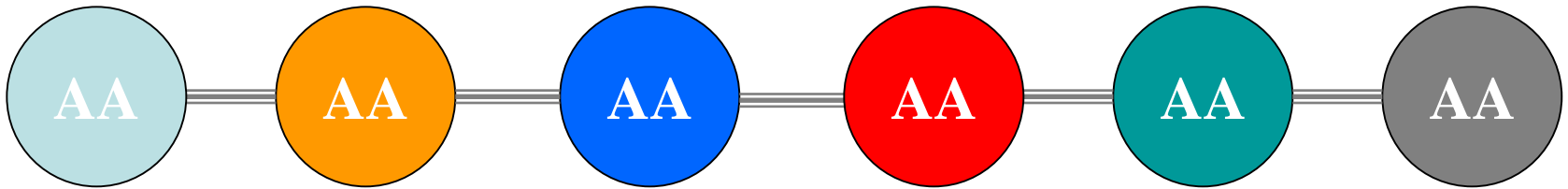


AMINO ACID MONOMERS \equiv = PEPTIDE BOND

POLYMER



ORGANIC COMPOUNDS

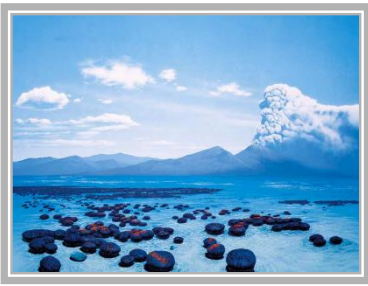


AMINO ACID
MONOMERS

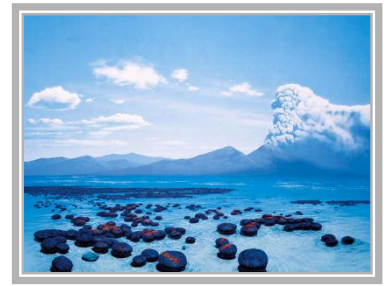
== = PEPTIDE BOND



PROTEINS



ORGANIC COMPOUNDS



B

NT

NT

NT

NT

NT

NT

NT

NT

NT

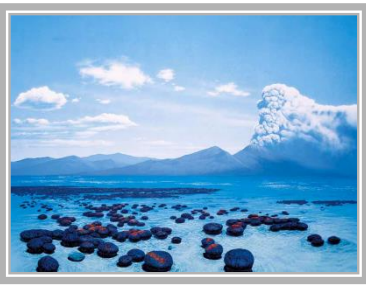
NT

NT

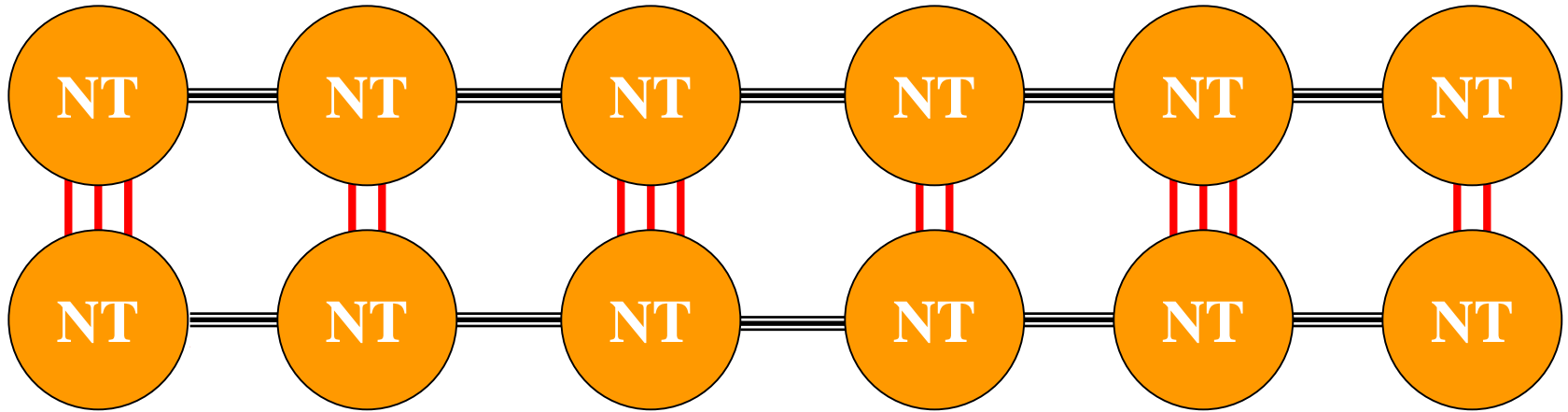
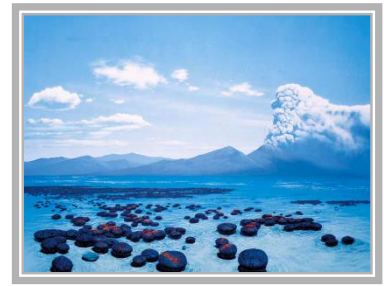
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**NUCLEOTIDE
MONOMERS**

POLYMER



ORGANIC COMPOUNDS



**NUCLEOTIDE
MONOMERS**

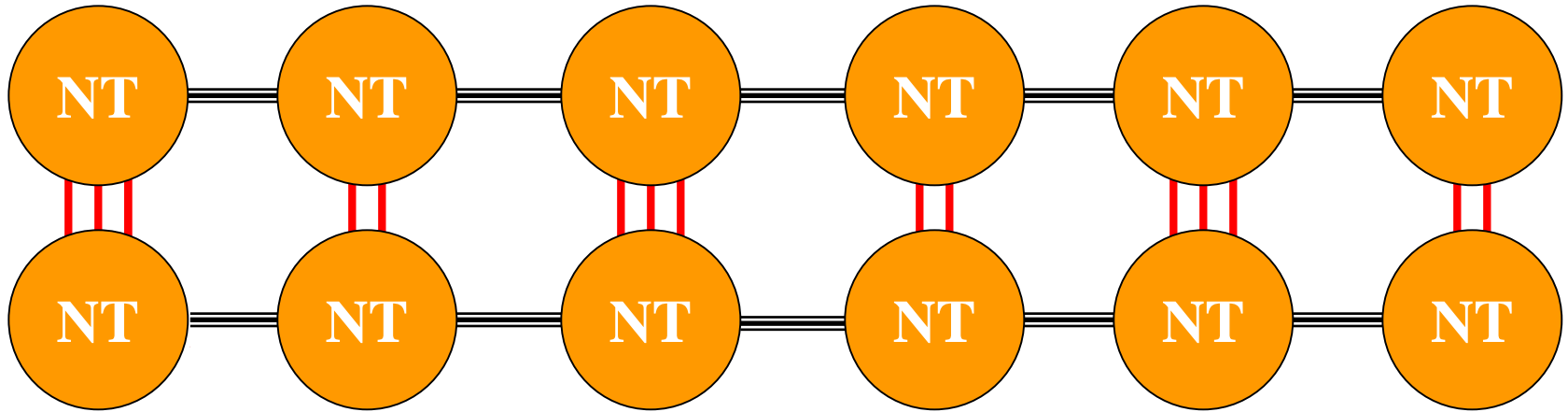
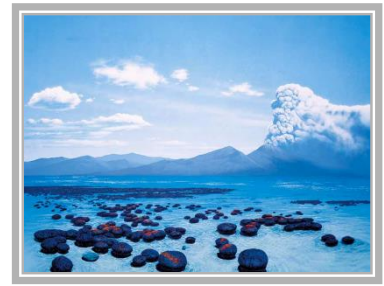
== = PHOSPHODIESTER BOND

— = HYDROGEN BOND

POLYMER



ORGANIC COMPOUNDS

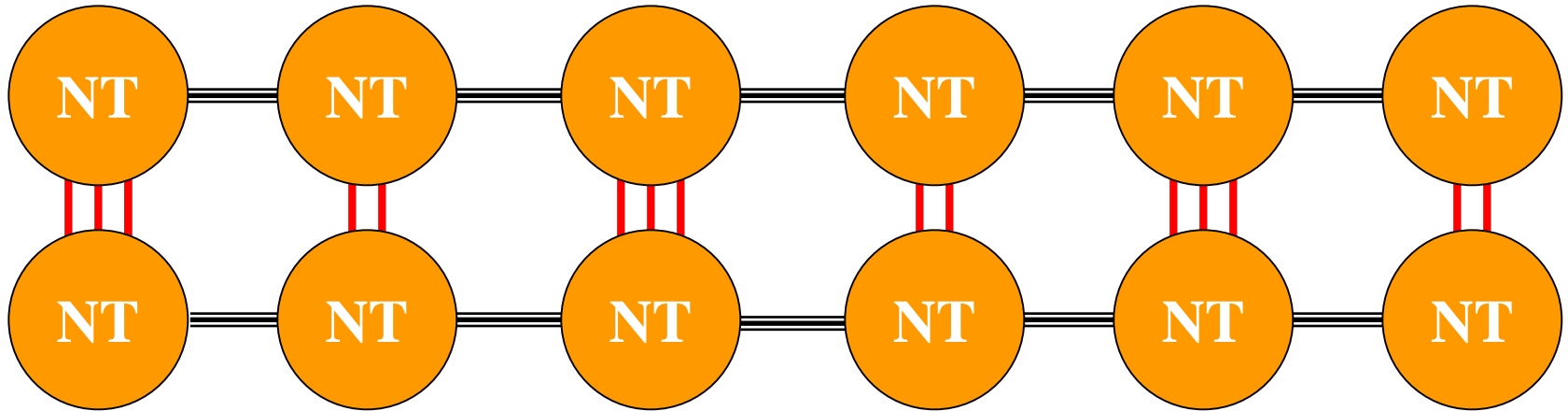


**NUCLEOTIDE
MONOMERS** **==** = **PHOSPHODIESTER BOND**
 — = **HYDROGEN BOND**

NUCLEIC ACIDS



ORGANIC COMPOUNDS



**NUCLEOTIDE
MONOMERS**

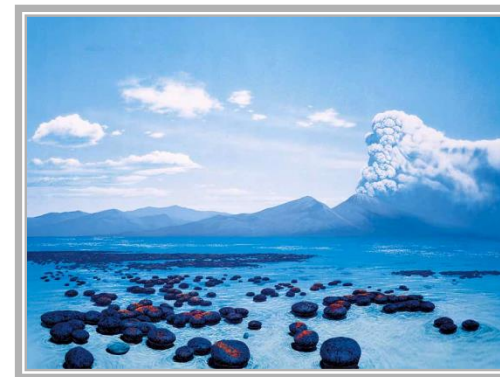
== = PHOSPHODIESTER BOND

— = HYDROGEN BOND

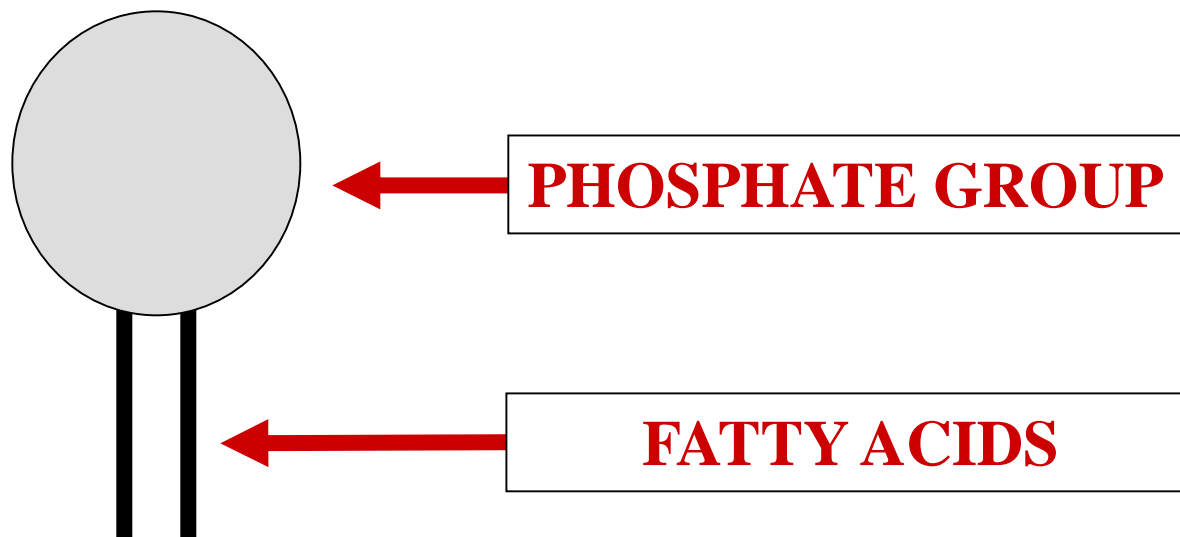
**NUCLEIC ACIDS
DNA & RNA**



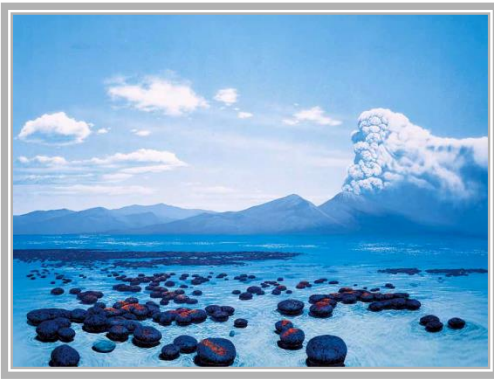
ORGANIC COMPOUNDS



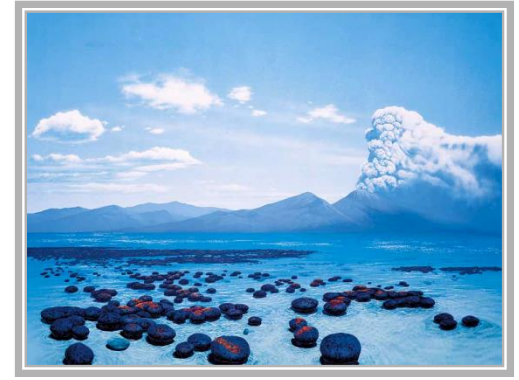
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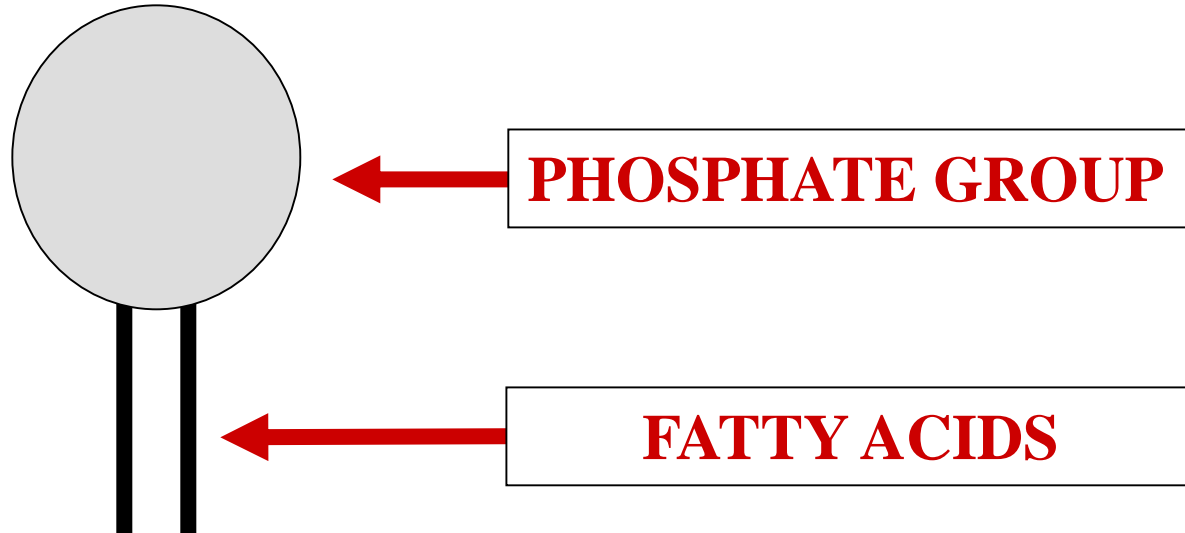
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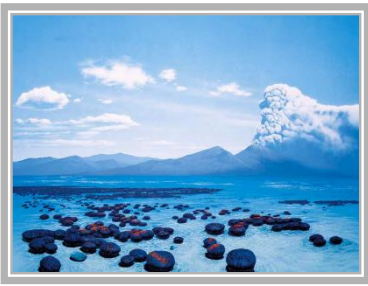
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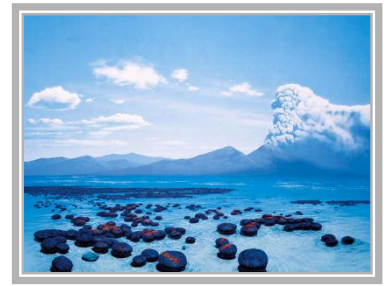
A



PHOSPHOLIPID



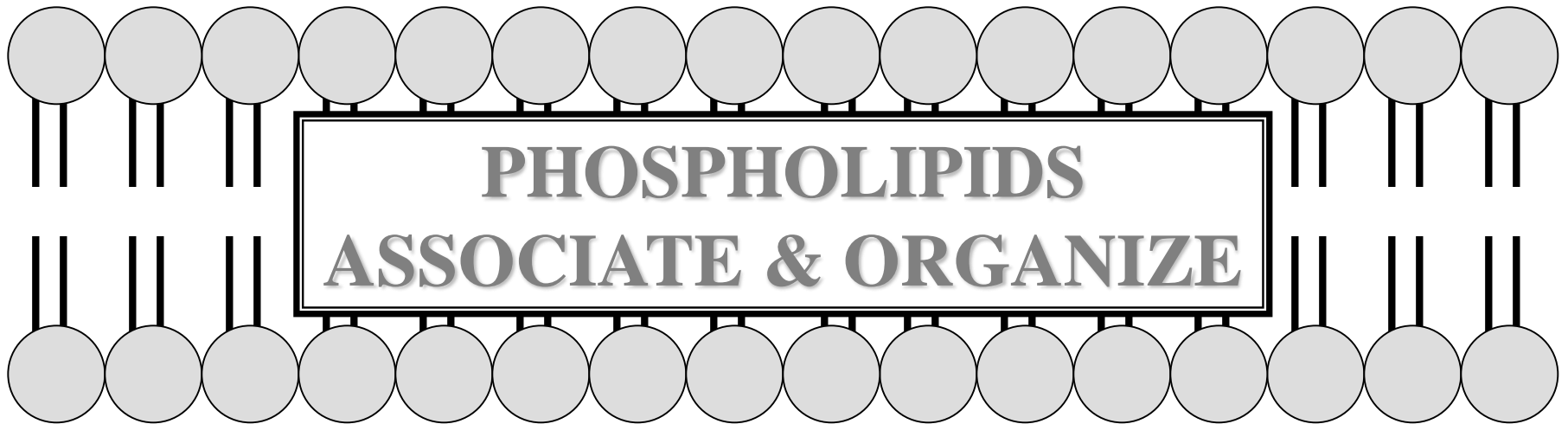
ORGANIC COMPOUNDS



WATER

WATER

WATER

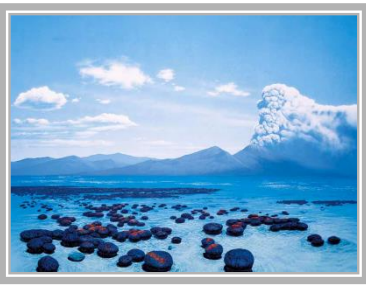


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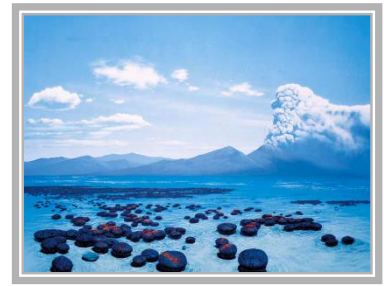
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WATER

