

ORIGIN OF LIFE

HISTORY OF LIFE

- Earth is 4.5 billion years old
- Oldest rock o 3.8 billion years old o Contains isotopes of carbon o Indicates metabolic activity
- Oldest fossils
 - 3.5 billion years old
 - Stromatolites
 - Banded domes of sedimentary rock
 - Resemble layered mats of cyanobacteria today
- Probably photosynthetic o Probably not first life forms
- First life forms were NOT photosynthetic

ONE HYPOTHESIS

CONDITIONS ON EARTH	SCENARIO
<ul style="list-style-type: none"> • Atmosphere had little O₂ • Intense o Lightning • Volcanic activity • Meteorite bombardment • UV radiation 	<ol style="list-style-type: none"> 1. Abiotic synthesis of organic monomers 2. Abiotic synthesis of polymers 3. Formation of protobionts 4. Origin of hereditary material

ABIOTIC SYNTHESIS OF ORGANIC MONOMERS

OPARIN & HALDANE 1920S	MILLER & UREY 1953
<ul style="list-style-type: none"> • Worked independently • Postulated • Conditions on primitive Earth favored abiotic synthesis of organic material <ul style="list-style-type: none"> o Atmosphere <ul style="list-style-type: none"> ▪ Contained less O₂ ▪ Less oxidizing than today's ▪ More reducing than today's 	<ul style="list-style-type: none"> • Tested Oparin & Haldane hypothesis • Created conditions on early Earth in lab • Atmosphere - H₂O, H₂, CH₄, NH₃ • Added spark • Created organic material • Other labs have created <ul style="list-style-type: none"> ○ All 20 AA ○ Some sugars & lipids ○ Purine & pyrimidine bases ○ ATP

ABIOTIC SYNTHESIS OF POLYMERS

- Example: connecting amino acids (AA) together to form proteins
- Occurred without enzymes
- Evidence
 - Synthesis of protenoids
 - Drip sol'n of AA on hot sand or clay
 - AA bonded together to form protein
 - Zn and Fe ions act as catalysts

FORMATION OF PROTOBIONTS

- Definition = aggregates of abiotically produced molecules with an internal environment different from external
- First primitive "cells"
- Evidence
 - Coacervates
 - Microspheres - self-assembled proteinoids; protein membrane selectively permeable; undergo osmosis
 - Liposomes: membrane of lipid bilayer; grow and split

ORIGIN OF HEREDITY

- Genetic information made it possible to pass along information for making new molecules
- Today: DNA → RNA → protein
- Originally: RNA → protein
- Support
 - RNA acts as enzyme (ribozymes)
 - Synthesized short segments of RNA in lab; replicate short segments of RNA without enzymes

MAJOR LINEAGES OF LIFE

OLD	NEW
5 Kingdoms Monera Protista Plantae Fungi Animalia	Domains Bacteria Archaea Eukarya <ul style="list-style-type: none">○ 5 proposed protista kingdoms○ Kingdom Plantae○ Kingdom Fungi○ Kingdom Animalia

MACROEVOLUTION

- Major events in history of life revealed in fossil record
- Origin of taxonomic groups higher than species
- Encompass origin of novel designs
- Produces explosive diversification in some groups
- Can cause mass extinctions

FOSSIL RECORD

- Ordered account of which fossils appear within layers of sedimentary rock
- Incomplete
- Fossils
 - Found in sedimentary rock
 - Hard parts of organism
 - Impressions left by body parts
 - Actual remains of organism
- Dating fossils
 - Relative
 - Younger strata forms on top of older strata
 - Younger fossils found in younger strata
 - Absolute
 - Radioactive dating
 - C-14 half life = 5,730 years
 - C-14 converted into C-12
 - If fossil contains $\frac{1}{4}$ of C-14 as living
 - $1 = \frac{1}{2} \times \frac{1}{2}$
 - $2 \times 5730 = 11,460$ years old

Questions:

25.1

1. How old is Earth? _____
How old are the oldest fossils? _____
Why are these fossils NOT considered to represent the first life forms on Earth?

