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Life: Characteristics, Origin

EVPP 110 Lecture
Fall 2003
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✓characteristics of life
✓origin of life

3 # Characteristics of Life

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✓What is **life**?
– What qualifies something as "living"?

5 In-Class Activity #5: Characteristics of Life
✓Work in groups of 3 - 5
✓prepare a list of characteristics that qualifies something as “living”

6 What is Life?
✓What is **life**?
– What qualifies something as "living"?
– consider *necessary* versus *sufficient* criteria
• *necessary*
– possessed by all life?
• *sufficient*
– possessed only by life?

7 What is Life?
✓What is **life**?
– four possible criteria of life
• movement
• sensitivity (responding to stimuli)
• death
• complexity

8 What is Life?
✓four possible criteria of life
– movement
• not *necessary*
–
• not *sufficient*
–
– sensitivity (responding to stimuli)
• not *necessary*
–
• not *sufficient*

–

9 What is Life?

✓four possible criteria of life

– death
  - *necessary*
    –
  - not good criterion because of circular definition

– complexity
  - *necessary*
    –
  - not *sufficient*
    –

10 All living things share key characteristics

11 All living things share key characteristics

✓ All organisms on earth exhibit these 7 fundamental properties

– **cellular organization**
– **sensitivity**
– **growth**
– **development**
– **reproduction**
– **regulation**
– **homeostasis**
– **heredity**

12 All living things share key characteristics

✓**cellular organization**
  - all organisms consist of one or more **cells**
    –

✓**sensitivity**
  - all organisms respond to stimuli
    – not to all stimuli in same way

13 All living things share key characteristics

✓**growth**

– assimilation of energy, use of it to grow
  - via a process called **metabolism**
  -
  -

14 All living things share key characteristics

✓**development**

– multi-cellular organisms
  - systematic, gene-directed changes through growth, maturity

15 All living things share key characteristics

✓**reproduction**

– passing on traits from one generation to the next
–
–

16 All living things share key characteristics

✓**regulation**

– coordination internal processes

✓**homeostasis**

– maintaining relatively constant internal conditions, different from their external environment

17 All living things share key characteristics

✓**heredity**

– genetic system based on replication of **DNA**

– allows for adaptation and evolution over time

18 Ideas about the origin of life

19 Ideas about the origin of life

✓ideas about the origin of life

– many, from different cultures, religions

– can't definitively answer question of how life originated

•

•

– **three possible explanations for the origin of life**

20 Ideas about the origin of life

✓ ideas about the origin of life

– **three possible explanations for the origin of life**

• **special creation**

• **extraterrestrial origin**

• **spontaneous origin**

21 Three possible explanations for the origin of life

✓ **special creation**

– hypothesis that life forms may have been put on earth by supernatural or divine forces

• at core of most major religions

–

– considered an "unscientific" explanation

• cannot be tested and potentially disproved

22 Three possible explanations for the origin of life

✓ **extraterrestrial origin**

– hypothesis that life did not originate on earth

• carried to earth by meteors or cosmic dust as an extraterrestrial "infection"

– cannot be rejected based on evidence currently available to science

• possible fossils in Mars rocks

• liquid water under surface of Jupiter's ice-shrouded moon Europa

– considered an "unscientific" explanation

• cannot be tested and potentially disproved

23 Three possible explanations for the origin of life

✓ **spontaneous origin**

– hypothesis that life evolved from inanimate matte

• associations among molecules became more and more complex

-
  - molecules increased their stability
    - persisted longer, initiated more and more complex associations
    - culminated in the evolution of cells

24 Three possible explanations for the origin of life

✓**spontaneous origin**

- this view does not preclude the other two possibilities
  - divine agency may have acted via evolution
  - life may have infected earth from some other world and then evolved

25 Three possible explanations for the origin of life

✓ **spontaneous origin**

- considered the only “scientific” explanation
  - could potentially be tested and disproved (or supported)
  - only explanation routinely focused on by “science”

26 Three possible explanations for the origin of life

✓**spontaneous origin**

- goal is attempting to understand whether
  - forces of evolution could have led to origin of life and, if so
  - how might the process have occurred

27 Figure 26.1 Some major episodes in the history of life

28 What was the early earth like?

29 What was the early earth like?

✓ exact composition not agreed upon by all scientists

✓ **some fundamental characteristics**

- **“reducing” atmosphere**

  - **high temperatures**

30 Figure 26.0 A painting of early Earth showing volcanic activity and photosynthetic prokaryotes in dense mats (Campbell & Reece)

31 What was the early earth like?

✓ **some fundamental characteristics**

- **reducing atmosphere**
  - early atmosphere contained
    - principally CO_2 , N_2 gas
    - significant amounts of water
    - H atoms, bound to light elements (S, N, C)
    - H_2 gas
    - little O_2 gas
    - no layer of ozone (O_3) to protective from ultraviolet light

32 What was the early earth like?

✓ **some fundamental characteristics**

- **reducing atmosphere**
  - called “reducing” atmosphere due to
    - ample availability of H atoms and their electrons
      - » facilitated gain of electrons by certain molecules (reducing charge of atom from

neutral to -)

- today's atmosphere
  - considered an "oxidizing", contains app. 21% oxygen

33 ☐ What was the early earth like?

✓ **some fundamental characteristics**

- **high temperatures**
  - 4.6 - 3.8 billion years ago (BYA), surface of earth was kept molten hot
    - bombardment from rubble
  - ~ 3.9 BYA, bombardment stopped, temperatures dropped, ocean temperature was 49 to 88 °C (120-190°F)
  - ~4.0 - 3.5 BYA life appeared

34 🖼

35 🖼 Figure 26.10x Lightning

36 ☐ Testing the spontaneous origin hypothesis

37 ☐ Testing the spontaneous origin hypothesis

✓What kinds of molecules might have been produced on the early earth?

- **Miller-Urey** experiment attempted to answer this question

38 ☐ Testing the spontaneous origin hypothesis

✓ **Miller-Urey experiment**

- by reproducing early conditions
  - assembled similar atmosphere
  - excluded gaseous oxygen
  - placed atmosphere over liquid water
  - maintained mixture just below 100 °C
  - simulated lightning
    - bombarded mixture with energy (sparks)

39 🖼

40 🖼 Figure 26.10 The Miller-Urey experiment (Campbell & Reece)

41 ☐ Testing the spontaneous origin hypothesis

✓ **Miller-Urey experiment**

- results (within 1 week)
  - 15% of C (originally methane gas (CH_4)) - converted to other simple C compounds
  - simple C compounds
    - combined to form formic acid, urea, amino acids glycine and alanine (building blocks of proteins)
  - in similar, later experiments, complex ring-shaped molecule adenine – a base found in DNA and RNA – was formed

42 🖼

43 🖼 Figure 26.0x Volcanic activity and lightning associated with the birth of the island of Surtsey near Iceland; terrestrial life began colonizing Surtsey soon after its birth (Campbell & Reece)

44 ☐ The End