PHOSPHOLIPIDS



ORGANIC COMPOUNDS

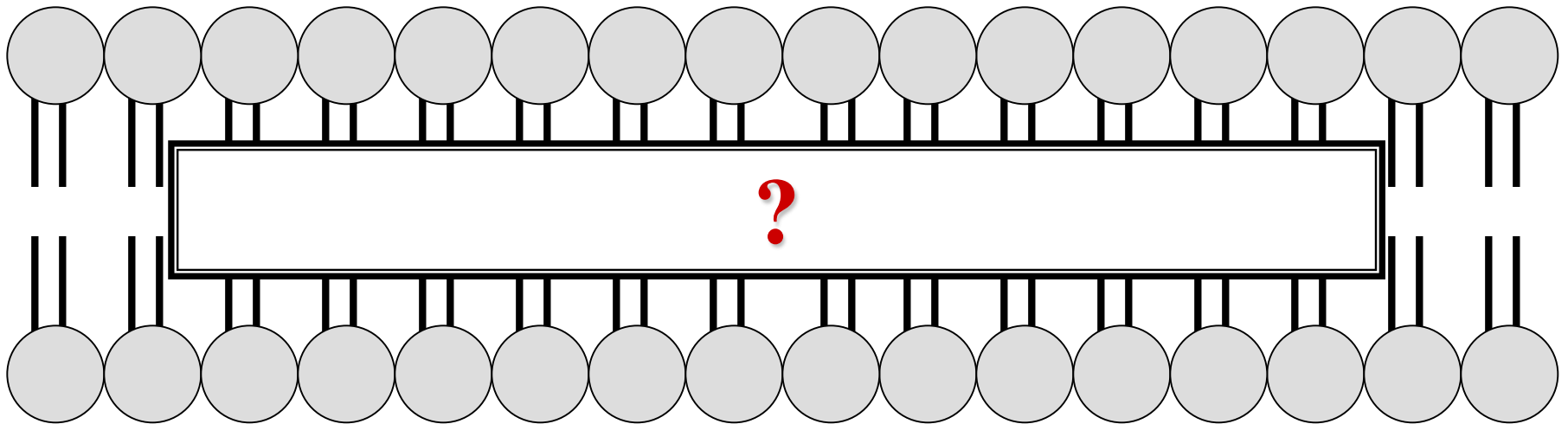


B

WATER

WATER

WATER



WATER

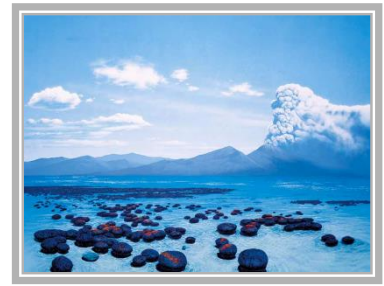
WATER

WATER

PHOSPHOLIPIDS



ORGANIC COMPOUNDS

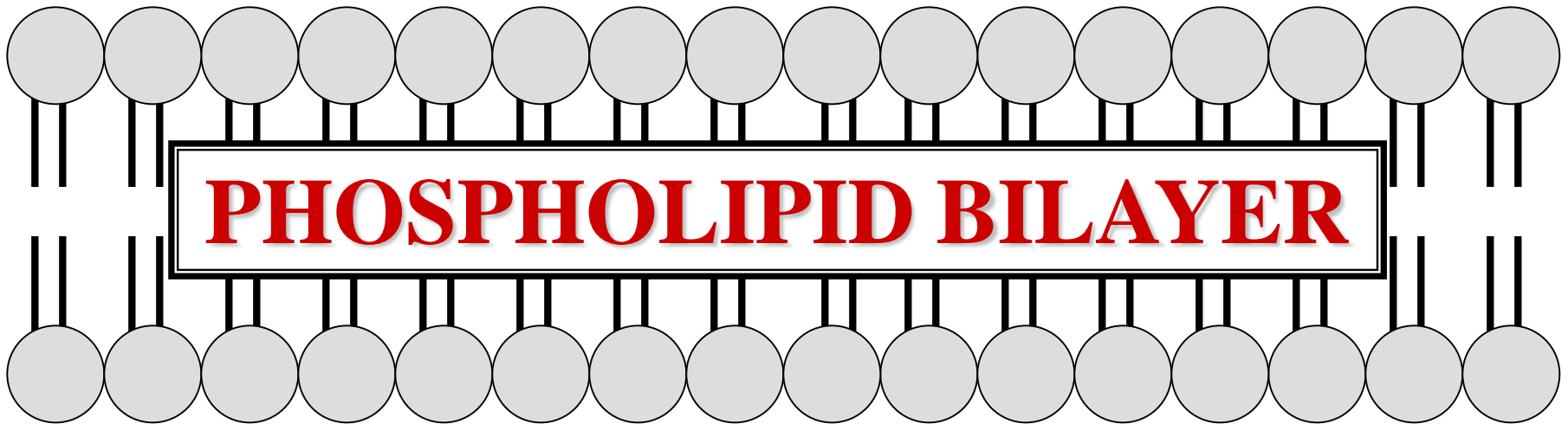


M

WATER

WATER

WATER

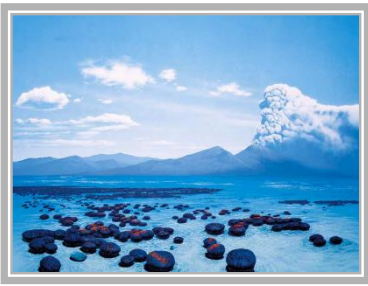


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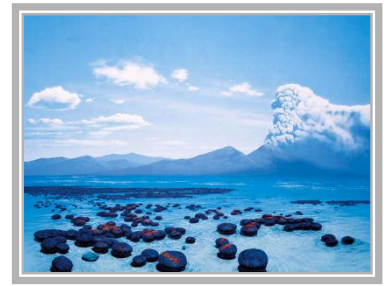
WATER

WATER

PHOSPHOLIPIDS



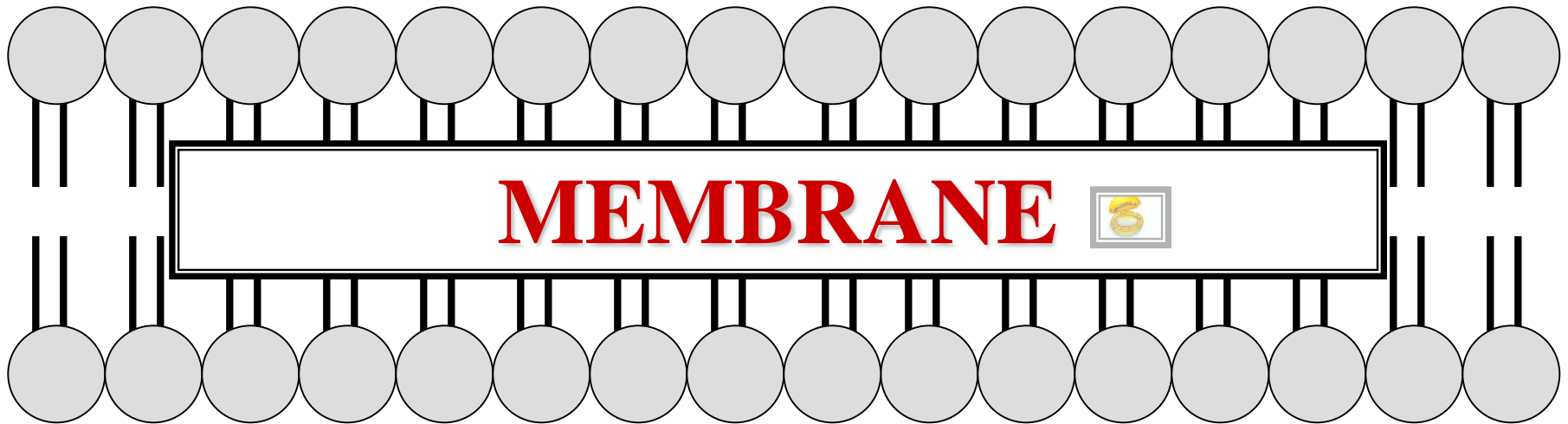
ORGANIC COMPOUNDS



WATER

WATER

WATER

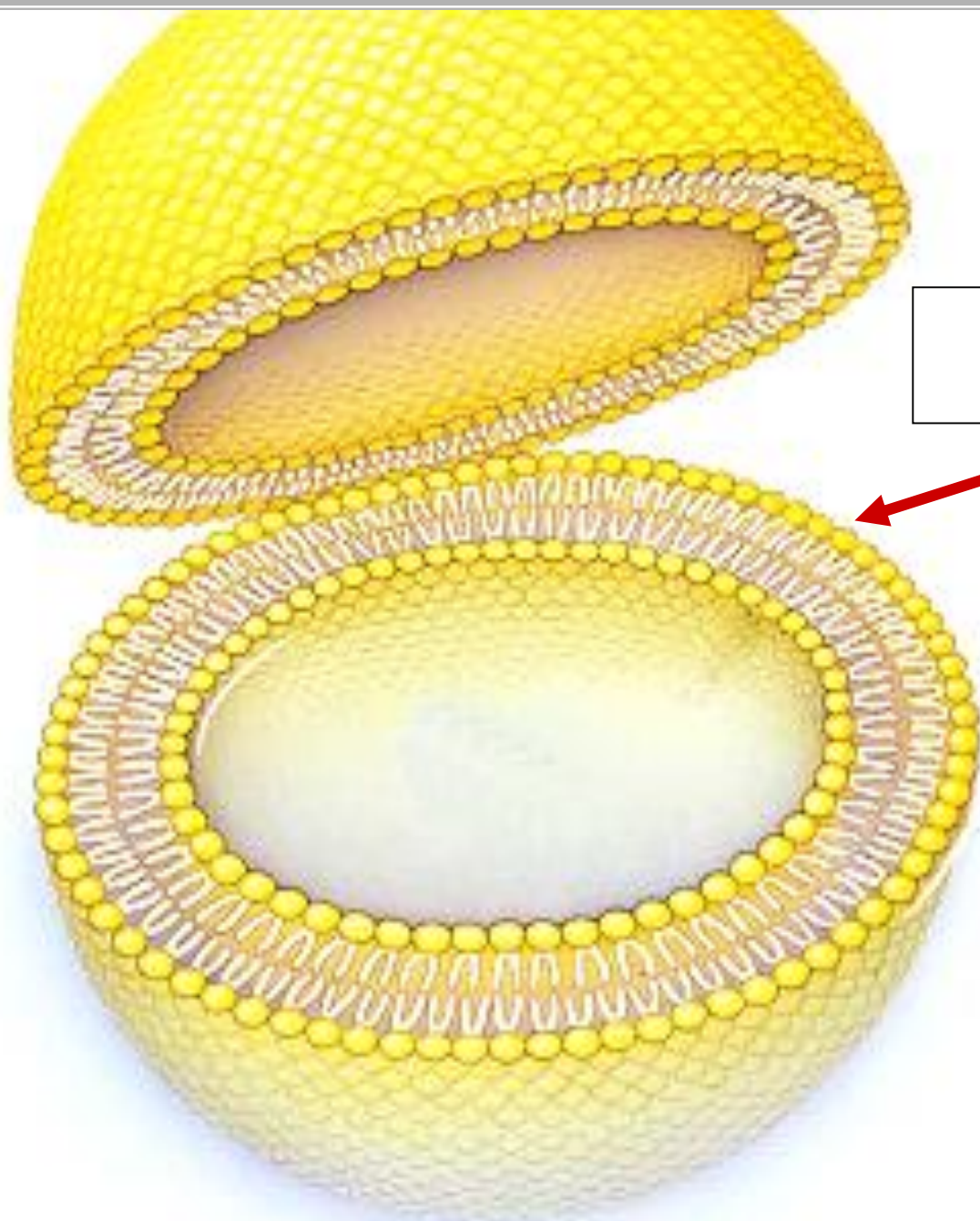


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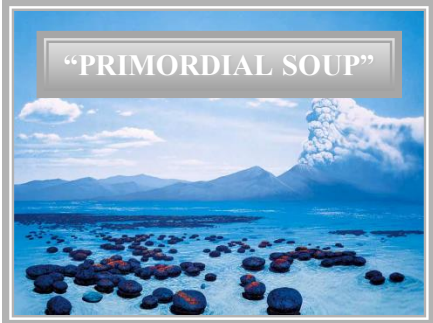
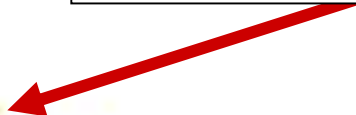
WATER

WATER

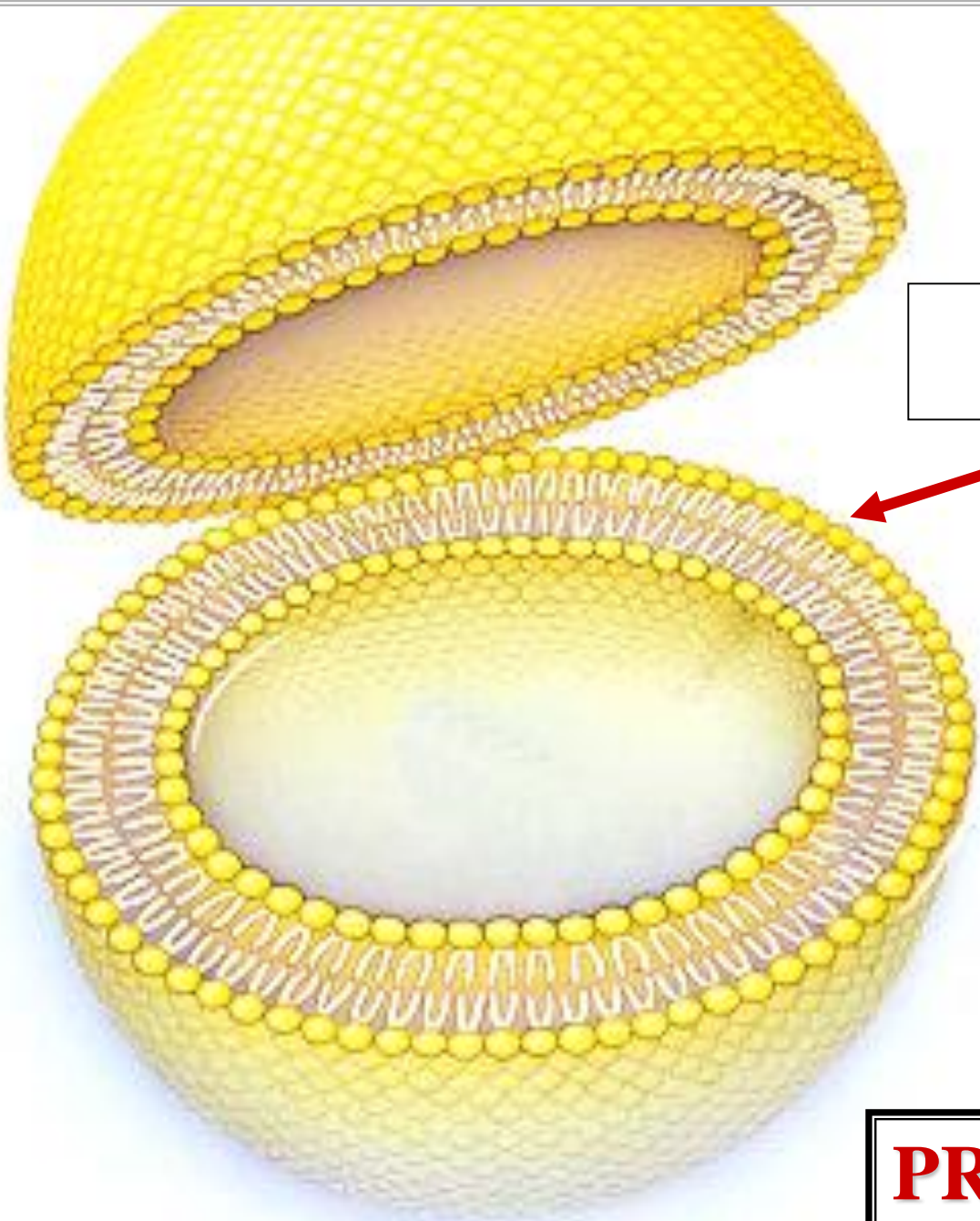
PHOSPHOLIPIDS



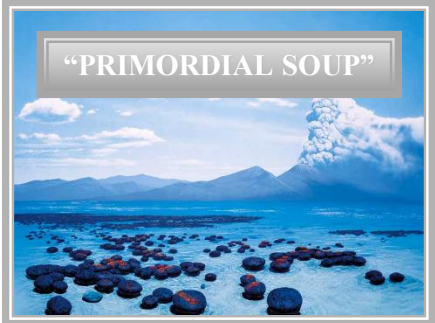
**PRIMITIVE
MEMBRANE**



“PRIMORDIAL SOUP”