2. Describe the conditions of Earth at the time life began.

3. Listed below are descriptions or supporting evidence of the four proposed steps in the chemical evolution that lead to the first cells. Identify each of the following as true of steps 1, 2, 3, or 4.

_____ Abiotic production of the 20 amino acids, sugars, lipids, purine and pyrimidine bases under controlled laboratory conditions

_____ Abiotic synthesis of organic molecules

_____ abiotic synthesis of polymers

_____ Aggregates of abiotically produce molecules that are able to maintain an internal environment different from the external

_____ Charge sites on clay and or iron pyrite held monomers together long enough for a bond to form between the monomers

_____ Energy from UV radiation, lightning, and heat catalyzed the formation of organic monomers from inorganic compounds

_____ Formation of protobionts

_____ Miller & Urey experiment

_____ Origin of genetic material

_____ Polymers synthesized by dehydration synthesis

_____ Produce polymers by dripping a solution with monomers on hot clay or sand

_____ Production of liposomes

_____ Ribozymes

_____ RNA abiotically synthesized

4. Why was the origin of genetic material important to the origin of life on Earth?

5. How can an RNA molecule have both a genotype and a phenotype?

6. How did the structure of RNA provide a mechanism for natural selection?

7. Match the term with the correct description or definition

- | | |
|--|----------------|
| _____ Before life | A. Abiotic |
| _____ Without life; inorganic | B. Prebiotic |
| _____ Abiotically synthesize proteins | C. Protenoids |
| _____ Aggregates of abiotically produced molecules that maintain an internal environment different from external | D. Protobionts |

8. RNA may not have been the first hereditary system to develop. Explain.

9. Where, according to the current hypothesis, did life begin on Earth?

Why is this hypothesis being challenged?

What alternative is being proposed as to where life began on Earth?

10. Indicate if each of the following is true of Domain **Bacteria**, Domain **Archaea**, Domain **Eukarya**.

- _____ Nuclear envelope and membrane-bound organelles absent
- _____ Nuclear envelope and membrane-bound organelles present
- _____ Peptidoglycan present in cell walls.
- _____ Peptidoglycan absent in cell walls.
- _____ Membrane lipids have unbranched hydrocarbon chains
- _____ Some membrane lipids have branched hydrocarbon chains
- _____ growth inhibited by antibiotics
- _____ growth not inhibited by antibiotics
- _____ Protists, plants, fungi, animals
- _____ Methanogens, halophiles, thermophiles

25.2

11. Define macroevolution.

12. What are the limitations of the fossil record?

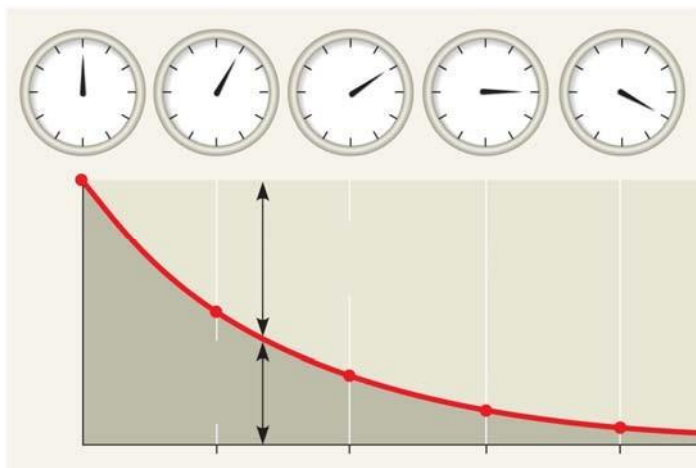
13. Define the term fossil:

14. What body parts usually form fossils? Why?

15. Explain how sedimentary rock forms.

16. How is sedimentary rock important to paleontologists?

17. Rocks and fossils are dated in several ways. *Relative dating* uses the order of rock strata to determine the relative age of fossils. *Radiometric dating* uses the decay of radioactive isotopes to determine the age of the rocks or fossils. It is based on the rate of decay, or **half-life** of the isotope. To determine the *absolute* age of a fossil, *radiometric dating* is used. Use this figure to explain the concept of radiometric dating. Label key elements.

