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Life: Early Cells, Classification of Life

EVPP 110 Lecture
Fall 2003
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✓evolution of cells
✓earliest cells
  – prokaryotic cells
  – eukaryotic cells
✓classification of life

3 # Evolution of early cells

4 ## Evolution of early cells

✓ Theories about **evolution of cells**
  – evolution of cells
    • early organic molecules assembled into functional, **independent units**
      – cells are “bags of fluid”
      – contents differed from environment outside “cell”
        » interior had a higher concentration of specific organic molecules

5 ## Evolution of early cells

✓ Theories about the **evolution of cells**
  – how did “bags of fluid” evolve from simple organic molecules?
    • **bubbles**
      – spherical, hollow structures
      – molecules with hydrophobic regions spontaneously form bubbles in water
      – structure shields hydrophobic regions from contact with water

6 # The Earliest Cells

7 ## The Earliest Cells

✓ Earliest evidence of life appears in **microfossils**

  • dating from ~3.5 billion years ago

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9 ## The Earliest Cells

✓Characteristics of earliest life forms
  – small (1-2 nanometers)
  – single-celled
  – no external appendages
  – little internal structure
  – no nucleus

- resembled today's **bacteria**
  - in group called **prokaryotes** ("before nucleus")

10 The Earliest Cells

✓ **Bacteria**

- divided into two groups
  - archaebacteria
  - eubacteria

11 Prokaryotic versus eukaryotic cells

✓ All life

- two types of cells
  - prokaryotic cells
  - eukaryotic cells

12 Prokaryotic cells are small and structurally simple

✓ **Prokaryotic cells**

- first appeared ~ 3.5 billion years ago
- "before nucleus"
- small, ~1/10th size of eukaryotic cells
- lack true, membrane-bound nucleus
- surrounded by plasma membrane
- lack true, membrane-bound organelles
- less complex than eukaryotic
- contain a simple DNA molecule

13 The First Eukaryotic Cells

✓ **Eukaryotic cells**

- first appeared ~ 1.5 billion years ago
- "true nucleus"
- larger than prokaryotic
- rapidly evolved to produce diverse life forms that inhabit earth today
- complex interiors

14 Eukaryotic cells are partitioned into functional compartments

✓ **Eukaryotic cells**

- **complex interior organization**
  - extensive compartmentalization
  - many membrane-bound organelles, internal membranes
  - true, membrane-bound nucleus
  - complex DNA molecule
  - contain vesicles and vacuoles which function in storage and transport

15 The eukaryotic cell probably originated as a community of prokaryotes

✓ fossil record indicates

- eukaryotes evolved from prokaryotes ~1.5 BYA

✓ how did eukaryoites arise?

- theory: through a combination of 2 processes
  - **membrane infolding**
  - **endosymbiosis**

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17 Eukaryotic cell probably originated as a community of prokaryotes

- ✓ **membrane infolding**
  - of plasma membrane of ancestral prokaryotic cells
    - gave rise to endomembrane system of eukaryotic cells
- ✓ **endosymbiosis**
  - thought to have generated first
    - **mitochondira**
      - heterotrophic prokaryote came to reside in ancestral prokaryote
    - **chloroplast**
      - photosynthetic prokaryote came to reside in ancestral prokaryote

18 The First Eukaryotic Cells

- ✓**Endosymbiont theory**
  - critical stage in evolution of eukaryotic cells involved symbiotic relationships with prokaryotic organisms (bacteria)
    - heterotrophic bacteria engulfed by larger bacteria - evolved into mitochondria
    - photosynthetic bacteria engulfed by larger bacteria - evolved into chloroplasts

19 The First Eukaryotic Cells

- ✓Support for the endosymbiont theory
  - existence of symbiotic relationships
  - presence of DNA in organelles
    - many organelles have their own DNA
      - mitochondria
      - chloroplasts
    - organelle DNA is similar to bacterial DNA in size and character

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22 Figure 28.4 A model of the origin of eukaryotes

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24 Classification of Life

25 Classification of Life

- ✓diversity of life can be arranged into three domains
  - **how we classify life**
    - therefore, organisms