**PRIMITIVE
MEMBRANE**



PROTOBIONT

PROTOBIONTS

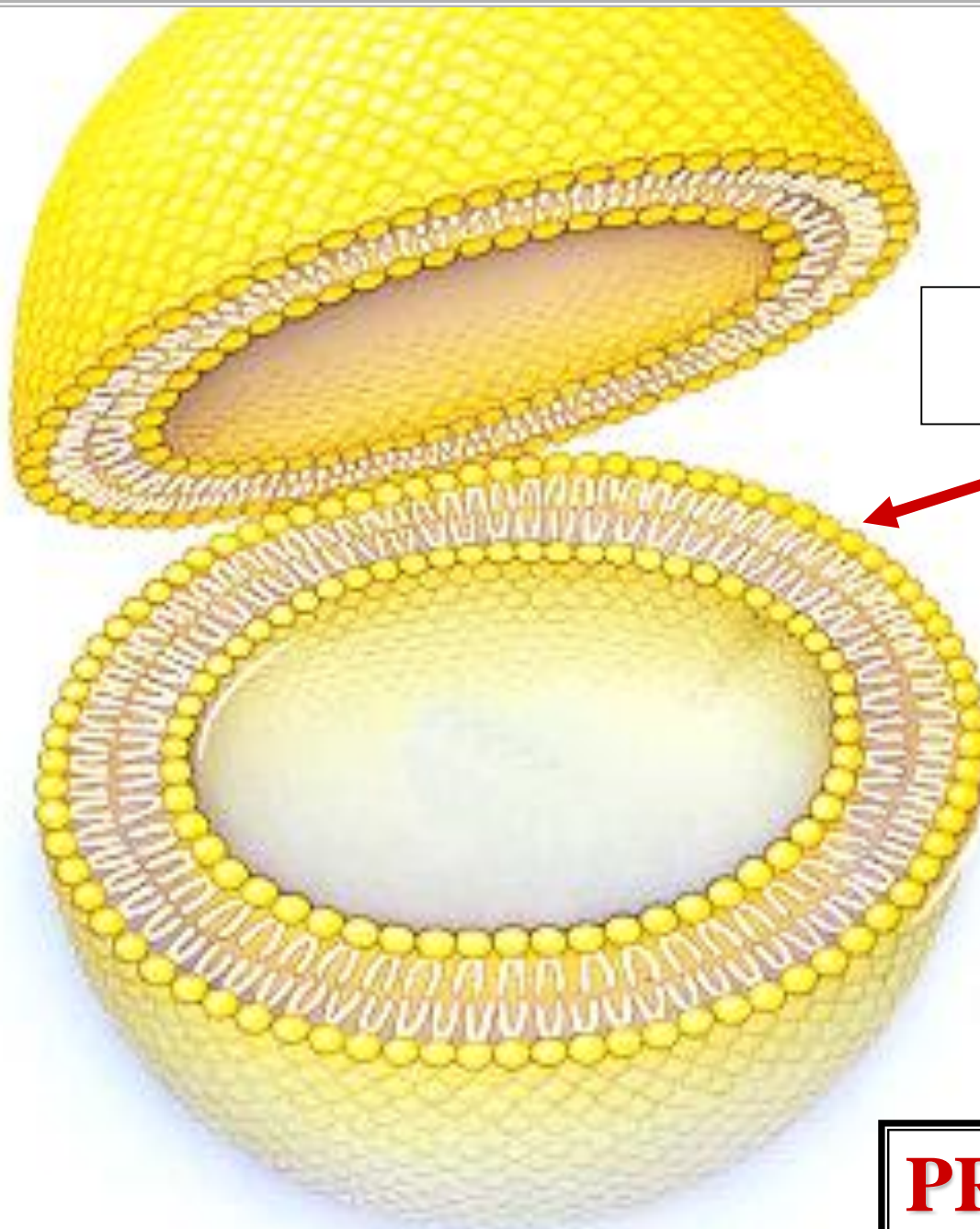
PROTOBIONTS

PROTOBIONTS

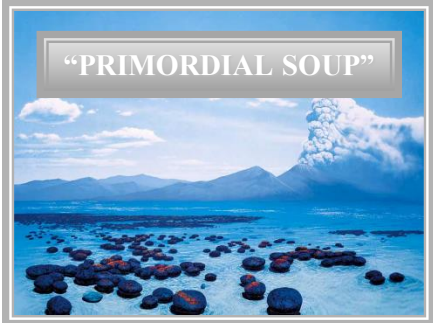
ABIOTIC

ORGANIC AGGREGATES

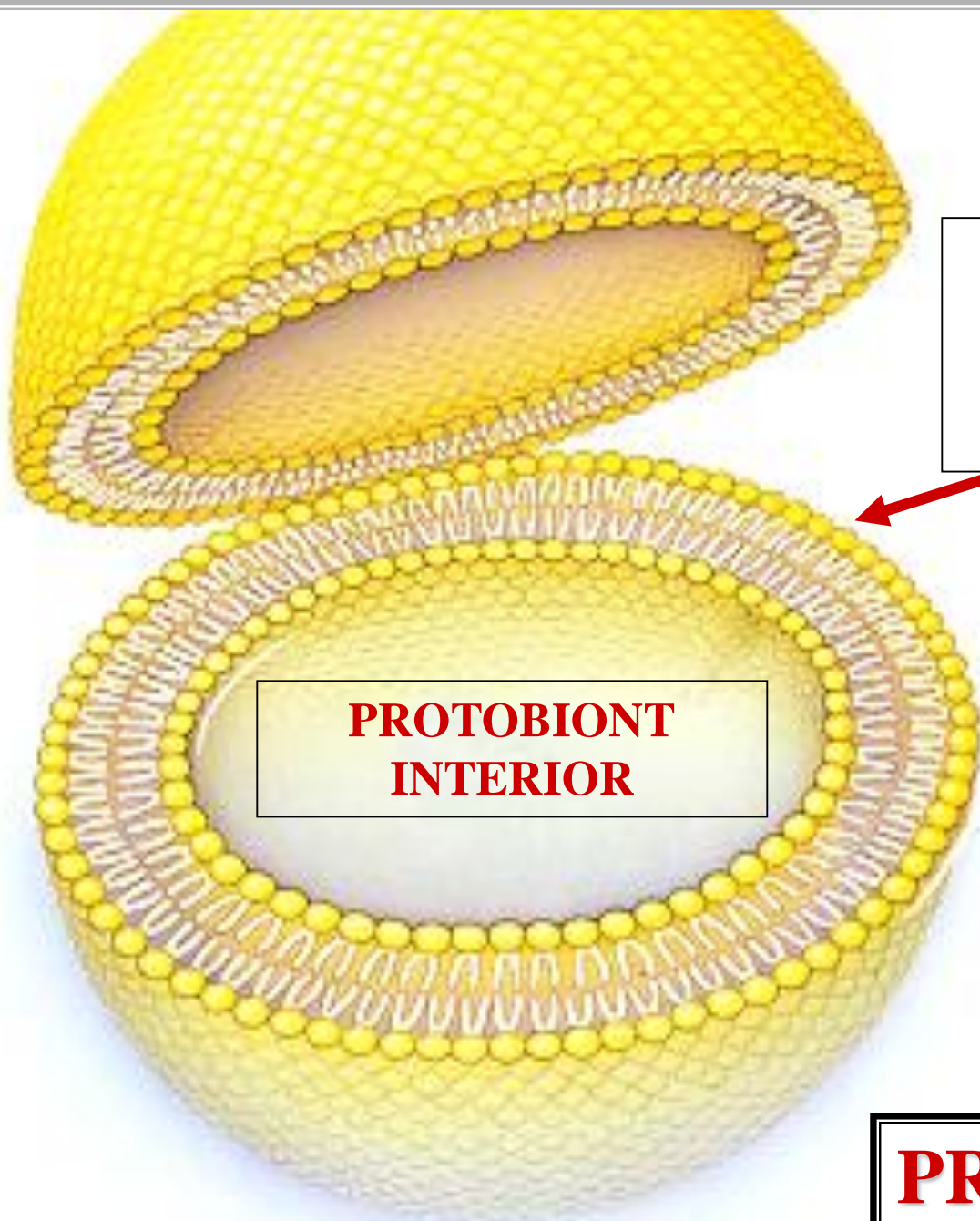
PROTOBIONTS



**PRIMITIVE
MEMBRANE**

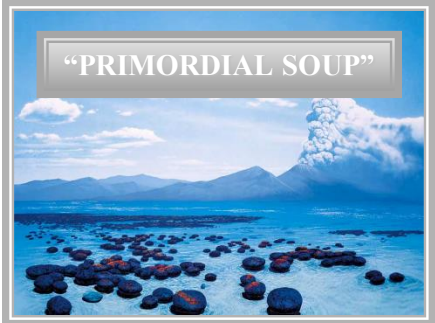


PROTOBIONT



**PRIMITIVE
MEMBRANE
REGULATES
PASSAGE**

**PROTOBIONT
INTERIOR**



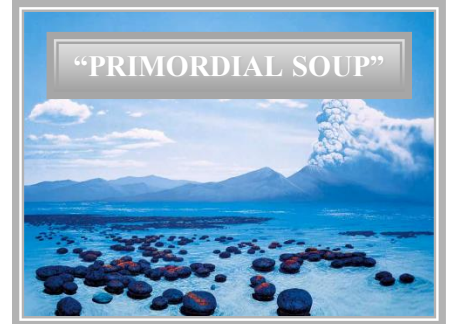
PROTOBIONT

LE

**PRIMITIVE
MEMBRANE
REGULATES
PASSAGE**

**HIGHER
ORGANIZATION**

“PRIMORDIAL SOUP”



PROTOBIONT

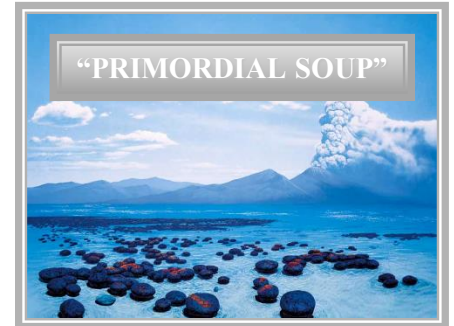
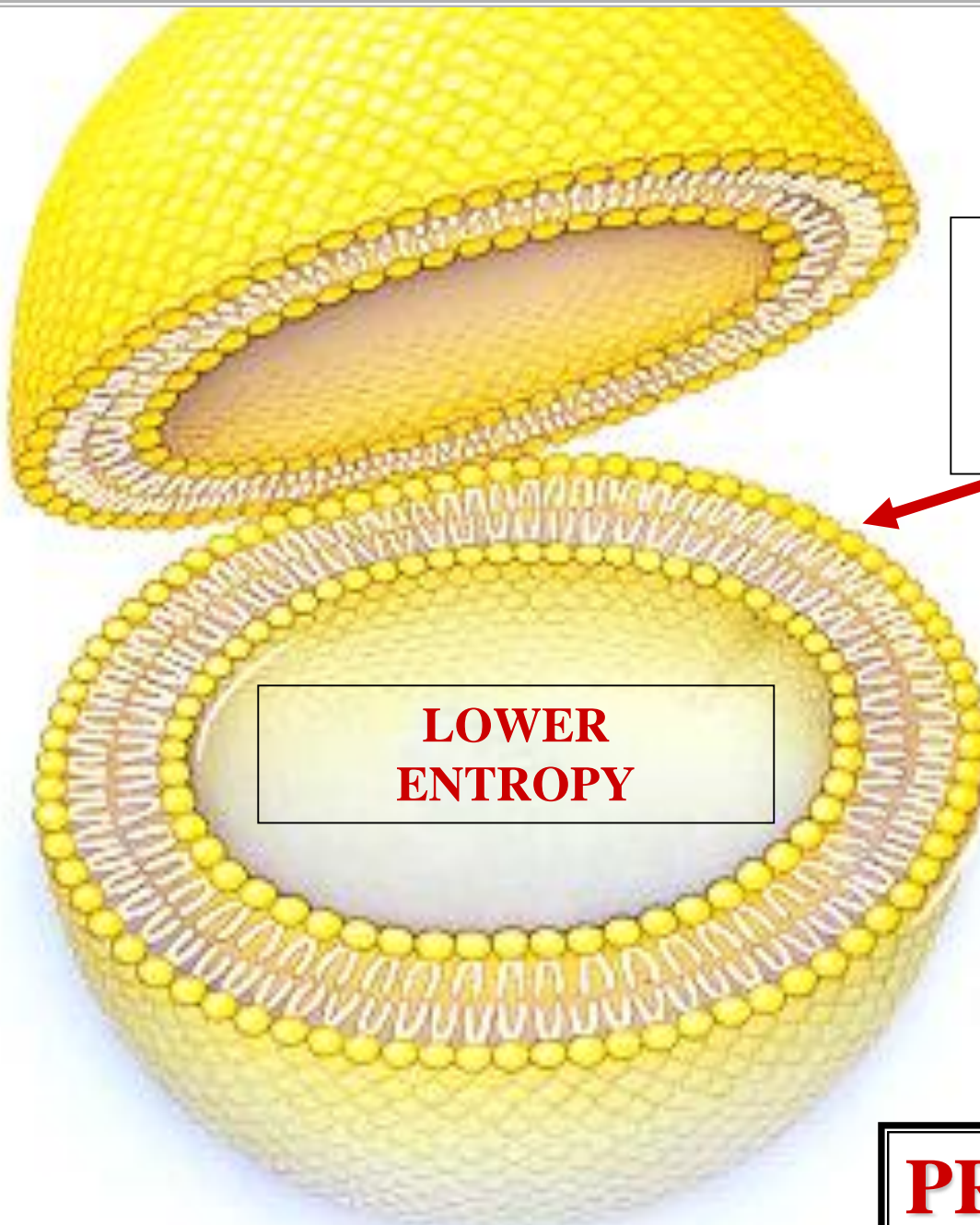
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**PRIMITIVE
MEMBRANE
REGULATES
PASSAGE**

**LOWER
ENTROPY**

“PRIMORDIAL SOUP”

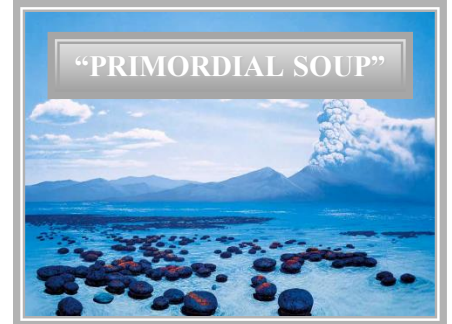
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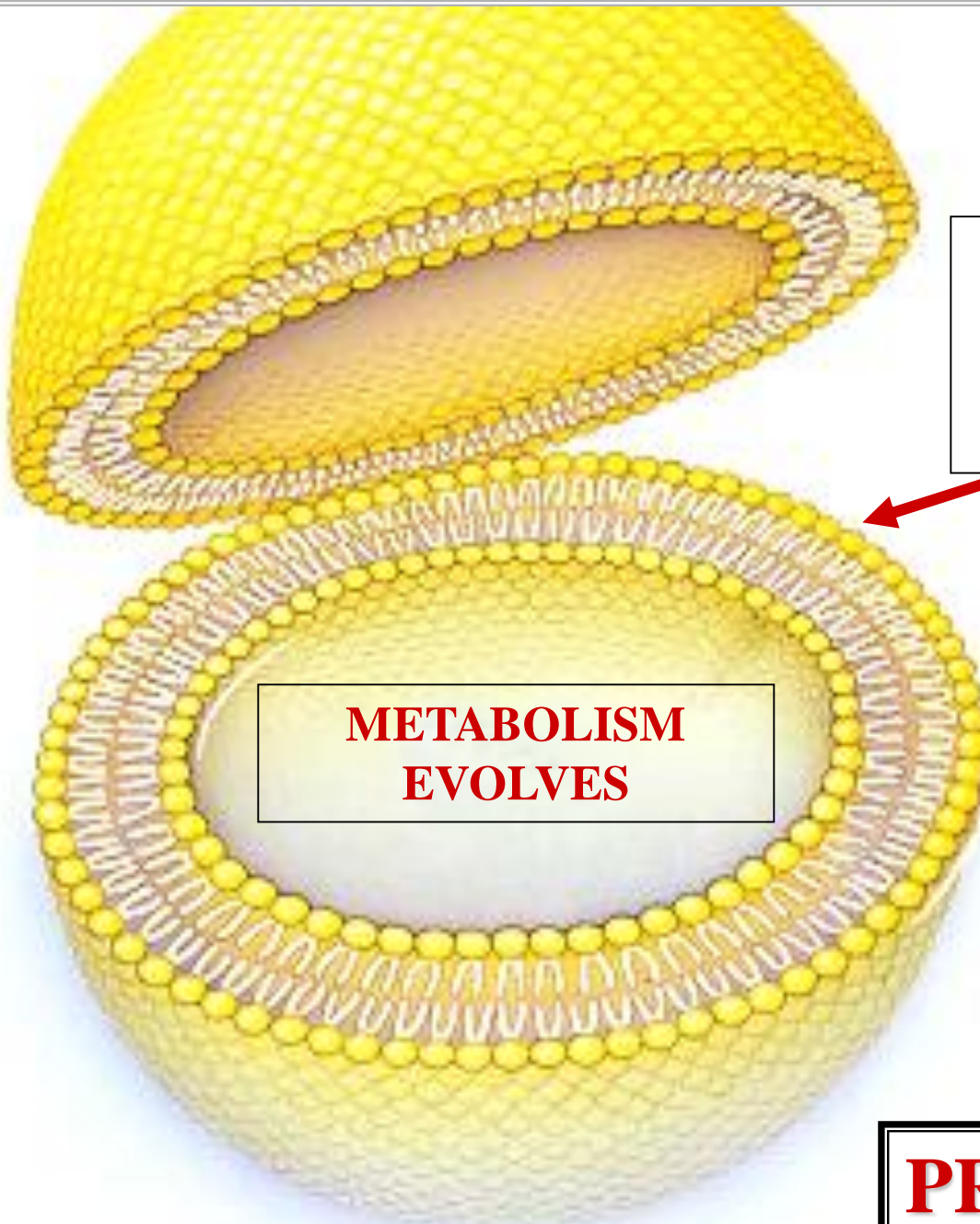
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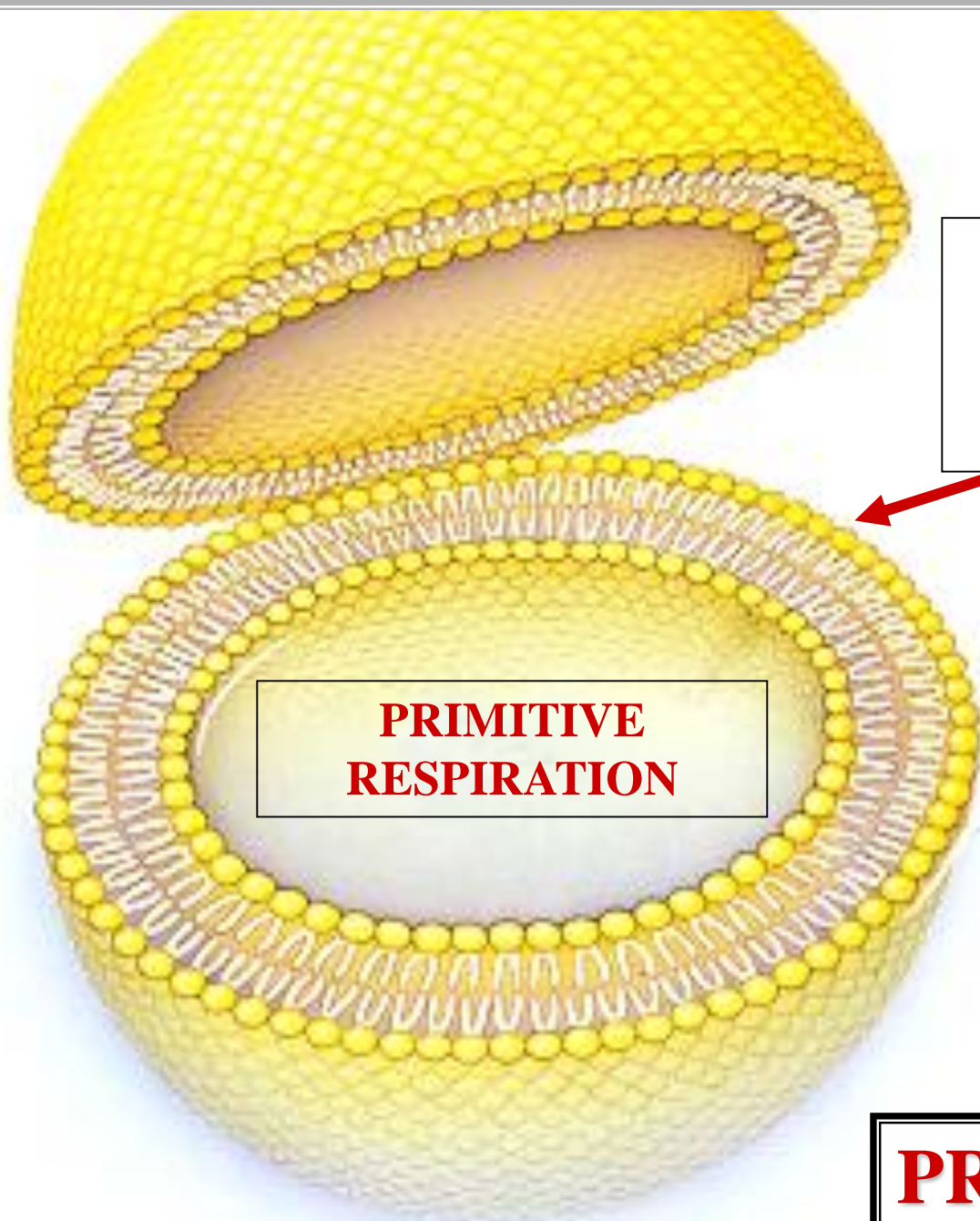
**PRIMITIVE
MEMBRANE
REGULATES
PASSAGE**