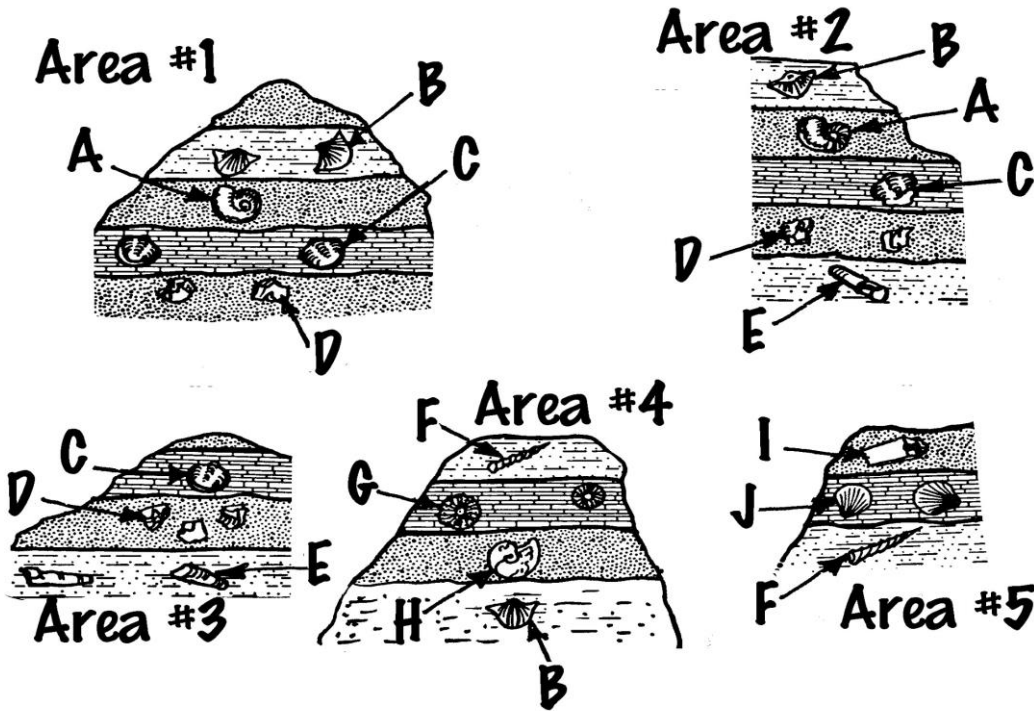


18. A fossil contains 1/16 of the original amount of ^{14}C . How old is this fossil?
 The half-life of ^{14}C is 5,730 years. Show your work and circle your answer.

Is this an example of absolute or relative fossil dating? _____

19. Potassium-40 has a half-life of 1.3 billion years. If an organism had 1 mg of potassium-40 when it died and its fossil now has 0.25 mg, how old is this fossil? _____

20. The following diagrams show the fossils found in four different areas. Use these diagrams to answer the questions that follow.



- a. Construct a fossil record for the fossils shown in the diagrams by putting the fossils (use the letters) in order according to age (start with the oldest).

