

BIOLOGY – THE STUDY OF LIFE

THE MOST ASTONISHING PHENOMENON ON EARTH!

Incredible complexity & amazing diversity

- Pinch of soil can contain more microorganisms than there are people on the planet
- We dwell on a largely unexplored planet:
~1.5 million known species
1-2 discovered each day...not just teeny ones
30-100 million estimated
- We are not alone: eyelash mite, symbiotic bacteria
Little fleas.
- What is a species? Similar organisms living in a population that can reproduce fertile offspring under natural conditions. (horse + donkey = mule)

BIOLOGY IS THE MOST DIVERSE OF ALL SCIENCES, IT DEALS WITH DIVERSITY ITSELF.

- THERE IS AN UNDERLYING UNITY TO THE DIVERSITY OF LIFE
- THE WORLD IS FULL OF A HUGE DIVERSITY OF ORGANISMS WITH AN ASTONISHING VARIETY OF STRUCTURES, LIFESTYLES & BEHAVIORS
- ALL LIVING THINGS ARE RELATED IN A TREE OF LIFE THAT SCIENTISTS ARE CONTINUING TO DECIPHER & COMPLETE
- THIS DIVERSITY HAS RISEN & FALLEN NATURALLY & DRASTICALLY IN THE PAST, BUT RECENTLY IS NOW DECLINING RAPIDLY D/T ONE SPECIES

THE STUDY OF BIOLOGY INCORPORATES:

1. Chemistry - 5 octillion atoms [C. Z. HOPKINS Mn
Ca Fe Mg NaCl 100 trillion cells
2. Mathematics – statistics
3. Physics – laws of nature
4. Geology – continental drift
5. Psychology – psychoneuroimmunology

TYPES OF BIOLOGICAL STUDY:

Zoology Botany Mycology
Cryptobiology Exobiology [astrospeliology]

THE CHARACTERISTICS OF LIVING THINGS

A. Complex and organized carbon based (organic)

1. subatomic particles – make up atoms
2. atoms - smallest particle of an element that retains the properties of that element (c z hopkins mn café mg nacl)
3. molecules – atom combos (*compounds*) via bonds
 - a. Sugars, Fats, Proteins
 - b. RNA & DNA software
 - c. ATP
4. Organelles – structures within cells that perform specific functions (hardware of the cell)
5. Cells – [Cytology] the smallest unit of life
6. Tissues – [Histology] similar cells perform specific functions
 - a. Muscle cell – contract
 - b. Nerve cells – send signals
 - c. Epithelial cells – line
 - d. Connective cells – protect, support, etc.
7. Organs – a structure of several tissues that form a functional unit
8. Organ Systems – two or more organs working together to execute a specific body function (11)
9. Multicellular Organisms – an individual living thing composed of many cells
10. Species – very similar, potentially interbreeding Organisms
11. Population – members of one species inhabiting the same area
12. Community – two or more populations of different species living and interacting in the same area
13. Ecosystem – a community together with its nonliving surroundings
14. Biosphere – that part of the earth inhabited by living organisms; including both living and nonliving components

- B. Metabolism – **must acquire & use materials & energy** – the sum total of chemical reactions to sustain life
1. Anabolism – synthesis
 2. Catabolism – lysis
 3. Materials – nutrients for chemical reactions
 4. Energy – for doing work
 - a. Photosynthesis – [Autotrops – self feeders] plants & some single cell organisms
 - b. Consumption – [Heterotrops – other feeders] fungi, animals, some plants & bacteria *rely on ingestion & absorption*
- C. Homeostasis – maintain a relatively constant internal environment (within a limited range)
1. Negative feedback – thermostat
 2. Positive feedback – cascade, domino effect
- D. Growth & Development
1. Differentiation
 2. Metamorphosis - ovum, fetus, embryo, larvae, pupa, adult
- E. Response to stimuli – irritability, movement
- F. Reproduction – asexual or sexual via DNA
1. continuity of life – offspring with forbearers genetic material
 2. diversity of life – offspring are different from forbearers
 3. DNA – the molecule of heredity – deviations & mutations
Provide variation
- G. Evolve – adaptation driven by natural selection
1. Adaptations – characteristics that help organisms cope with changing environment
 2. Environmental Inducers
 - a. climate change
 - b. resources change
 - c. predators
 - d. diseases

CATEGORIZATION OF THE DIVERSITY OF LIFE

A. Domains – cell type, number & mode of nutrition

placed in 3 domains, but some argue 2 kingdoms

1. Bacteria } monera, prokaryotic
2. Archaea }
3. Eukarya – true kernel, eukaryotic

B. KINGDOMS

- | | |
|-------------|-------------|
| 1. Protista | 3. Plantae |
| 2. Fungi | 4. Animalia |