**METABOLISM
EVOLVES**



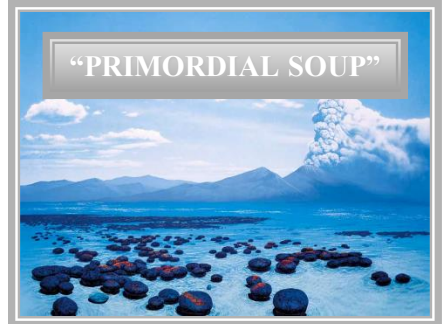
PROTOBIONT





**PRIMITIVE
MEMBRANE
REGULATES
PASSAGE**

**PRIMITIVE
RESPIRATION**



PROTOBIONT

RESPIRATION

GLUCOSE

RESPIRATION

HEXOKINASE

F

ATP

EGY

ADP

GLUCOSE-6-PHOSPHATE

PHOSPHOGLUCOISOMERASE

FRUCTOSE-6-PHOSPHATE

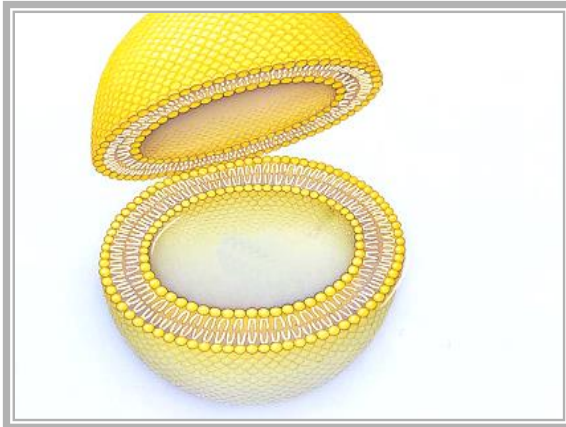
PHOSPHOFRUCTOKINASE

ATP

EGY

ADP

FRUCTOSE-1-6-PHOSPHATE



3-PHOSPHOGLYCERATE - PGA

ENOLASE

3-PHOSPHOENOLPYRUVATE

PYRUVATE KINASE



3-PHOSPHOGLYCERATE - PGA

ENOLASE

3-PHOSPHOENOLPYRUVATE

PYRUVATE KINASE

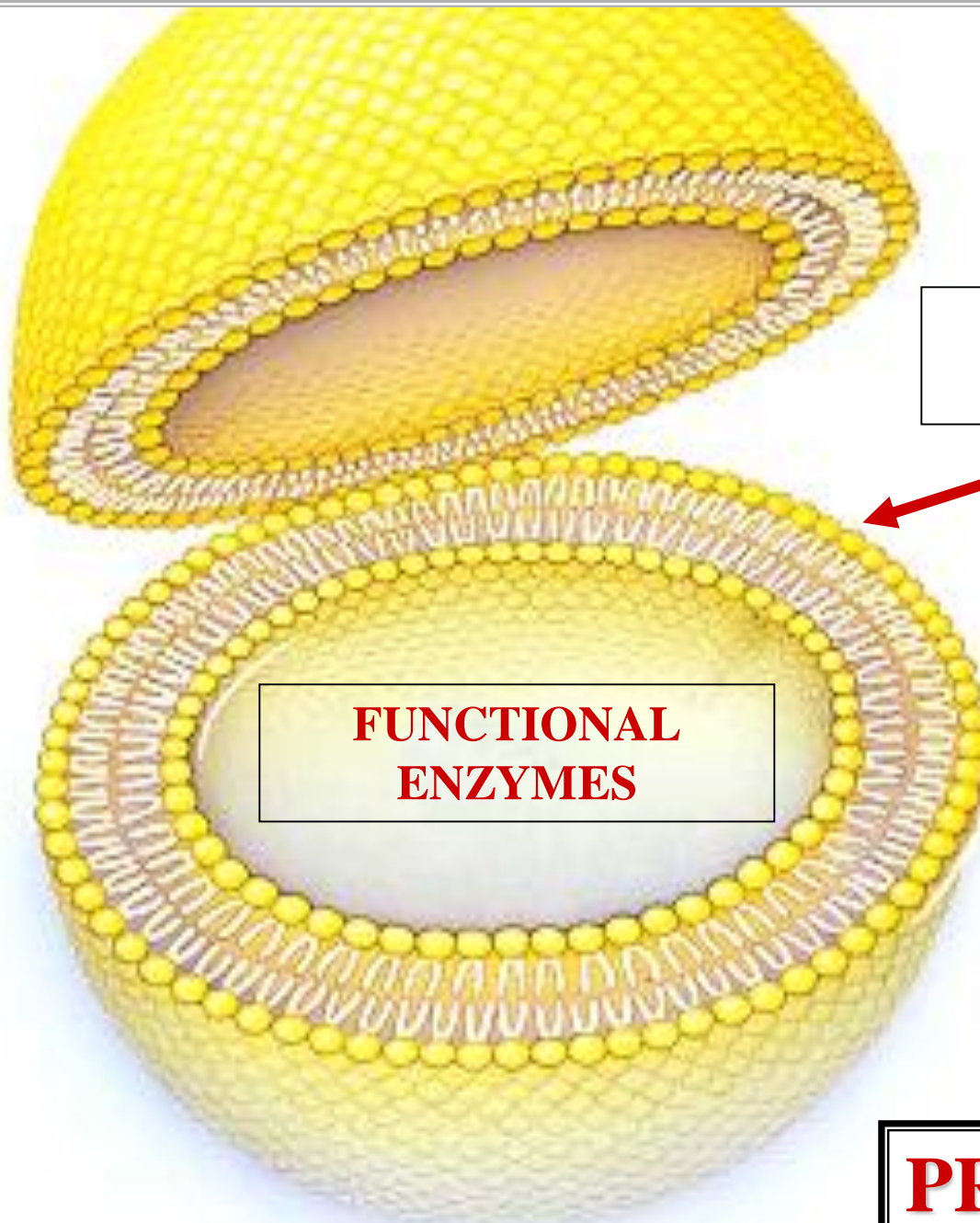


+



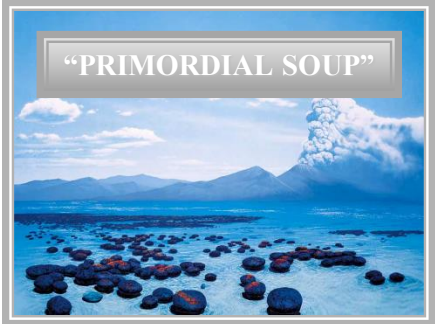
ATP = BIOLOGICAL ENERGY MOLECULE

FUNCTIONAL ENZYMES



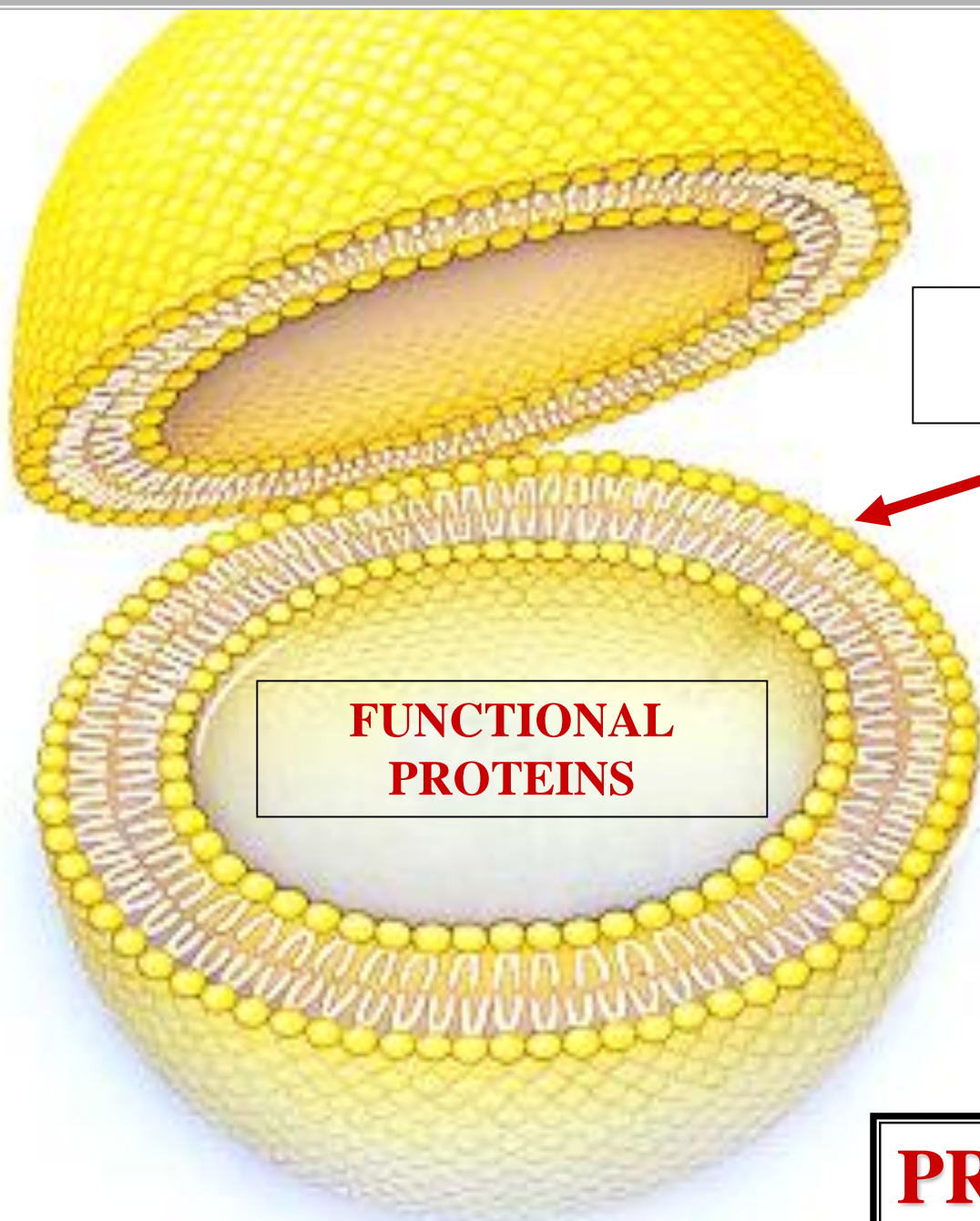
**PRIMITIVE
MEMBRANE**

**FUNCTIONAL
ENZYMES**



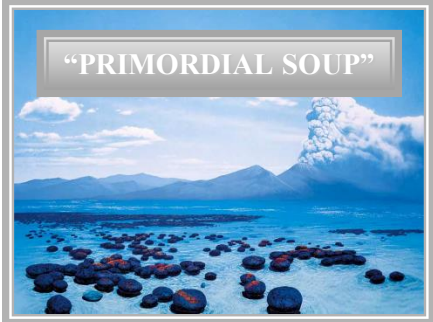
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PS

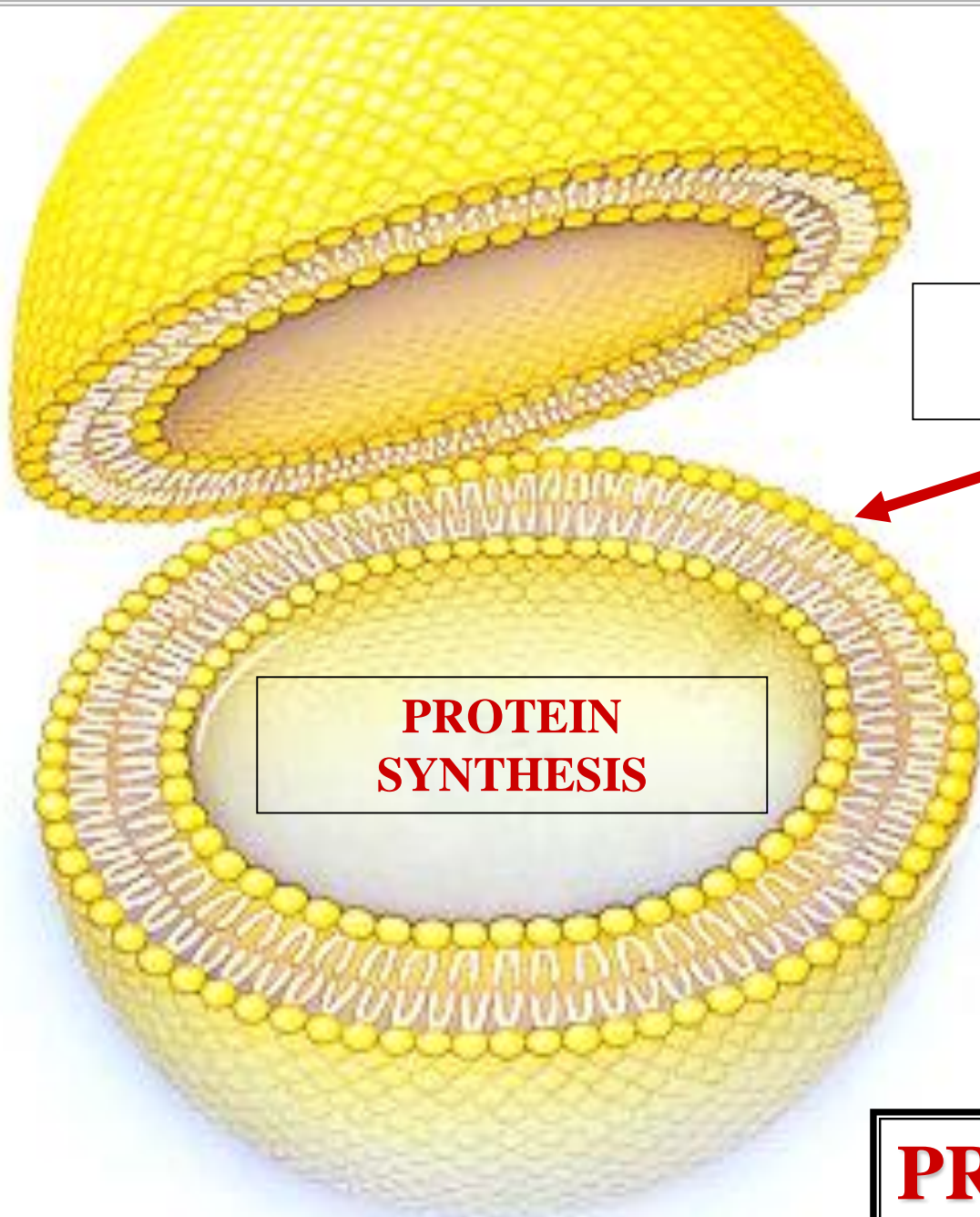
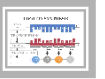