Oldest fossil

Most recent

- b. Is this an example of absolute or relative fossil dating? _____

Explain. _____

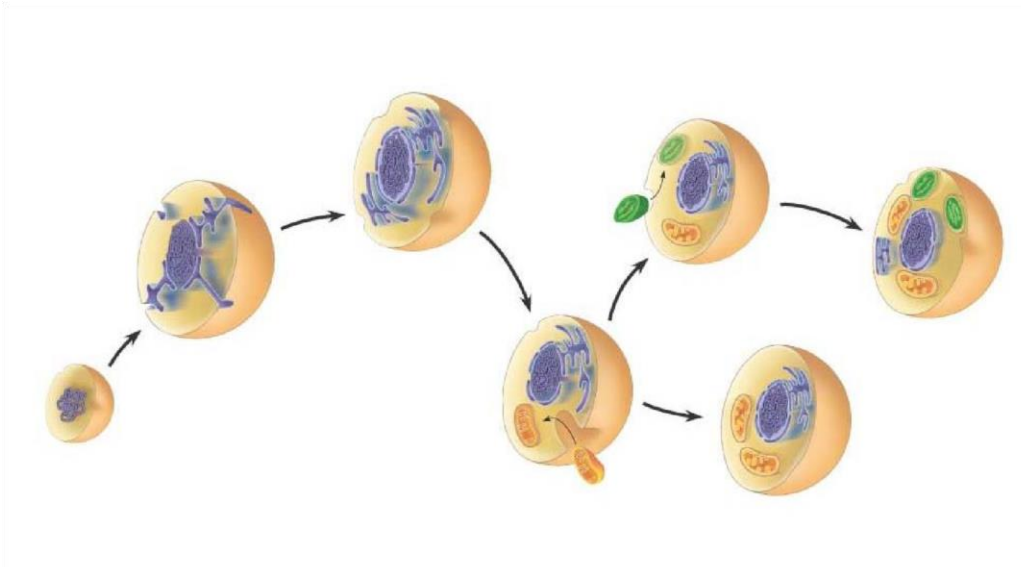
21. Using radioactive isotopes is one method of absolute fossil dating. Describe another method.

25.3

19. What was the earliest form of life on the planet? How long ago did this life-form first occur?

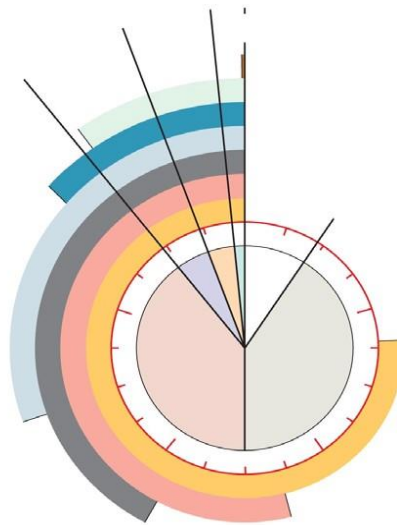
20. What unique ability was originated with *cyanobacteria*? How did this alter life on Earth and lead to a wave of mass extinctions?

21. The first *eukaryotes* did not appear until approximately 2.1 billion years ago. Using the figure, label and explain the evolution of eukaryotes by *endosymbiosis*.



22. Summarize three lines of evidence that support the model of endosymbiosis.

23. Use the clock model to note the following events in the life of the planet: *origin of the Earth, appearance of prokaryotes, evolution of atmospheric oxygen, occurrence of eukaryotic cells, multicellularity, and life moves onto land.* For each event, also label the number of years ago it occurred.



25.4

22. What is continental drift?

What effect has continental drift had on life on Earth?

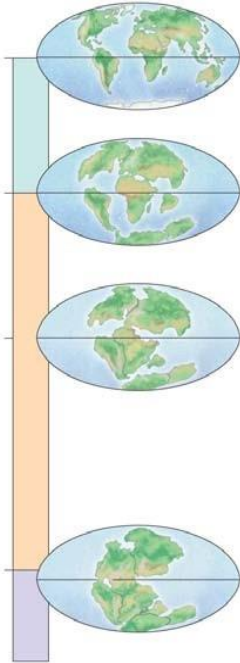
23. Marsupials evolved in what is now North America, yet their greatest diversity is found in Australia. How can you account for this biogeographical distribution?