TAXONOMY – Lineus (Carl von Linne), *Kopernik*

- ❖ KINGDOM
- ❖ PHYLUM
- ❖ CLASS
- ❖ ORDER
- ❖ FAMILY
- ❖ GENUS
- ❖ SPECIES

SCIENCE & PSEUDOSCIENCE

A. Primitive man's categorizations

1. Eatable and Yucky
2. Flying, running, swimming
3. Plant or Animal

B. Sympathetic Magic vs. Scientific Method

1. Magic of contagion [remote manipulation]
2. Magic of association [frogs & rain]
3. Spontaneous generation

C. Universal explanations - curiosity

D. Cosmologies

- | | |
|----------------|----------------------------|
| 1. Chinese | 7. Euclid - geometric |
| 2. Vedic lotus | 8. Copernicus - |
| 3. Egyptian | heliocentric |
| 4. Babylonian | 9. Galileo – the father of |
| 5. Hebrew | Modern Science |
| 6. Aristotle | |

Subjective vs. Objective reality (Kant, Hume & Berkley)

Opinion, esthetic & moral judgments

Open inquiry to evidence – intellectual honesty

Belief vs. Faith (trust)

Most scientists have no problem with faith, because trust, unlike belief is open-ended.

SCIENTIFIC PRINCIPLES

- A. Natural Causality – all events can be traced to natural causes that are potentially within our ability to comprehend
- B. Uniformity in Space & Time – natural laws are derived from nature, and do not change with distance or time
- C. Common Perception – all humans perceive natural events in fundamentally similar ways, providing us with reliable info. about the natural world

The study of life, like all science is based on:

THE SCIENTIFIC METHOD:

- ❖ Observation
- ❖ Hypothesis – question; a supposition based on observation
- ❖ Experiment – support or refute a hypothesis
 - Variables
 - Controls
 - Repeatability
- ❖ Conclusion – drawn on the validity of the experimentation
SPONTANIOUS GENERATION & FRANCESCO REDI
ALEXANDER FLEMING & PENICILLIUM
- ❖ Theory – much more than a hunch, a general explanation of natural phenomena, developed through extensive & reproducible observations
- ❖ Law – only found in exact sciences
Science is necessarily uncertain (open-ended) & therefore cannot demonstrate absolute truth; but can only approximate reality.

THE THEORY OF EVOLUTION: (THE UNIFYING THEME IN BIOLOGY)
MODERN ORGANISMS DESCENDED WITH MODIFICATION FROM PREEXISTING
FORMS [CONCEPT THAT ALL ORGANISMS ARE RELATED TO EACH OTHER BY
COMMON ANCESTRY] EVIDENCE:

1. GEOLOGICAL
2. FOSSIL RECORD
3. RADIOACTIVE DATING
4. GENETICS
5. MOLECULAR BIOLOGY
6. BIOCHEMISTRY
7. BREEDING EXPERIMENTS

BASED ON 3 NATURAL PROCESSES:

- GENETIC VARIATION – DNA DIVIATION & MUTATIONS
- INHERITANCE – PASSES VARIATIONS TO OTHER GENERATIONS
- NATURAL SELECTION – a mechanism for how evolution occurs

Charles Darwin & Alfred Wallace, 19th century biologists, formulated
Artificial Selection – man selects traits in offspring,
Ex: domesticated animals, farm crops

- **Adaptation** – structures, physiological processes or behaviors that aid in survival & reproduction in a particular environment. Survival of those offspring best adapted to the conditions in which they live
- Molded by millions of years of *mutation, variation* and *natural selection*
- What may be of benefit today can be a liability tomorrow
- Living fossils (sharks) have not changed for 10s of millions of years
- **Extinction** comes from not being able to adapt to change
- **Biodiversity** – the diversity of species & the complex interrelationships that sustain them [the richness of an ecological community]
- The rate of environmental change has accelerated in the last few decades by a single species, **Homo sapiens** – pollution, global warming, destruction of the rain forests etc.

COMMON MISCONCEPTIONS

1. Evolution is *only* a theory
2. Evolution has never been observed
3. Evolution violates the 2nd law of thermodynamics
4. No transitional fossils exist
5. The Theory is based on random chance
6. There is no room for faith in evolutionary theory
7. We came from monkeys

THE KNOWLEDGE OF BIOLOGY ILLUMINATES EVERYDAY LIFE

1. Knowledge of life does not detract from the appreciation of life
2. Understanding increases a sense of wonder
3. Open ended [not arrogant] :
“The only solid piece of scientific truth about which I truly feel confident is that we are profoundly ignorant about nature.” -Lewis Thomas
4. The study of life can be a pathway of understanding ourselves and the life around us