**PRIMITIVE
MEMBRANE**

**FUNCTIONAL
PROTEINS**

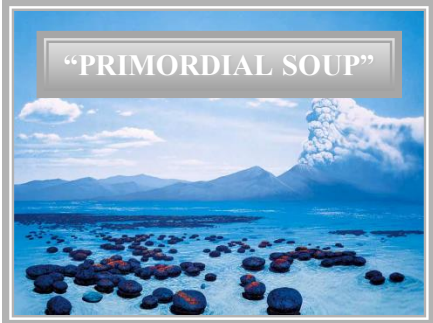


PROTOBIONT



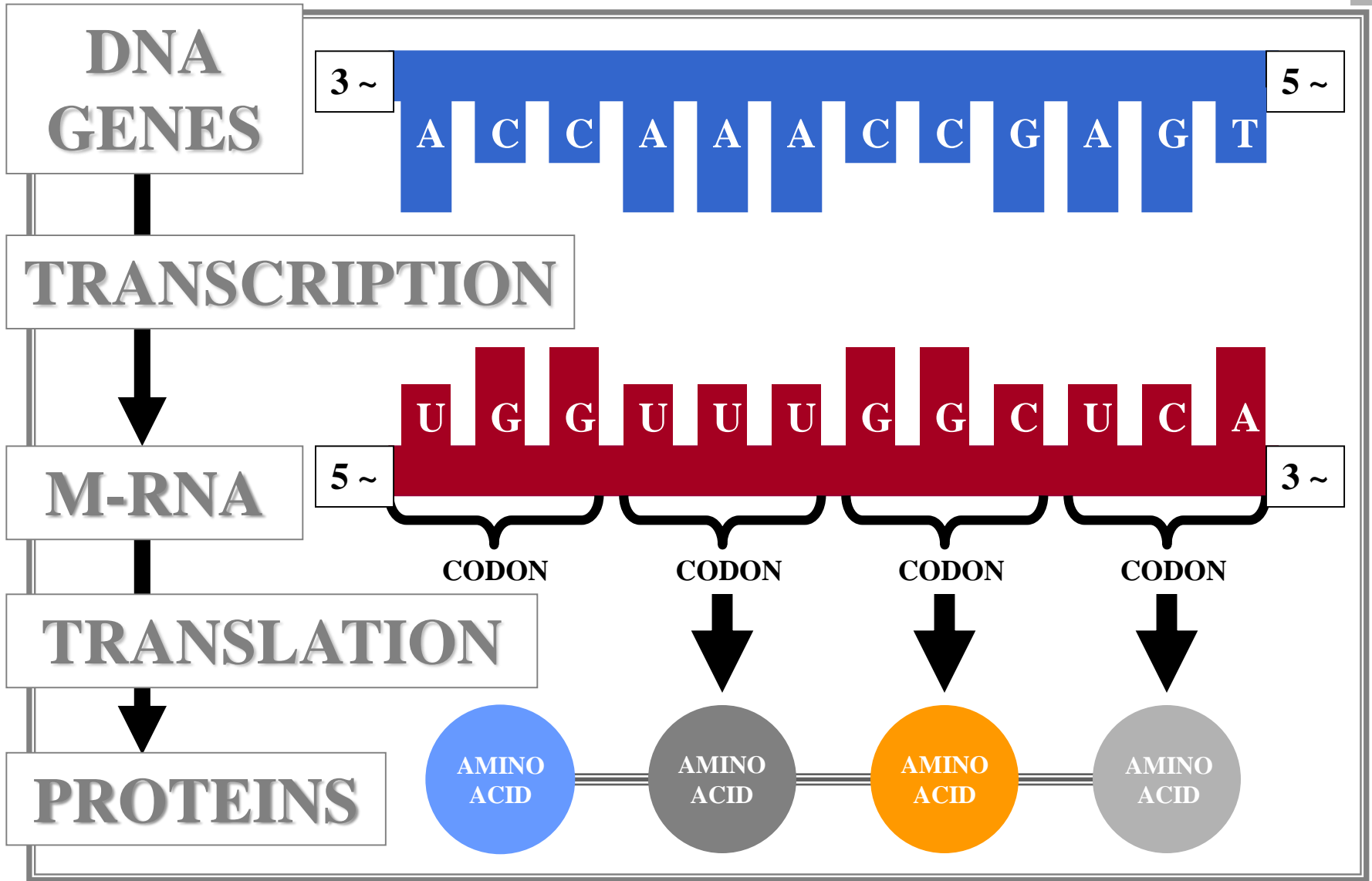
**PRIMITIVE
MEMBRANE**

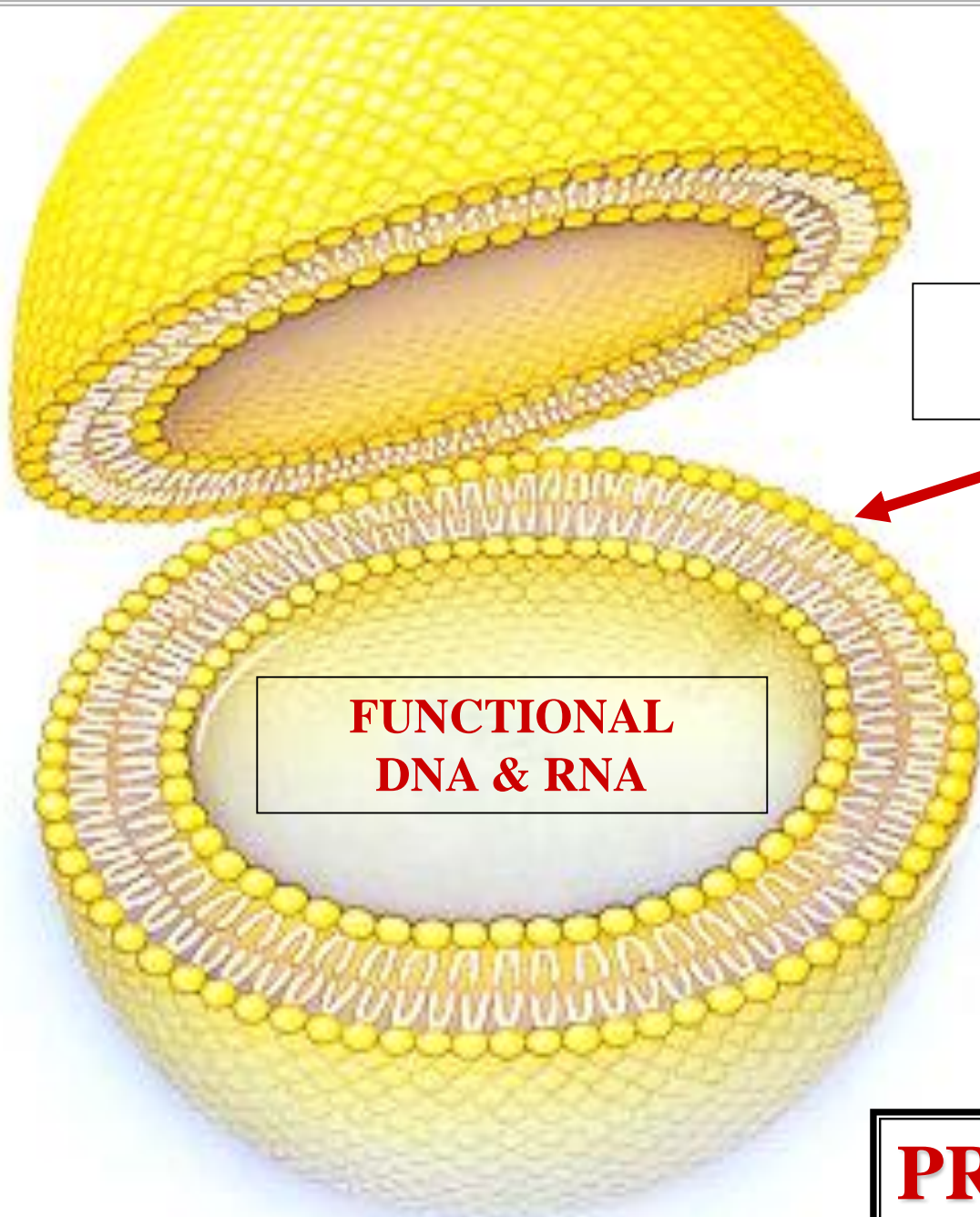
**PROTEIN
SYNTHESIS**



PROTOBIONT

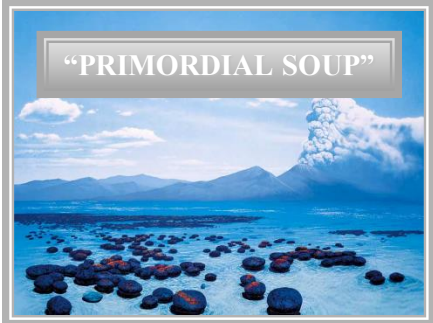
PROTEIN SYNTHESIS





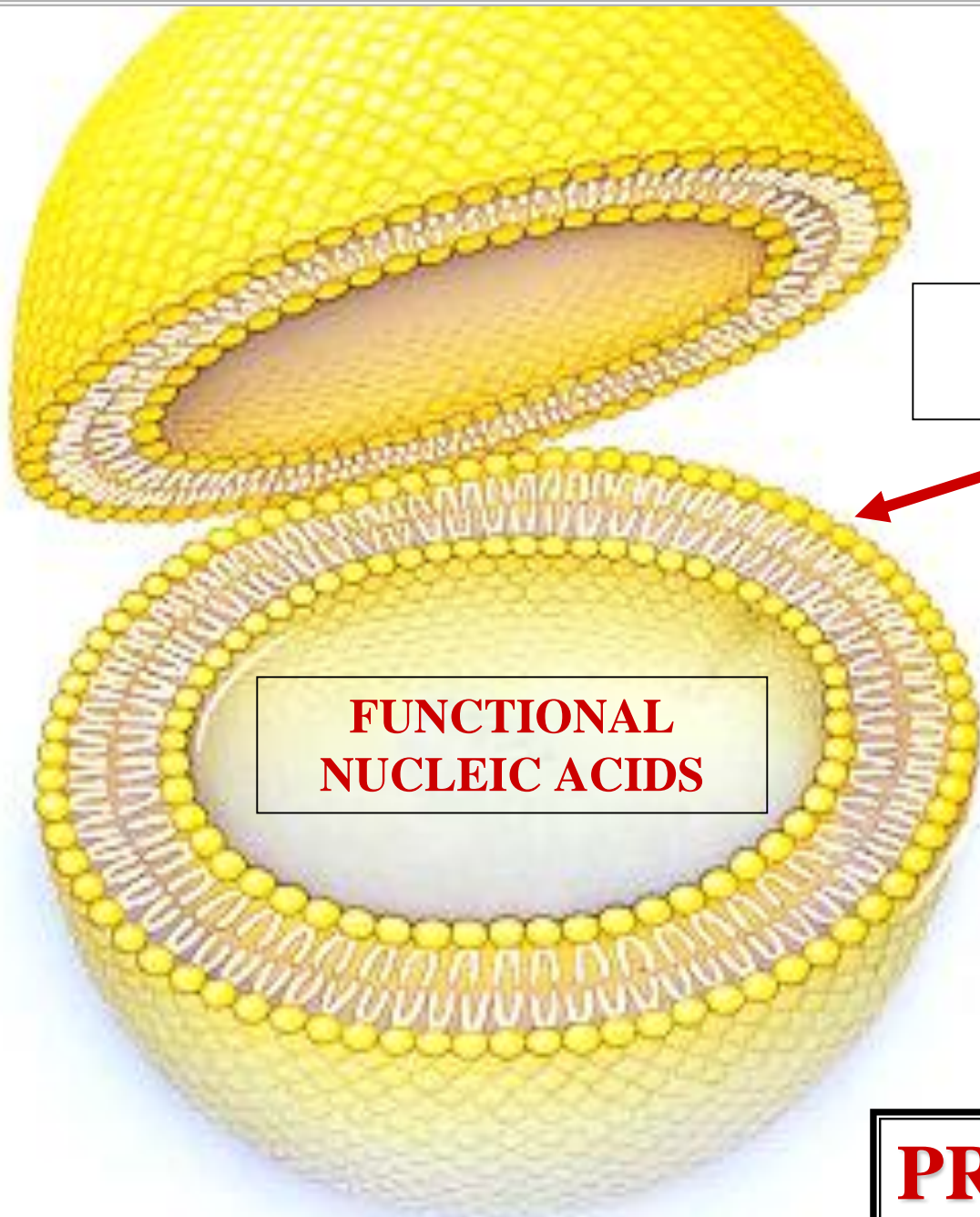
**PRIMITIVE
MEMBRANE**

**FUNCTIONAL
DNA & RNA**



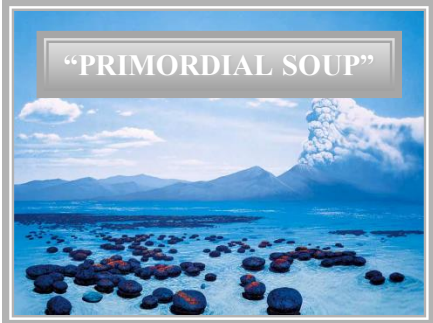
PROTOBIONT

LO



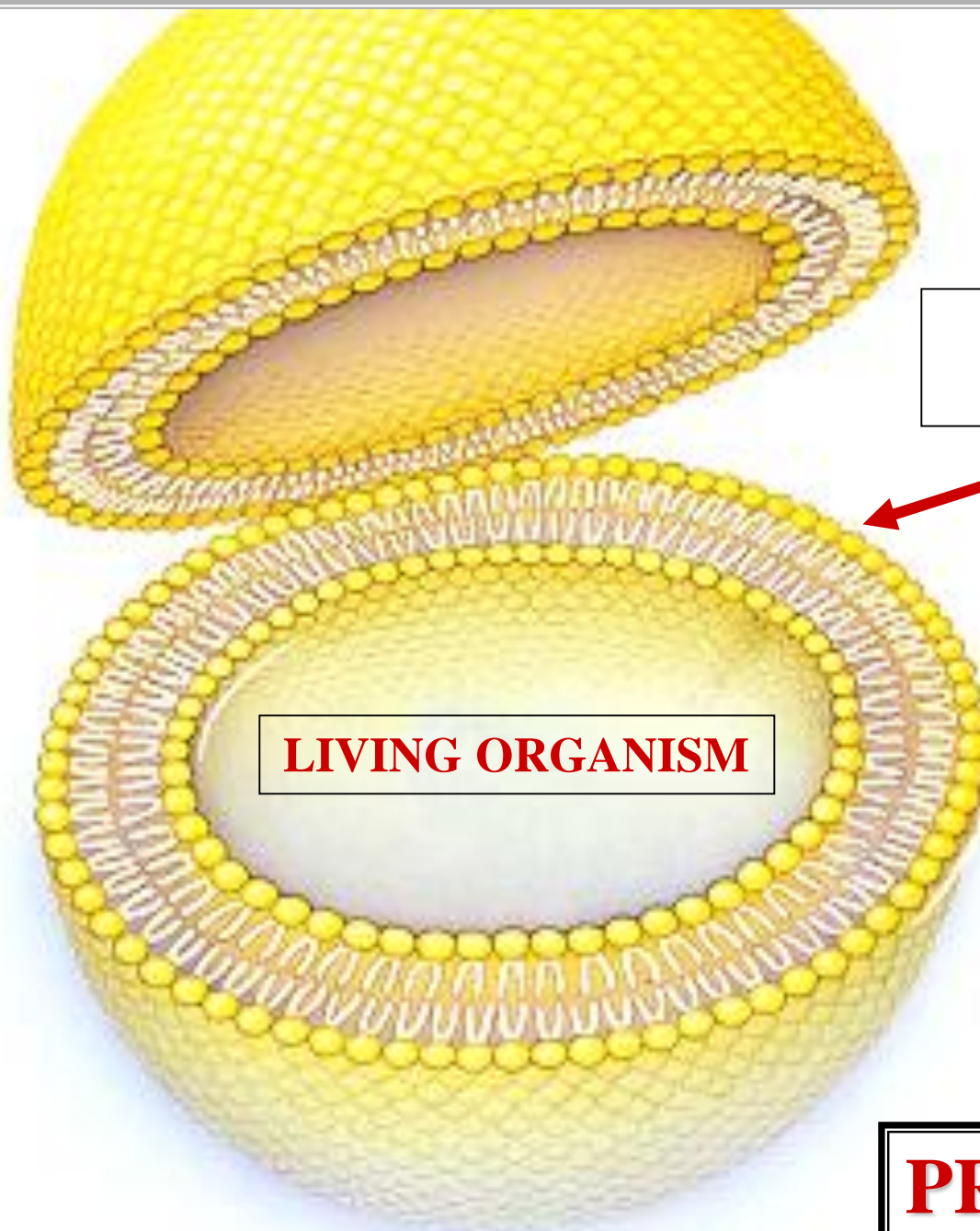
**PRIMITIVE
MEMBRANE**

**FUNCTIONAL
NUCLEIC ACIDS**



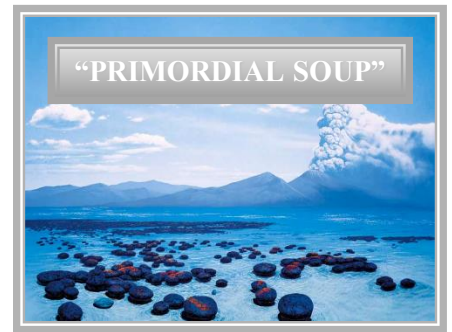
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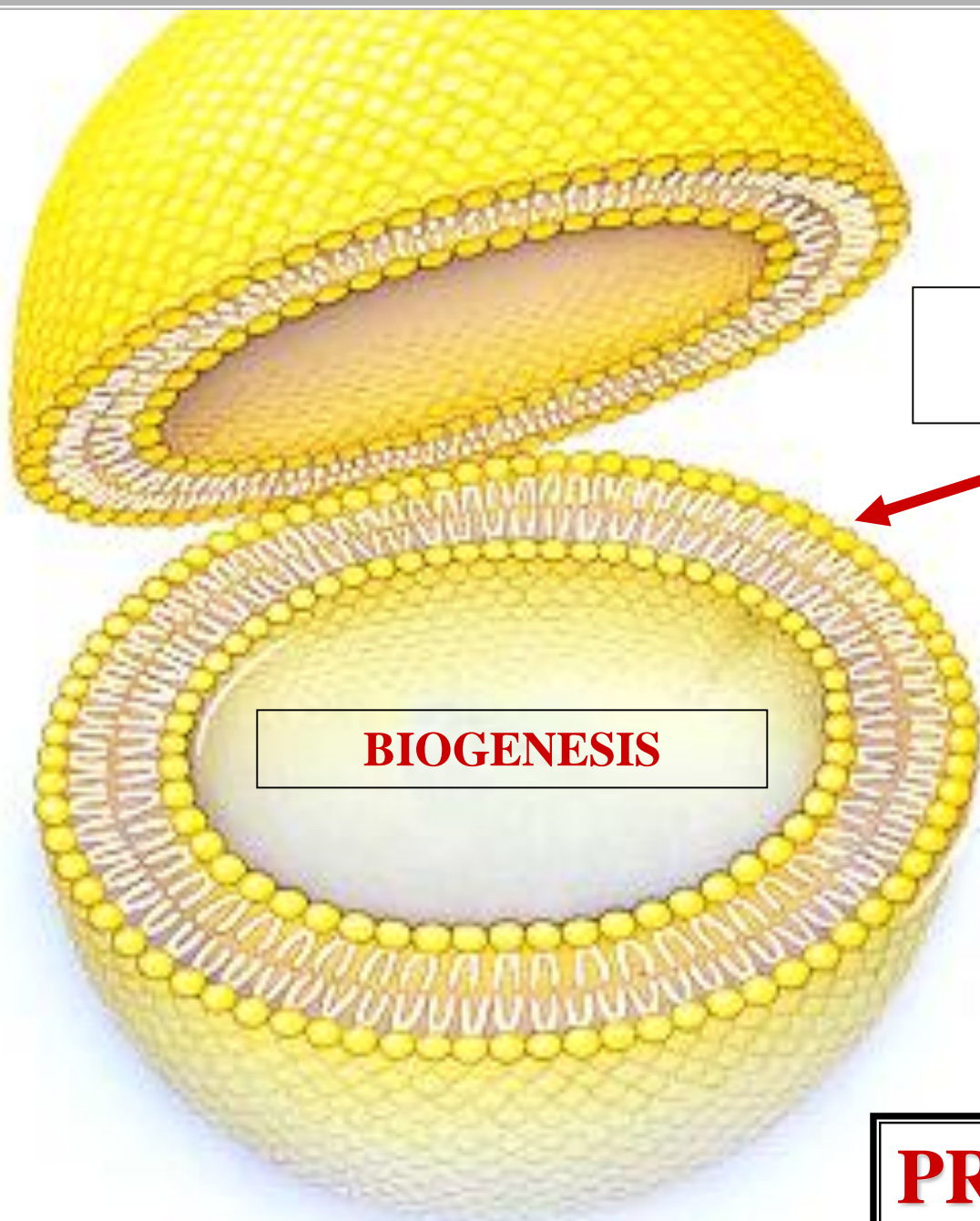


**PRIMITIVE
MEMBRANE**

LIVING ORGANISM

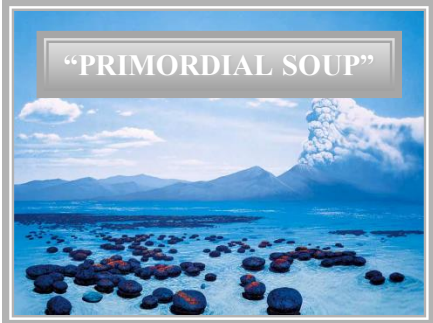


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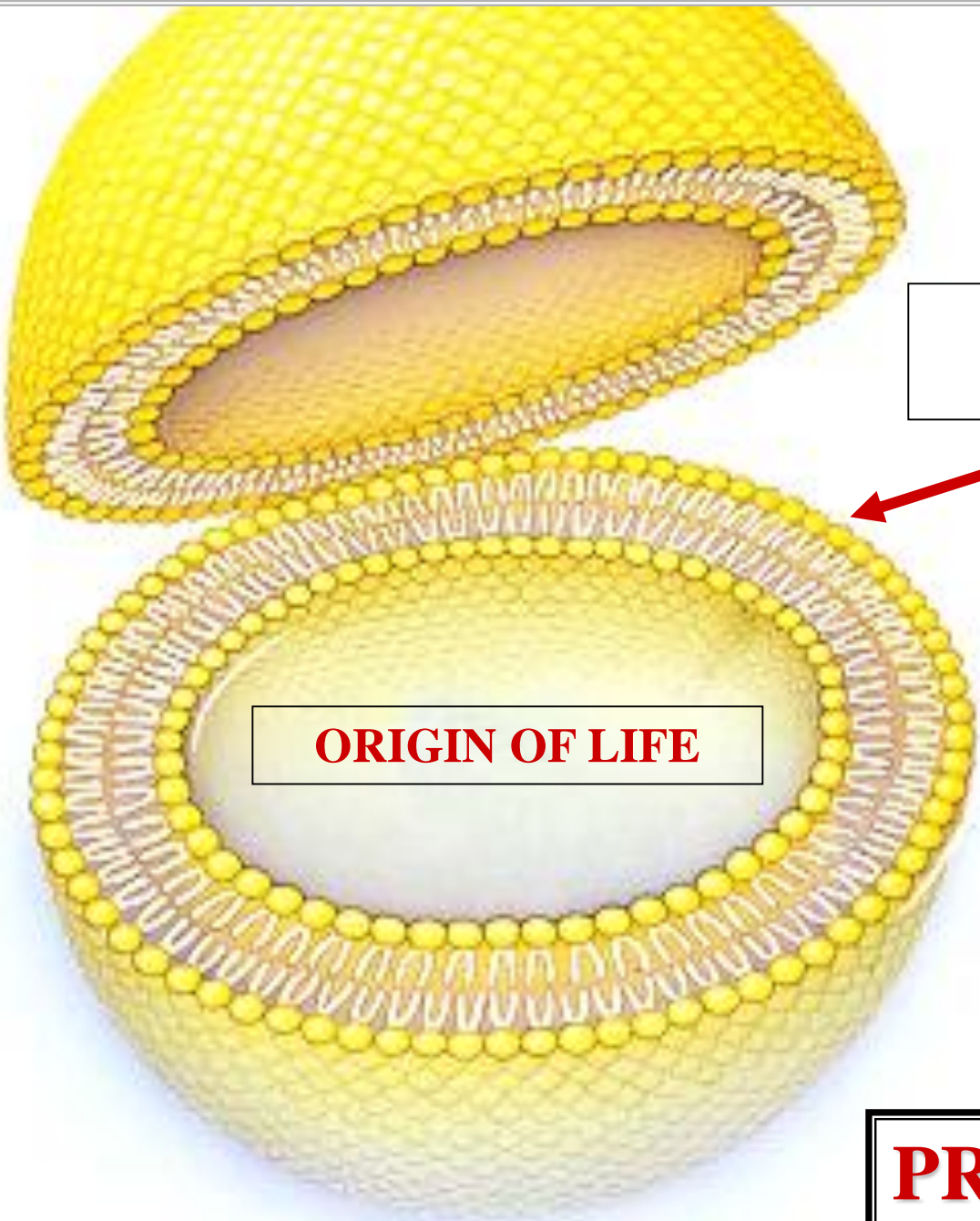


**PRIMITIVE
MEMBRANE**

BIOGENESIS

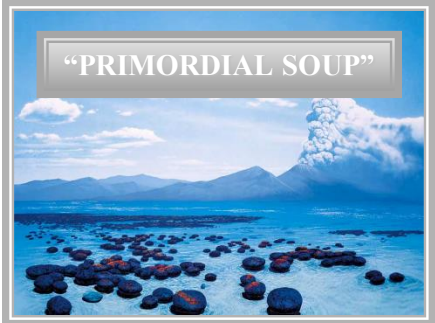


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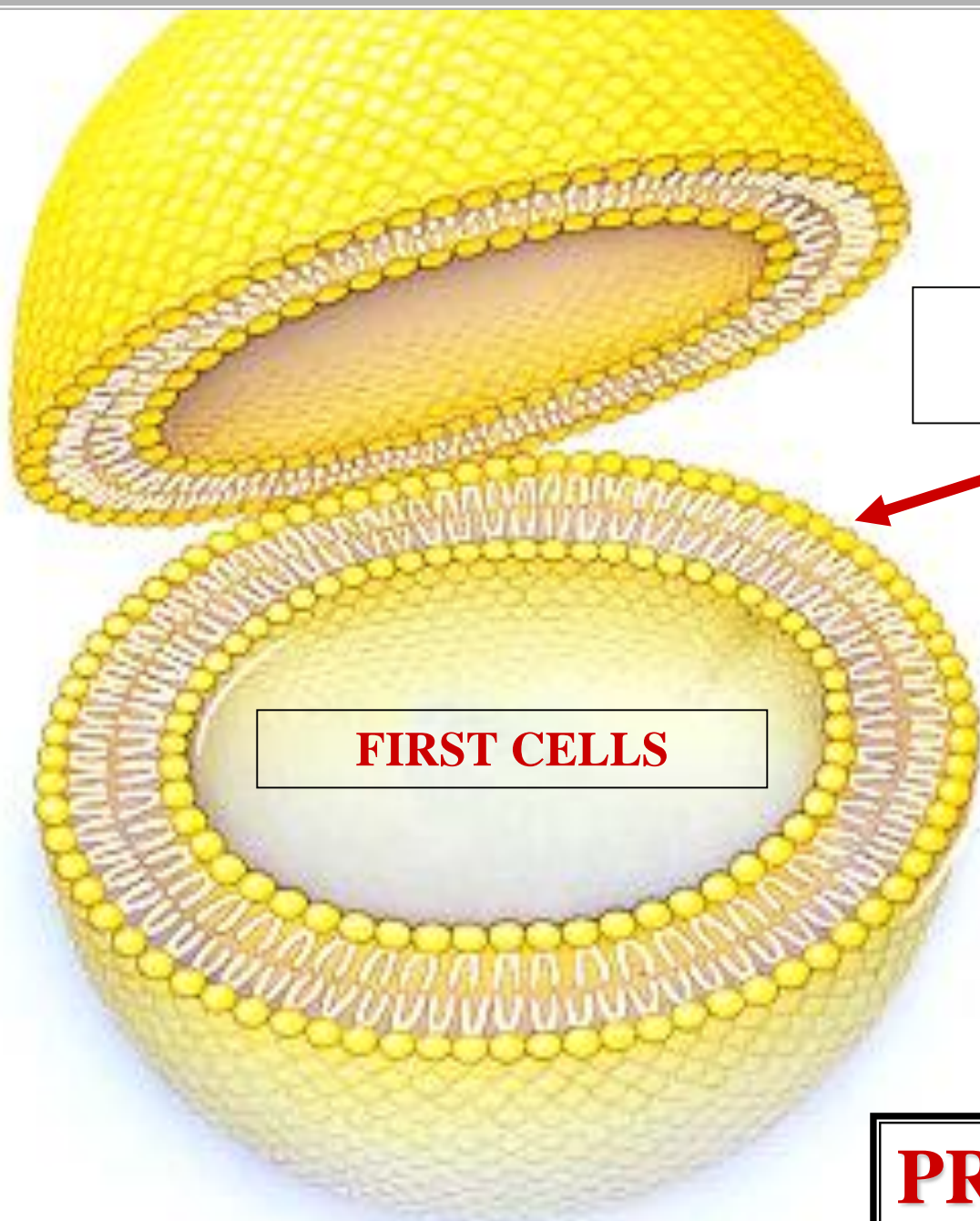
**PRIMITIVE
MEMBRANE**