24. How long ago did:

a. Pangea form? _____

b. Pangea break up? _____

24. On the figure below, label Pangaea, Gondwana, and Laurasia.



25. What is an adaptive zone?

26. What must occur before a new adaptive zone can be exploited?

27. What effect did the origin of shells and skeletons have on the diversity of sea animals?

Why did this occur? _____

28. Does an evolutionary novelty guarantee a species entry into a new adaptive zone? Explain.

29. What event probably caused the first major adaptive radiation of mammals?

30. Why do extensive adaptive radiations often follow mass extinctions?

31. Describe the two examples of mass extinctions listed below by completing the chart.

Mass Extinction Example	PERMIAN EXTINCTIONS	CRETACEOUS EXTINCTIONS
Between what two eras did the extinctions occur?		
How many years ago did the extinctions occur?		
What effect did the extinctions have on life on earth?		
What probably caused the extinctions? (Be specific)		

25.5

31. What two areas of biology are merged in the field of study commonly called evo-devo?

32. What is an evolutionary change in the rate or timing of developmental events?

33. *Homeotic genes* are master regulatory genes that determine the location and organization of body parts. Mutations in a *homeotic gene* can have a profound effect on morphology. Homeotic gene mutations can contribute to the potential for evolutionary change. The *Hox* genes are one class of homeotic genes. What do they control?

25.6

34. When a structure that has evolved in one context becomes co-opted for another purpose, this event is called _____.

End of Chapter Synthesis and Evaluation Problems

1. Answer question 1-5, 7-8, 12. Then, check and correct your answers for 1-5, 7 and 8 in the back of the text.

- 1. _____
- 2. _____
- 3. _____
- 4. _____
- 5. _____
- 7. _____
- 8. _____

***Question #12 should be typed out, then answered in no more and no less than 100 to 150 words. Turn in separately to the tray. This is worth **20 points!** Do not plagiarize. Use your own words and thoughts...but, use vocabulary terms and ideas taught in this chapter!

Study Guide/ISN (20 points)

- 1. In your study guide book, review pages 161-164. In your ISN, title a page as follows: **Chapter 25 The History of Life Must Know!** In one color, copy down the must know items listed on page 161 in study guide leaving space underneath to include in an different color a brief description, diagram, model, or pneumatic device that will help you study for the unit test and more importantly the AP Test in May.
- 2. **TEST PREP (covers chapters 22-25):** Answer Topic 6 questions on page 164-170 in study guide. Then, correct your answers. Pay special attention to any questions you missed and write a short explanation next to your wrong answer that explains the correct answer. This will really help you in seeing what you do and don't know, as well as, help you with retention of material.

Level 1

Answers	Corrections	Notes
1. _____	_____	
2. _____	_____	
3. _____	_____	
4. _____	_____	
5. _____	_____	
6. _____	_____	
7. _____	_____	
8. _____	_____	
9. _____	_____	
10. _____	_____	
11. _____	_____	
12. _____	_____	
13. _____	_____	
14. _____	_____	
15. _____	_____	
16. _____	_____	
17. _____	_____	
18. _____	_____	
19. _____	_____	
20. _____	_____	

Level 2---use a different color to make corrections and notes

Answers	Corrections	Notes
1. _____	_____	
2. _____	_____	
3. _____	_____	
4. _____	_____	
5. _____	_____	
6. _____	_____	
7. _____	_____	
8. _____	_____	

Free Response Question

Type out the question and your responses. Turn in separately to the tray. No word minimum or limit. Do not plagiarize. Use your own words and thoughts...but, use vocabulary terms and ideas taught in this chapter!

Bozeman Science/ AP Biology/ISN (See Syllabus for format) (20 points each)

1. Abiogenesis (Big Idea 1)
2. The origin of life-Scientific evidence (Big Idea 1)
3. Three domains of life (Big Idea 1)
4. Endosymbiosis (Supplemental AP Bio Resources)