26 Classification of Life

- ✓To bring order to diversity of life, a system of classification exists
- ✓**Taxonomy**
  - science of classifying and naming organisms

27 Classification of Life

✓ earliest classification schemes
  – only two broad groups recognized (kingdoms)
✓ as knowledge increased about significant differences among living organisms
  – classification system was developed that recognized a taxonomic level higher than kingdom
    • **domain**

28 ## Classification of Life

✓ All life can be classified into one of
  • **three domains**
    – **Archaea**
    – **Bacteria**
    – **Eukarya**

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30 ## Classification of Life

✓ **Domain Archaea**
  – **single-celled, “ancient” bacteria**
✓ **Domain Bacteria**
  – **single-celled, “true” bacteria**
✓ **Domain Eukarya**
  – **single-celled protists, paramecia, single- and multi-cellular algae**
  – **fungi**
  – **plants**
  – **animals**

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33 ## Classification of Life

✓ All organisms are grouped into a few major categories
  – earliest classification systems recognized 2 kingdoms of life
    • animal kingdom
    • plant kingdom
  – kingdoms were added over time
    • new organisms were discovered
    • understanding of relationships/differences grew

34 ## Classification of Life

✓ How many kingdoms?
  – all “life” currently classified into 6 kingdoms
    • **Archaebacteria**
    • **Eubacteria**
    • **Protista**
    • **Fungi**
    • **Plantae**
    • **Animalia**

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36 Six Kingdoms Relative to 3 Domains

- ✓**Domain Archaea**
  - **Kingdom Archaebcateria**
- ✓**Domain Bacteria**
  - **Kingdom Eubacteria**
- ✓**Domain Eukarya**
  - **Kingdom Protista**
  - **Kingdom Fungi**
  - **Kingdom Plantae**
  - **Kingdom Animalia**

37 Six Kingdoms Relative to Prokaryotic Versus Eukaryotic Cells

- ✓**Prokaryotic kingdoms**
  - **Archaebacteria**
  - **Eubacteria**
- ✓**Eukaryotic kingdoms**
  - **Protista**
  - **Fungi**
  - **Plantae**
  - **Animalia**

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Figure 1.11 Three domains of life (Biology, 6th Ed., Campbell & Reece)

39 Classification of Life

- ✓ binomial system
  - early
    - developed by Swedish biologist, Carl Linnaeus (1707-1778)
      - gave two-part (binomial) name to each species
      - names eventually came to be written in Latin

40 Classification of Life

- ✓ Binomial system
  - current
    - unique 2-part name for each organism
    - first part designates genus
      - capitalized
      - underlined or italicized in print
    - second part designates species
      - not capitalized
      - underlined or italicized in print

41 Classification of Life

- ✓Examples
  - Homo sapiens or H. sapiens (human)
  - *Quercus alba* or *Q. alba* (white oak)

42 Taxonomic Classification is Hierarchical

- ✓ taxonomic heirarchy

- over time, genera were grouped into large, more inclusive categories known as **families**
  - grouping intended to reflect relationships between genera included
- taxonomic system extended to include several, more inclusive units

43 ## Taxonomic Classification is Hierarchical

- ✓ **Species**
  - grouped to form a genus
- ✓ **Genera** (plural of genus)
  - grouped together to form a family
- ✓ **Families**
  - grouped to form orders
- ✓ **Orders**
  - grouped to form classes
- ✓ **Classes**
  - grouped to form divisions or phyla
- ✓ **Phyla or Divisions**
  - grouped into **kingdoms**

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45 ## Classification of the Human Being

- ✓**Domain:** Eukarya
- ✓**Kingdom:** Animalia
- ✓**Phylum:** Chordata
- ✓**Class:** Mammalia
- ✓**Order:** Primates
- ✓**Family:** Hominidae
- ✓**Genus:** *Homo*
- ✓**Species:** *sapiens*

46 Figure 1.10 Classifying life (Biology, 6th Ed., Campbell & Reece)

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48 ## The End.