ORIGIN OF LIFE



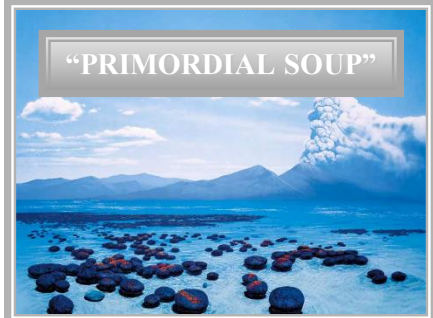
PROTOBIONT

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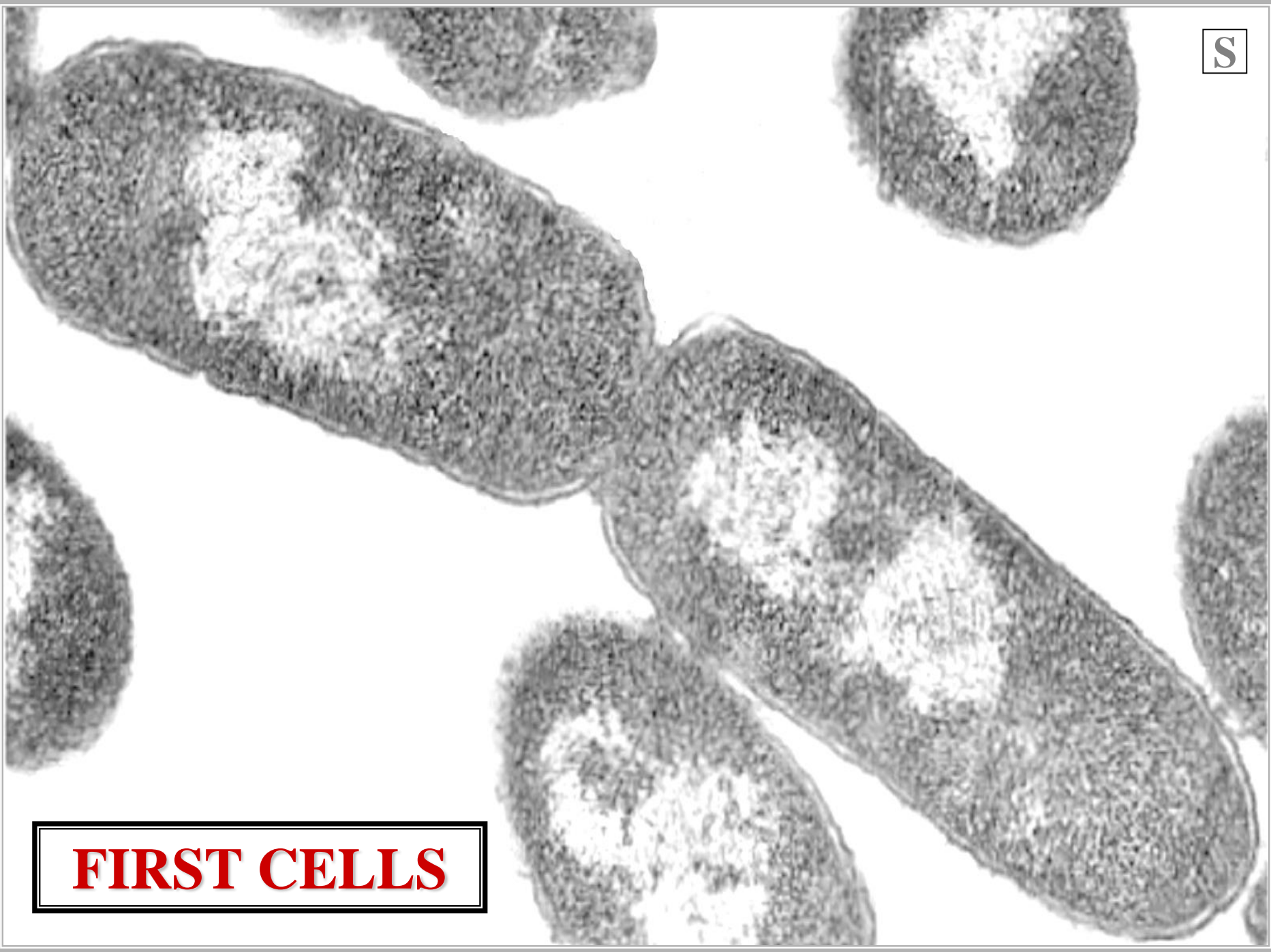
**PRIMITIVE
MEMBRANE**

FIRST CELLS



PROTOBIONT

S



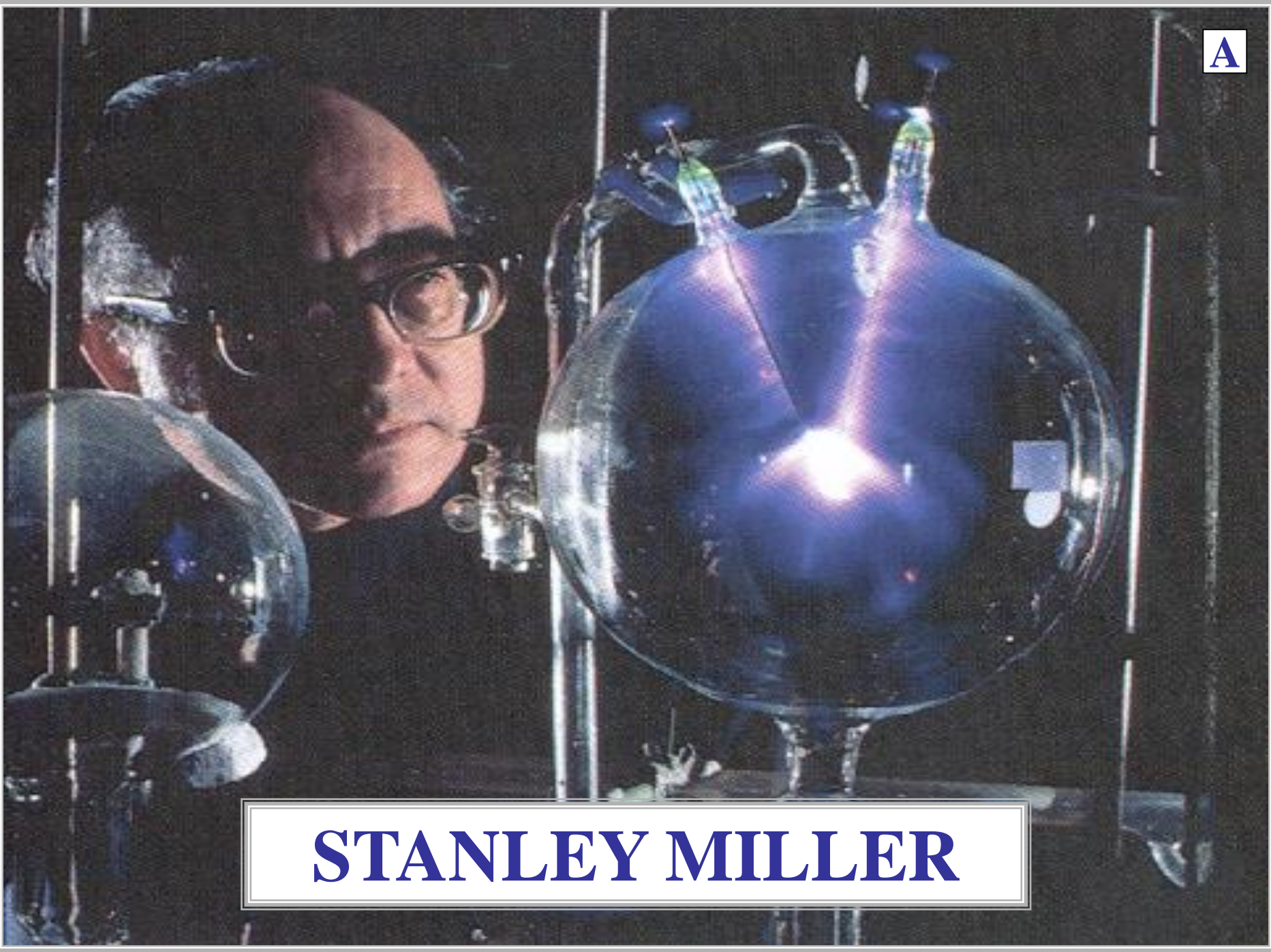
FIRST CELLS



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

A photograph of Stanley Miller in his laboratory. He is wearing glasses and looking towards a large glass apparatus. The apparatus consists of a large round-bottom flask containing a liquid, with two vertical glass tubes extending upwards. The tubes are connected to a network of smaller glass tubes and valves. The entire setup is supported by a metal frame. The lighting is dramatic, with a strong light source from the right, creating a bright glow within the flask and casting shadows on Miller's face.

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 on the scientist and his work.

DERIVE ORGANIC CMPS

STANLEY MILLER



AMINO ACIDS - NUCLEOTIDES

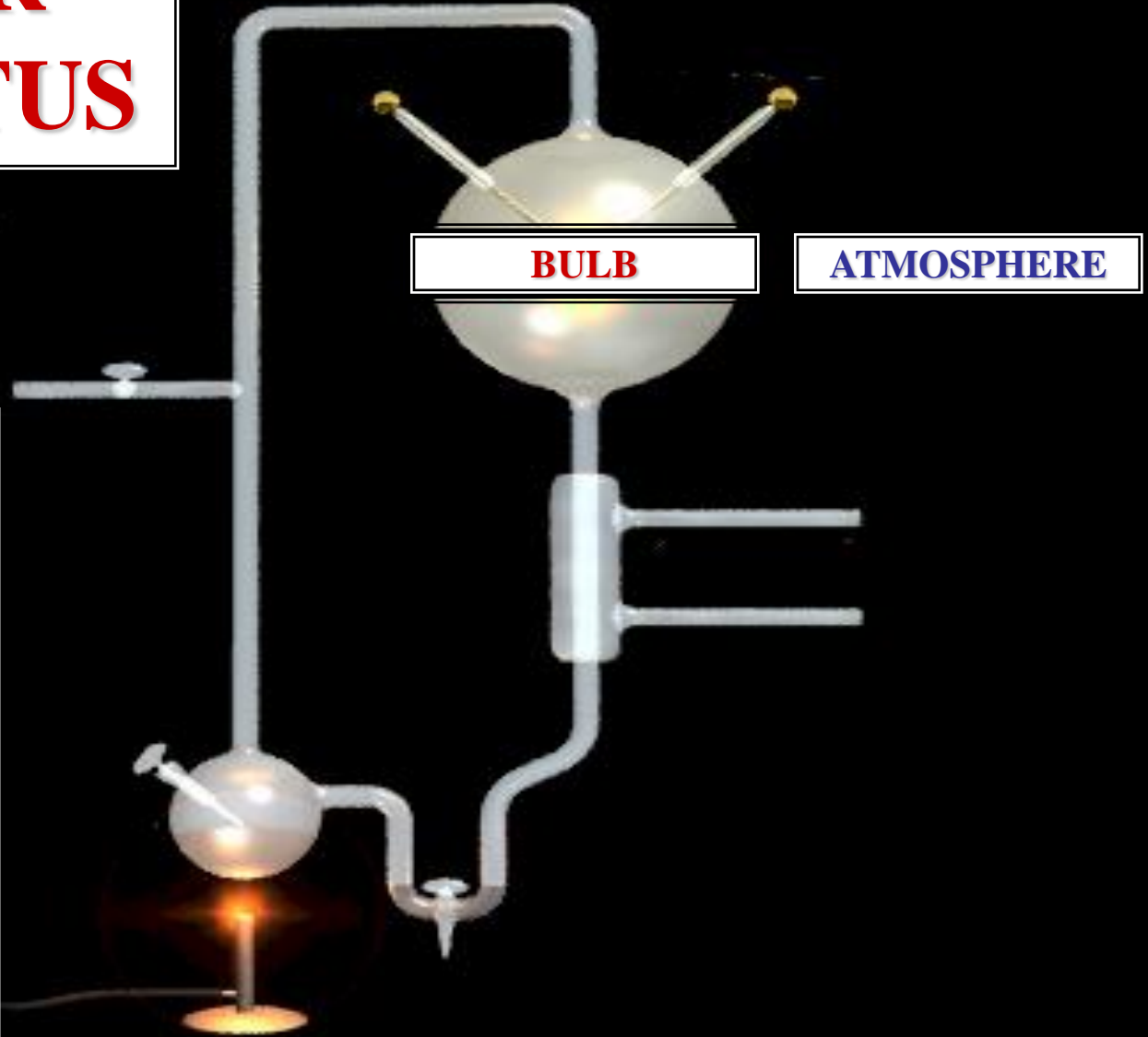
STANLEY MILLER

MILLER APPARATUS



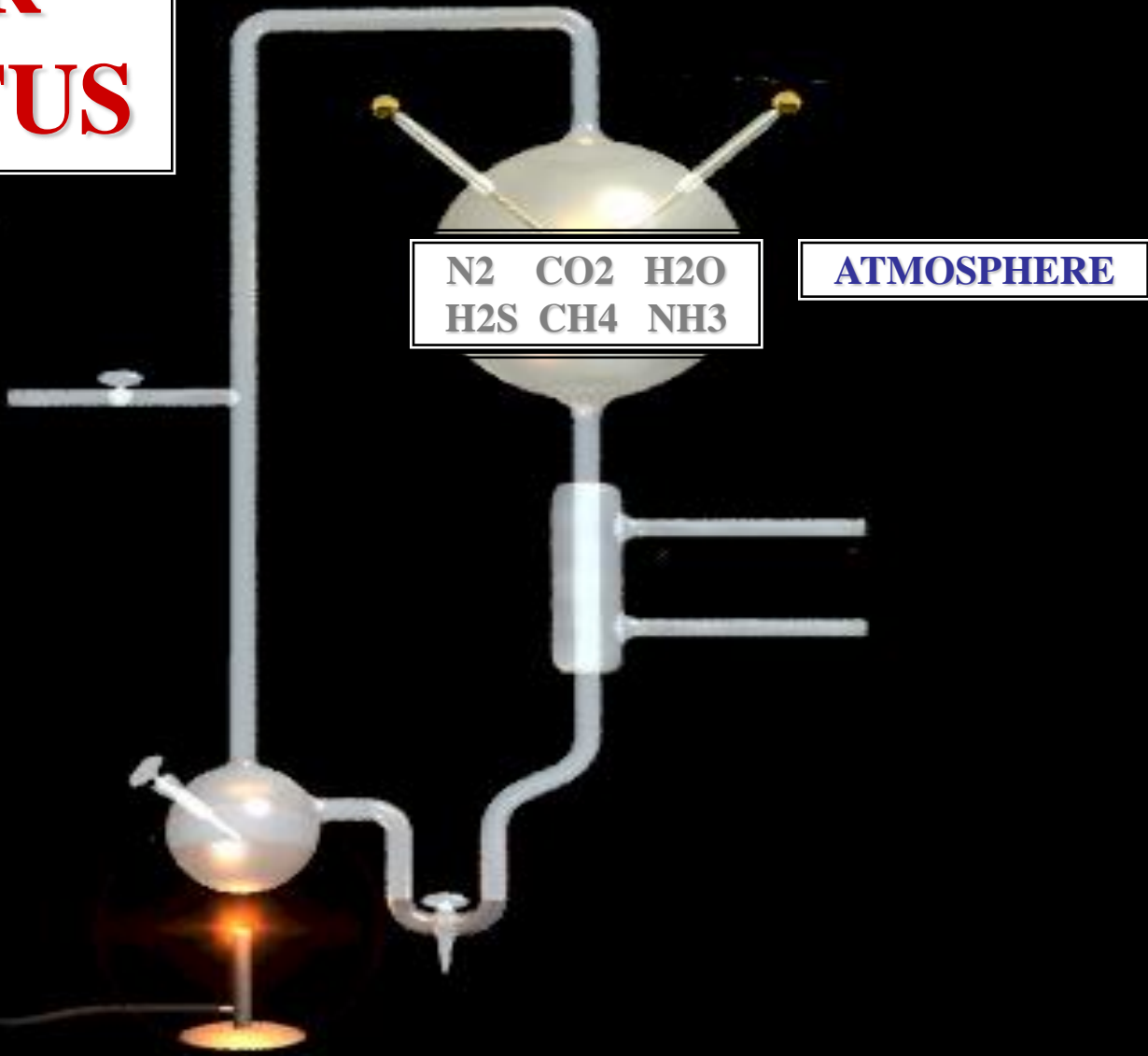
STANLEY MILLER

MILLER APPARATUS



STANLEY MILLER

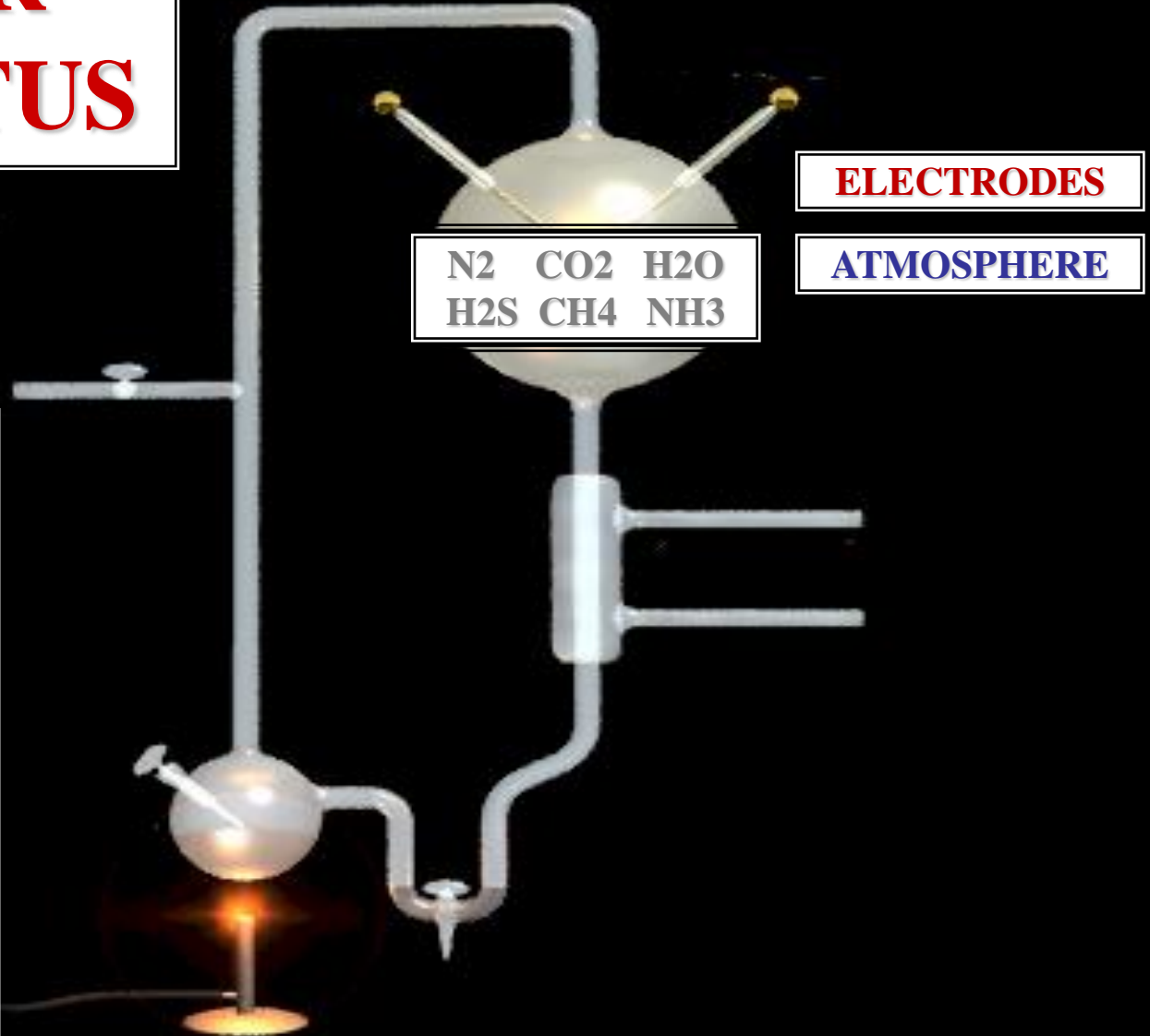
MILLER APPARATUS



STANLEY MILLER



MILLER APPARATUS



ELECTRODES

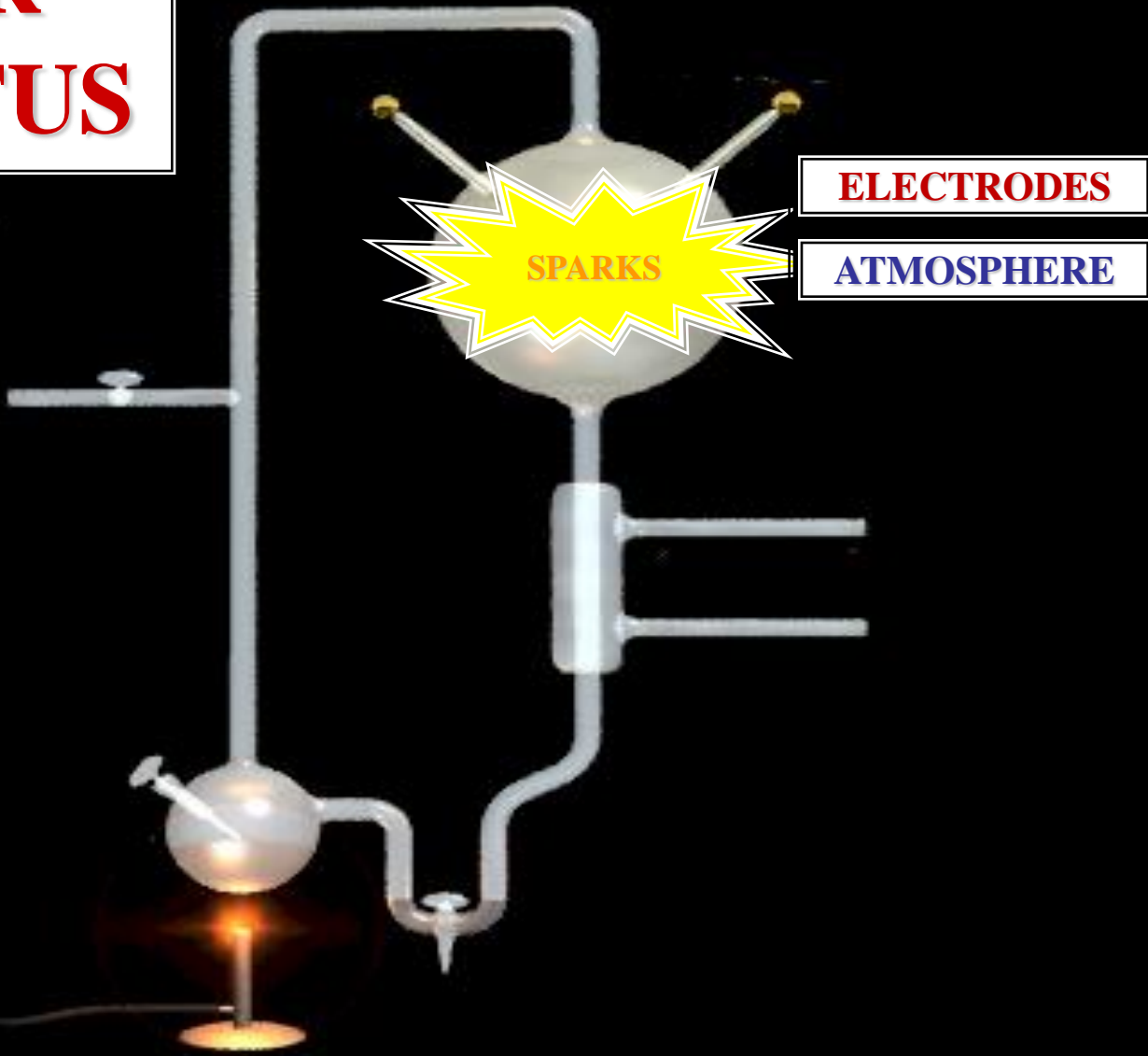
ATMOSPHERE

N₂ CO₂ H₂O
H₂S CH₄ NH₃



STANLEY MILLER

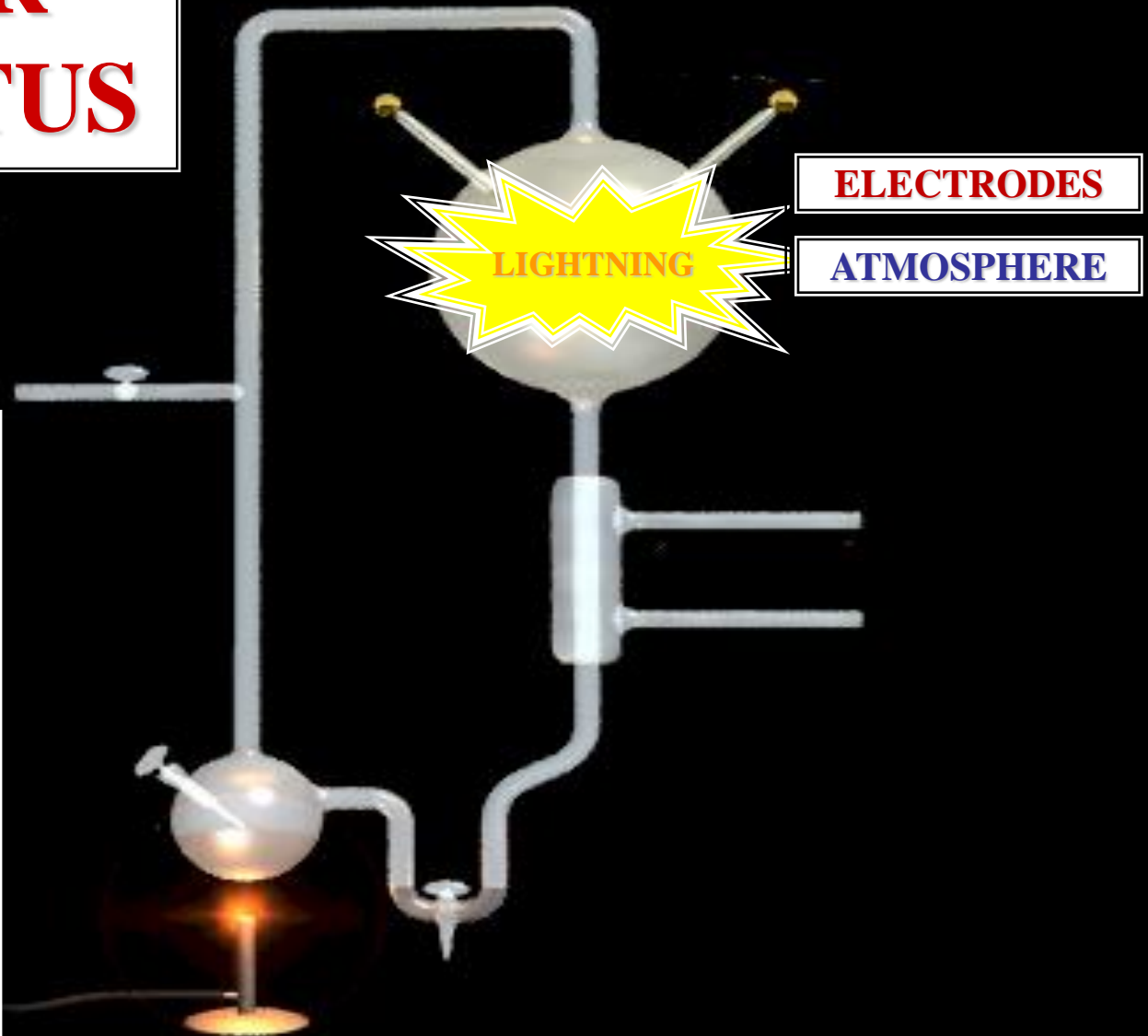
MILLER APPARATUS



STANLEY MILLER

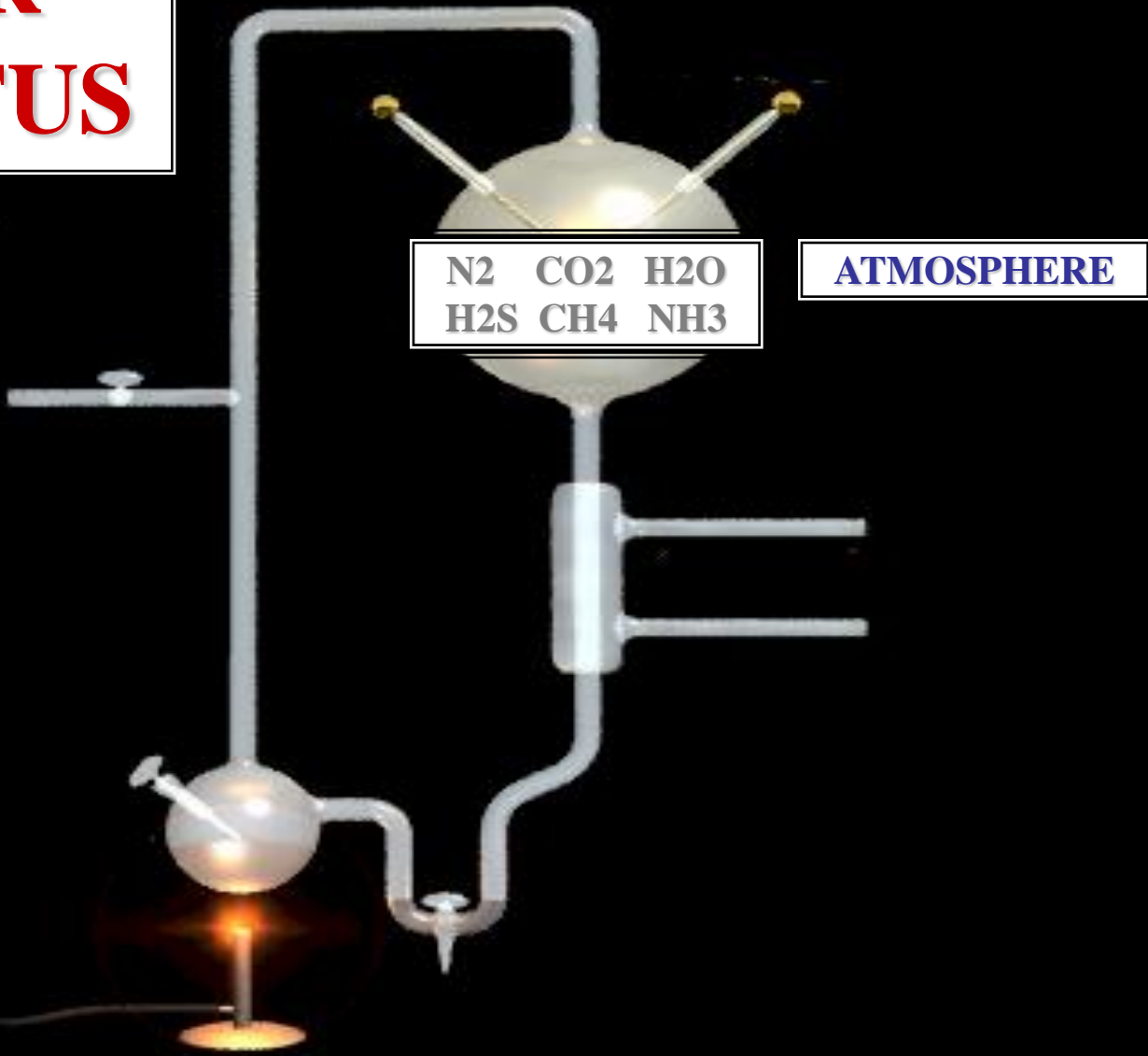
MILLER APPARATUS

N



STANLEY MILLER

MILLER APPARATUS



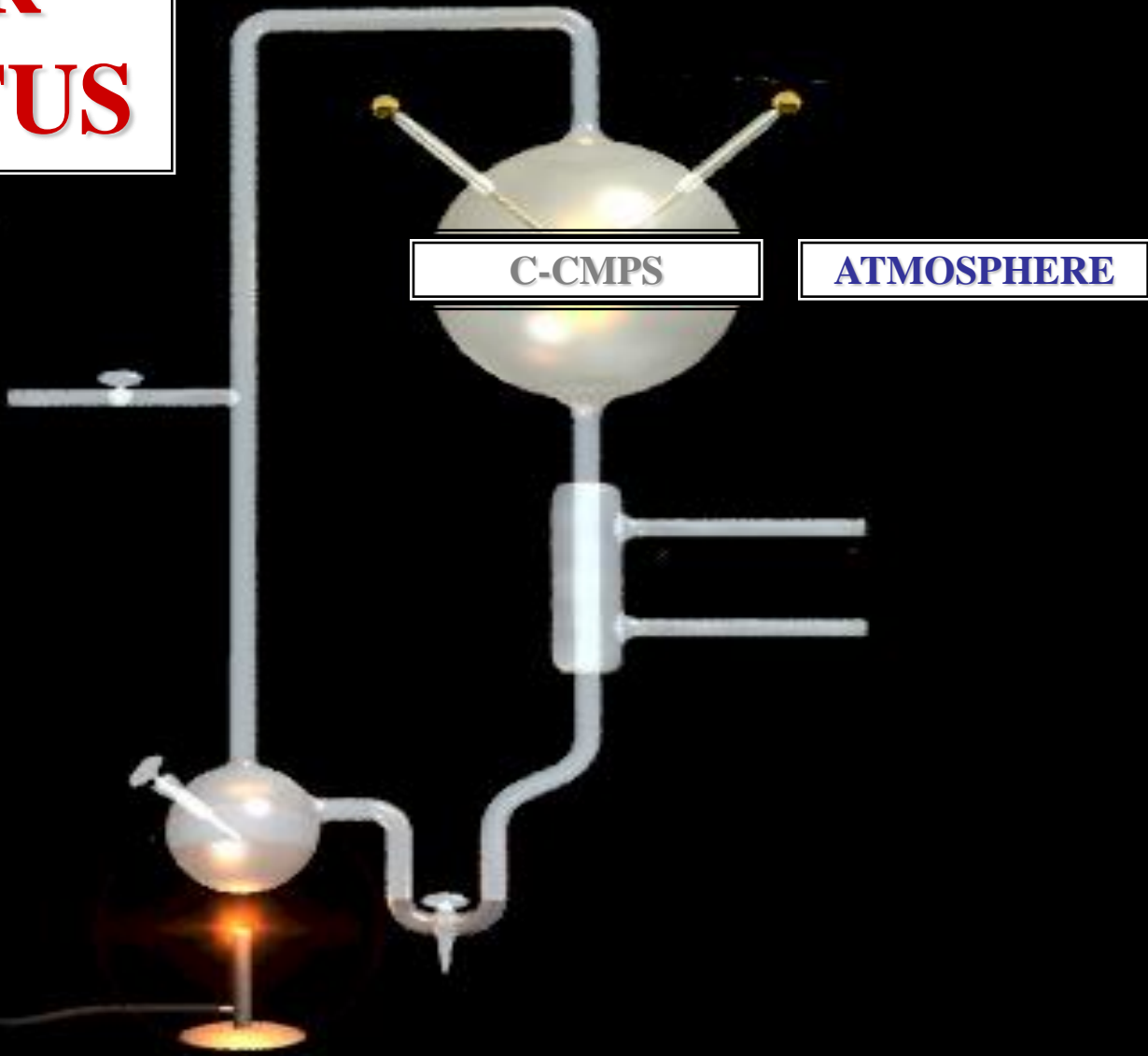
ATMOSPHERE

N_2 CO_2 H_2O
 H_2S CH_4 NH_3



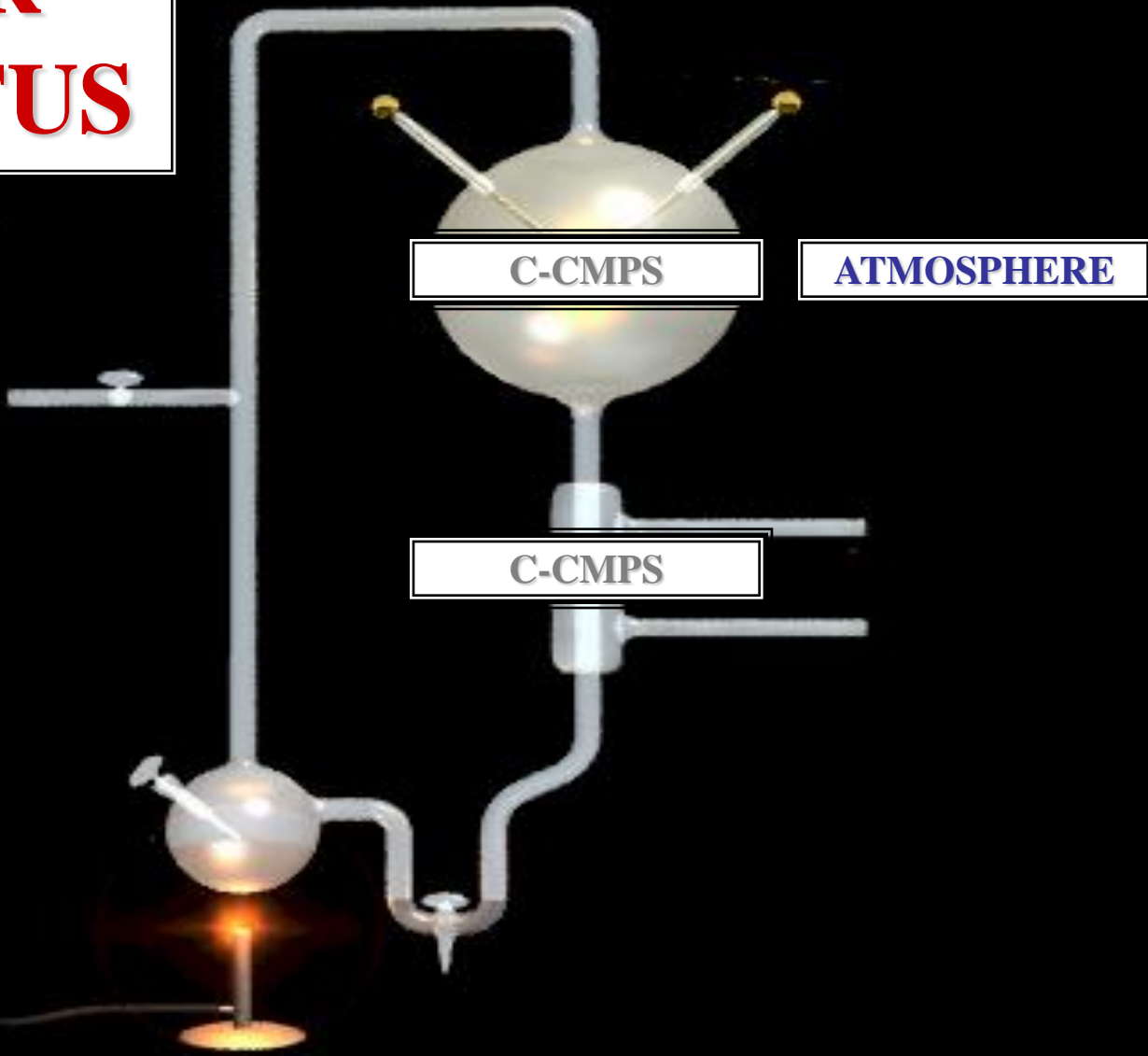
STANLEY MILLER

MILLER APPARATUS



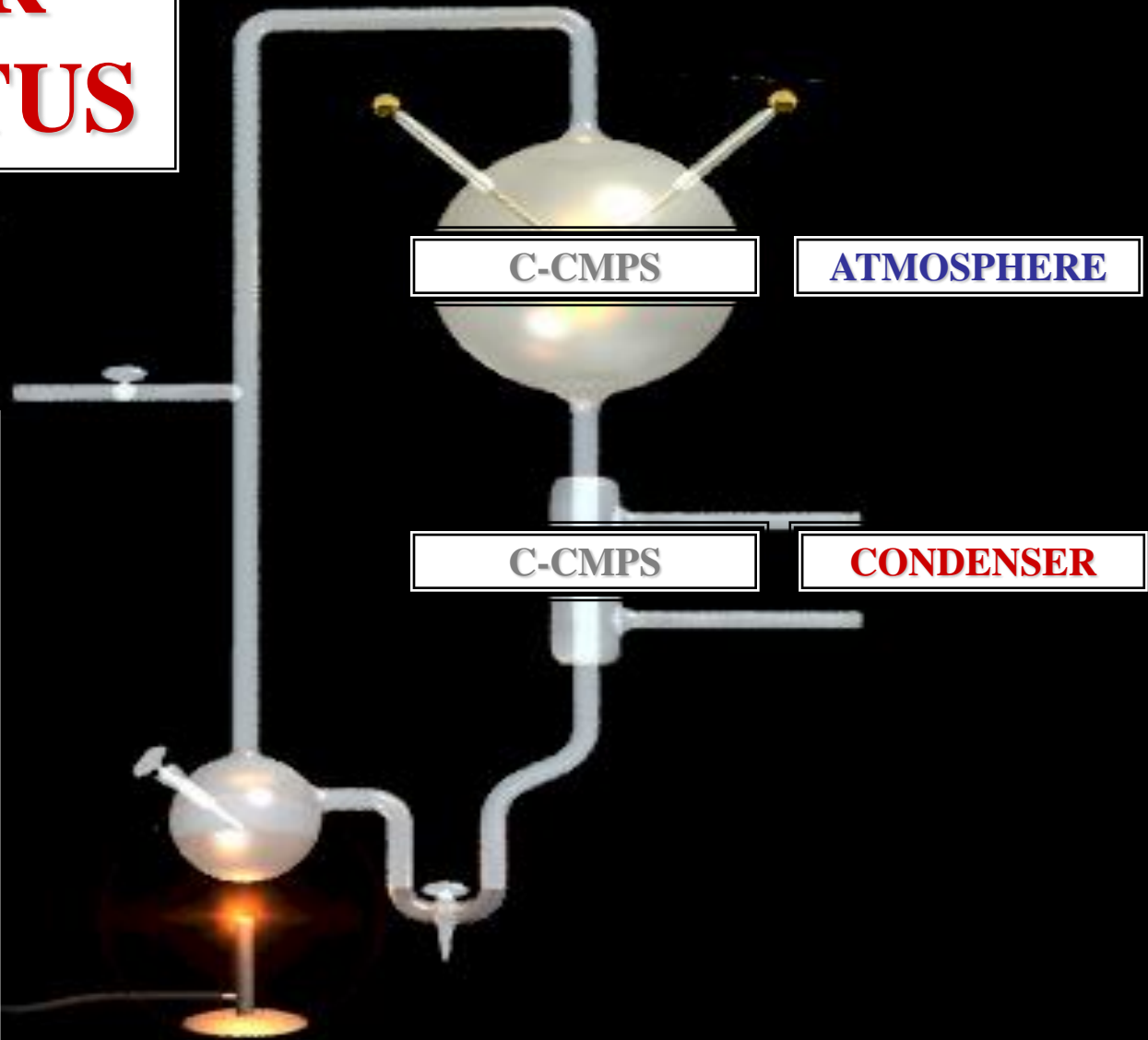
STANLEY MILLER

MILLER APPARATUS



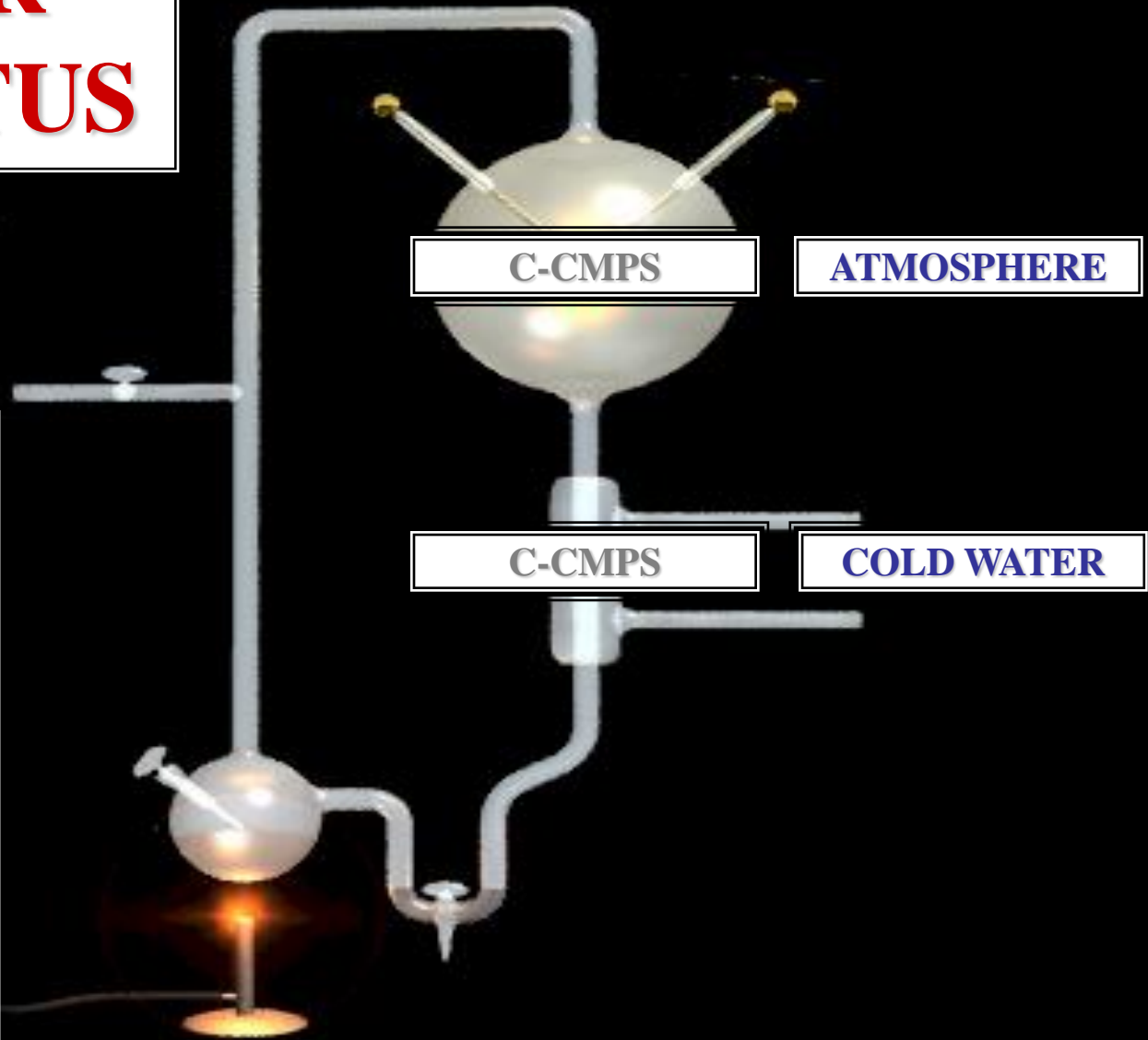
STANLEY MILLER

MILLER APPARATUS



STANLEY MILLER

MILLER APPARATUS

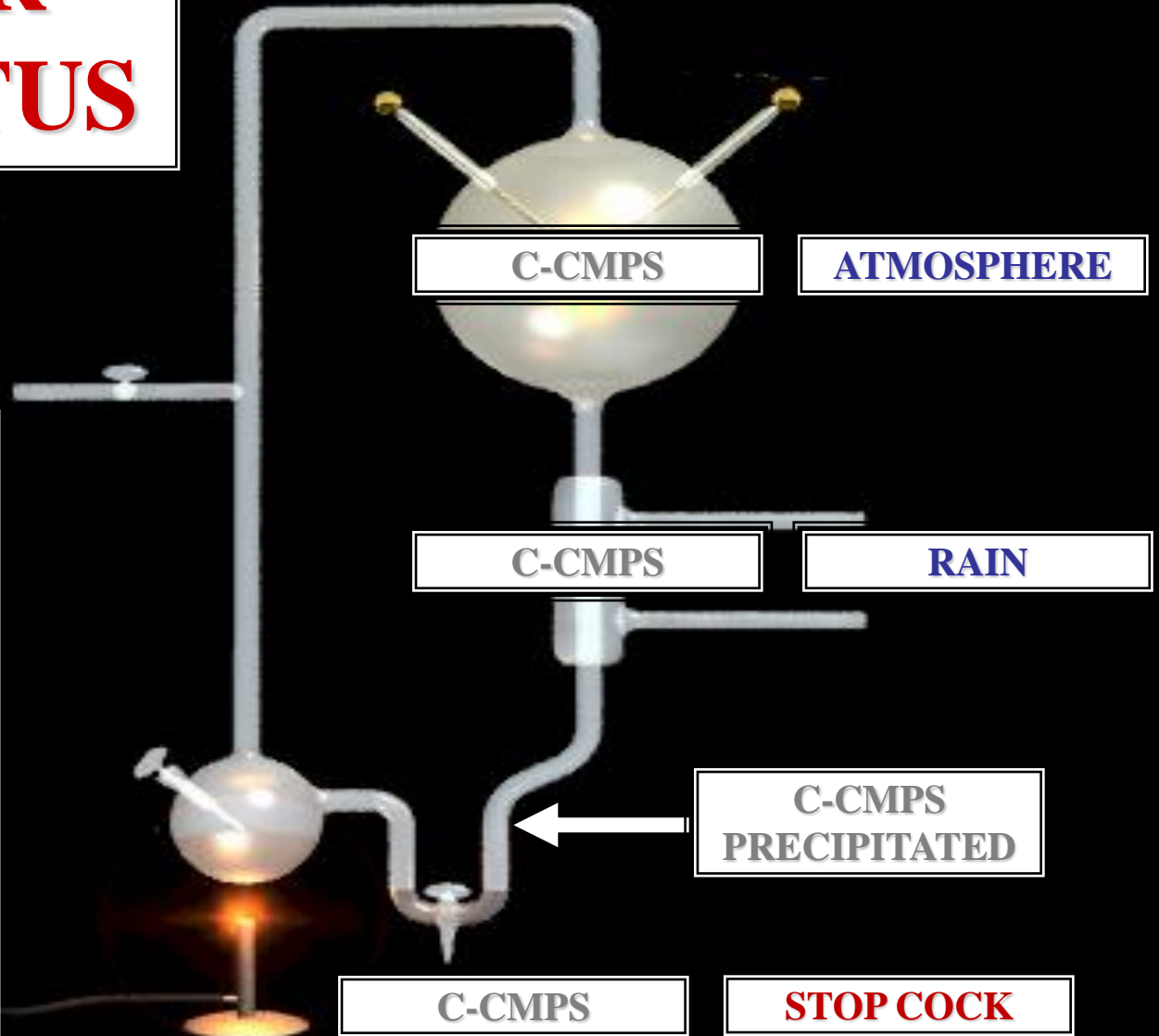


STANLEY MILLER

MILLER APPARATUS

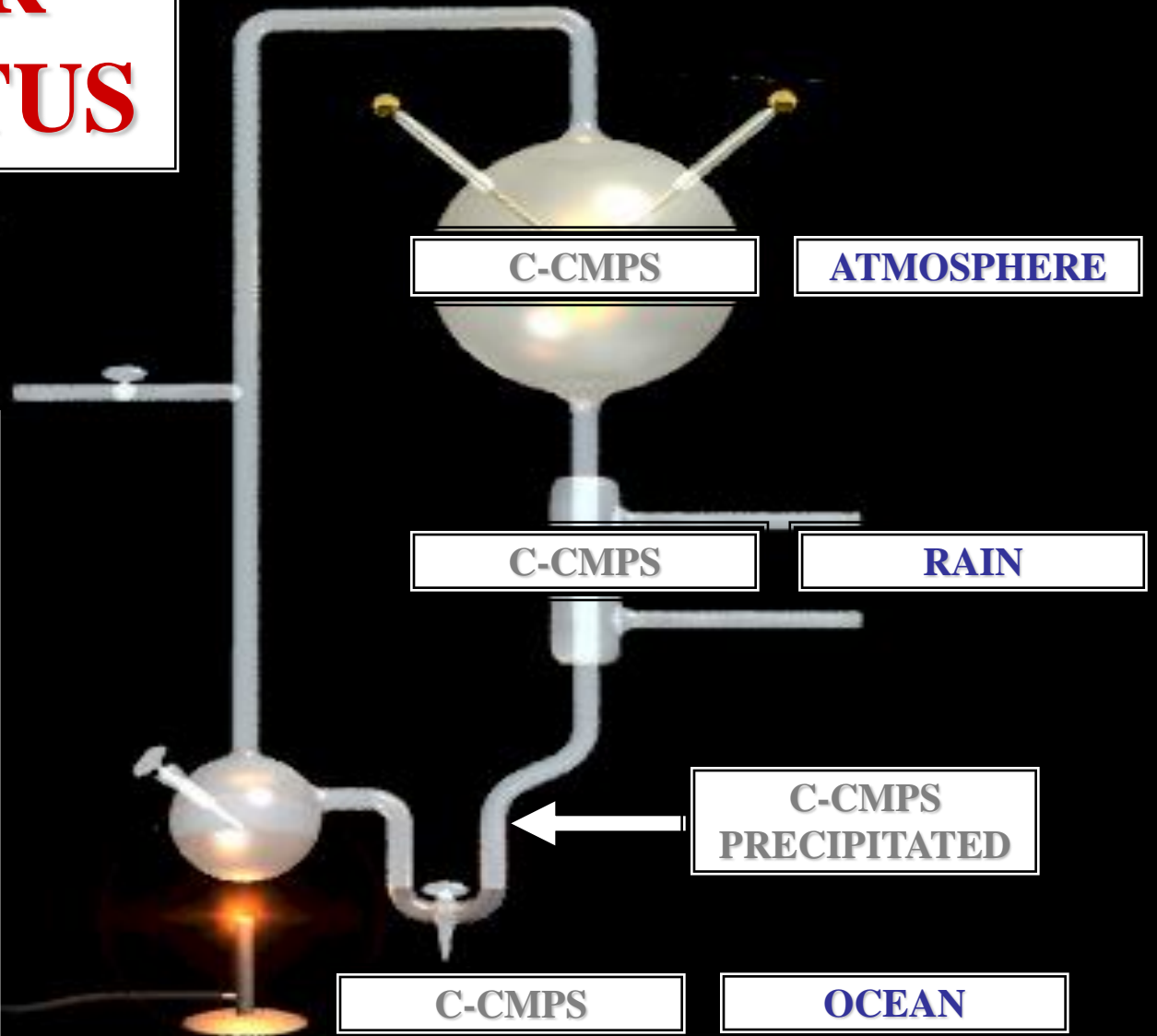


STANLEY MILLER



MILLER APPARATUS

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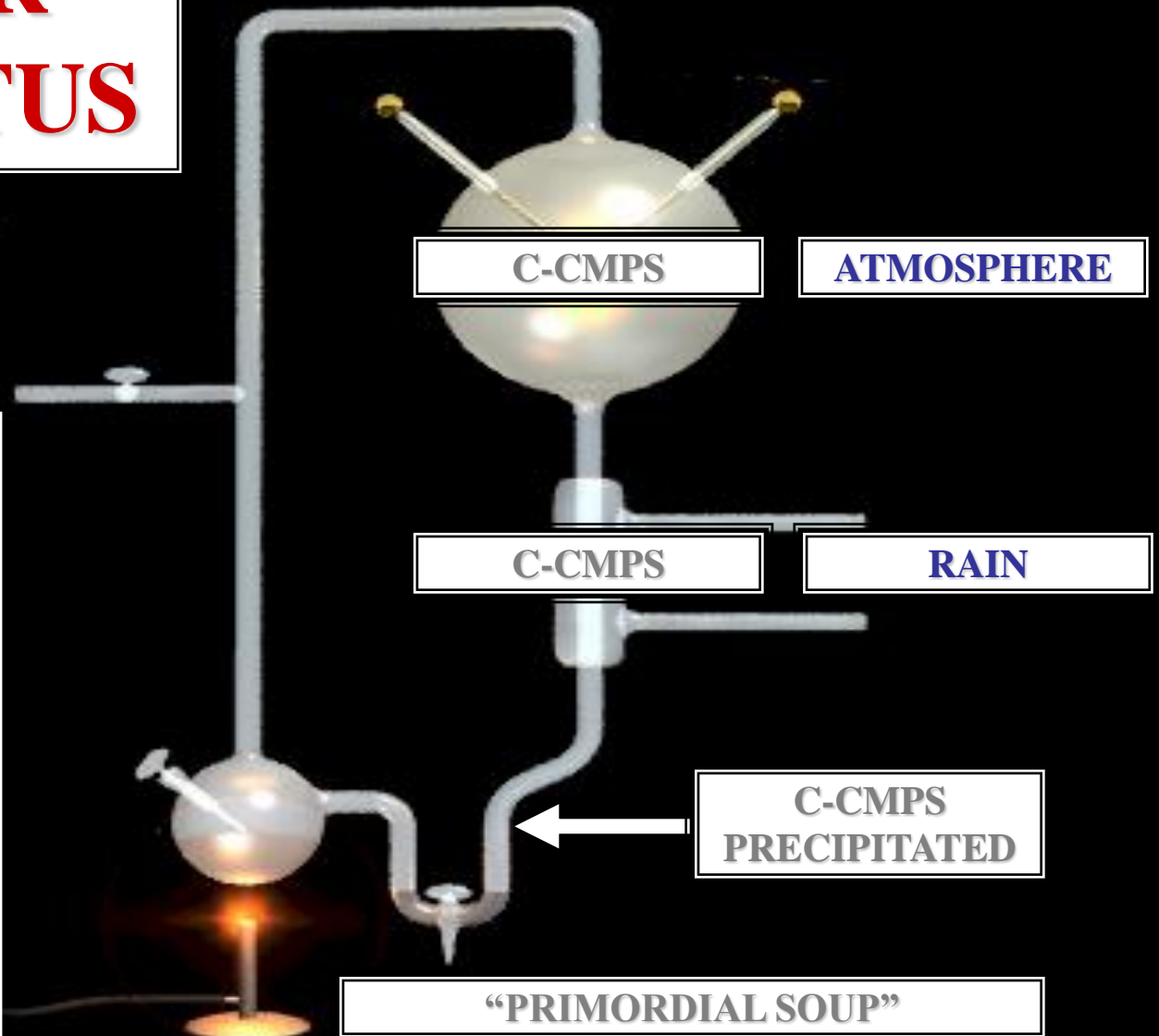


STANLEY MILLER

MILLER APPARATUS

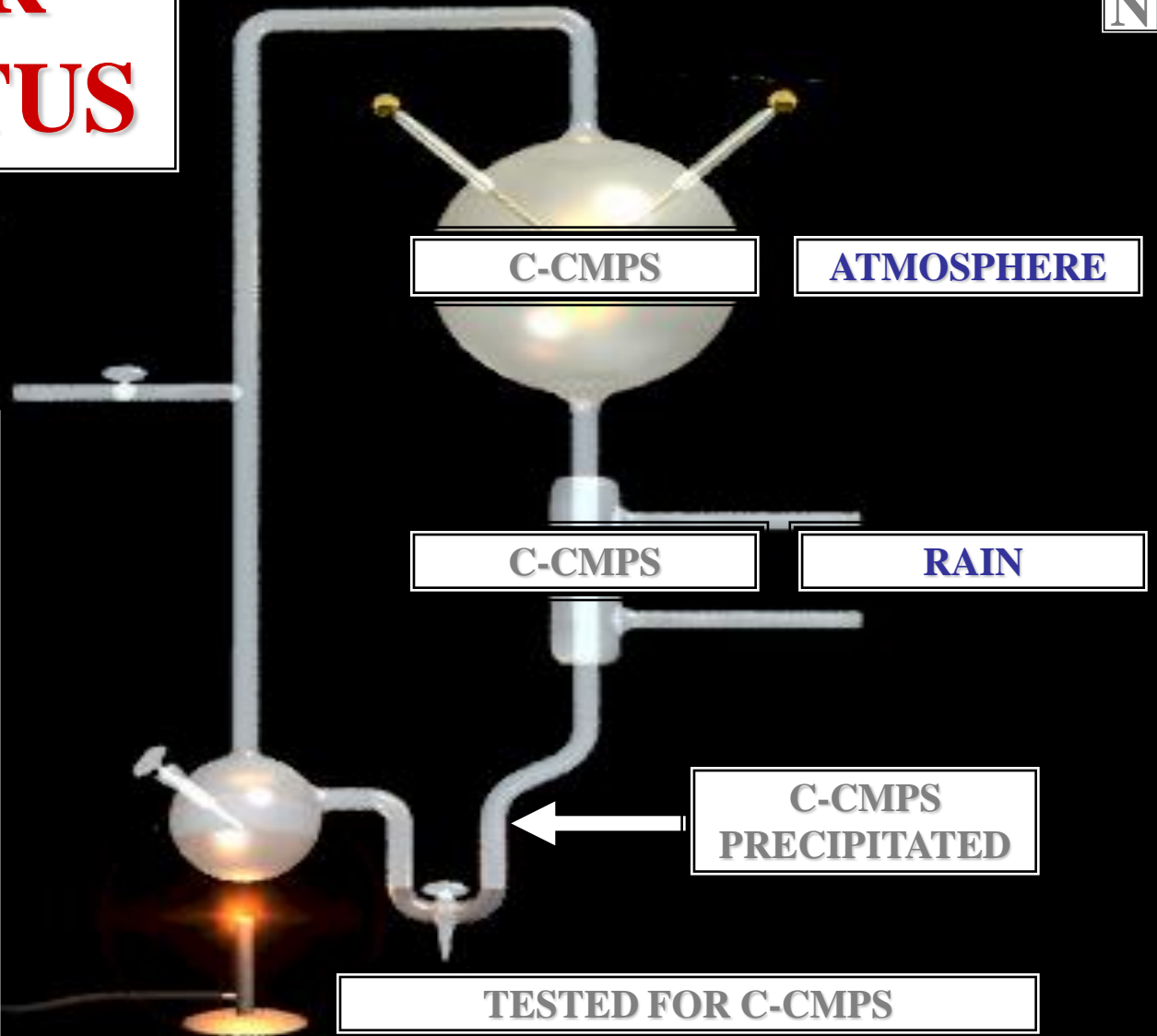


STANLEY MILLER



MILLER APPARATUS

A
N



STANLEY MILLER