Biology 1020

Unit 1 – Biology and the Scientific Study of Life

Chapter 1 – Read P.3-18
1.0 Biology and the Scientific Study of Life

1.1 Define science
1.2 Define biology
1.3 Describe the levels of organization that defines biology
1.4 List and define several areas of specialization within the field of biology, i.e., physiology, cytology, ecology, mycology, entomology, taxonomy, zoology
1.5 Explain the importance of other sciences in the study of biology
1.6 Describe and compare the methods used to study biology, i.e., Discovery science versus Hypothesis – driven science. Provide examples of each
1.7 Distinguish between a hypothesis and a theory
1.8 Explain the components of the scientific method including problem, question, hypothesis, prediction, experiment (various variables i.e. independent, dependent, control), results, discussion including sources of error and conclusion.
1.9 List and describe the characteristics of life including homeostasis, metabolism, respiration, growth, reproduction, and evolution
Science – is an approach to understanding the natural world that is based on inquiry – a search for information, explanations, and answers to specific questions.

Biology – is the scientific study of life
Levels of organization that defines Biology

The highest level of organization for living things is the biosphere; it encompasses all other levels. The biological levels of organization of living things arranged from the simplest to most complex are: atom, molecule, compound organelle, cells, tissues, organs, organ systems, organisms, populations, communities, ecosystem, and biosphere.
Areas of Specialization within the field of Biology

Physiology  
Cytology  
Ecology  
Mycology  
Entomology  
Taxonomy  
Zoology

There are many more – these are the specialties we will touch on this year – Biology 1020 and 1021.
Physiology

- the branch of biology that deals with the normal functions of living organisms and their parts.
  - the way in which a living organism or bodily part functions.
  - "the physiology of the brain"

https://www.youtube.com/watch?v=pVkUCrgQCCc
Cytology

- the branch of biology concerned with the structure and function of plant and animal cells.

[YouTube video link] https://www.youtube.com/watch?v=5a2_oggyh8Q
Ecology

- the branch of biology that deals with the relations of organisms to one another and to their physical surroundings.

https://www.youtube.com/watch?v=TGR-QGdH3QU
Mycology

the scientific study of fungi.

https://www.youtube.com/watch?v=DE6JmqCq2o
Zoology

- the scientific study of the behavior, structure, physiology, classification, and distribution of animals.
- the animal life of a particular area or time. “The zoology of Russia's vast interior"

https://www.youtube.com/watch?v=2rNHYmC5JVs
Entomology

- the branch of zoology concerned with the study of insects.

https://www.youtube.com/watch?v=Q-38ocCB0ss
Taxonomy

- the branch of science concerned with classification, especially of organisms; systematics. The classification of something, especially organisms. "the taxonomy of these fossils"
- a scheme of classification.

https://www.youtube.com/watch?v=aiC_Z8Za7wc
Science Inquiry, a search for information and explanation, often focusing on specific questions.

Two Types:

Discovery Science vs Hypothesis Driven Science

Discovery Science brought about Hypothesis Driven Science
Discovery Science

- In discovery science, you make observations or analyze data, usually a large amount, to see what kinds of patterns you can find. If you do think you find patterns or other information. General – cell theory.

- Discovery science, also called descriptive science, is mostly about describing nature.

- Describes natural structures and processes as accurately as possible through careful observation and analysis of data. Discovery science for example has built our understanding of cell structure and classification of the diverse species on earth.
Recording observations in the form of qualitative and quantitative data is the foundation of this kind of experimenting. Jane Goodall, for example, spent decades recording her observations of chimpanzee behavior.

Discovery science can lead to important conclusions based on a type of logic called induction, where we derive generalizations from a large number of specific observations.

Verifiable data

Interpreting data worksheet
Hypothesis-Driven Science

- In hypothesis-based science, you form an educated guess, or hypothesis (which is almost always based on previous observation), then devise a way to test that hypothesis in a controlled fashion.

- Hypothesis-based science is mostly about explaining nature...formulate problem – hypothesis – prediction – experiment – observations – conclusion.

- Often stimulated by discovery science this type is more based on the why? and what caused it? type of questions.
Hypothesis-Driven Science

- Involves making predictions that can be tested by making additional observation or performing experiments... a hypothesis that is a tentative answer to a well formed question, an explanation on trial.

- A type of logic called deduction is built into hypothesis based science. In deductive reasoning, the logic flows in the opposite direction as inductive from general to specific, If.... then.... because....

- A controlled experiment is often then created to test this hypothesis, where experimental groups are compared with a control group ideally with only one differing factor to be tested.

- Hypothesis based science can lead to theories...
Hypothesis vs Theory

A hypothesis is either a suggested explanation for an observable phenomenon, or a reasoned prediction of a possible causal correlation among multiple phenomena.

In science, a theory is a tested, well-substantiated, unifying explanation for a set of verified, proven factors. A theory is always backed by evidence; a hypothesis is only a suggested possible outcome, and is testable and falsifiable.

https://www.youtube.com/watch?v=lqk3TKuGNBA
**Theory:** Einstein's theory of relativity is a theory because it has been tested and verified innumerable times, with results consistently verifying Einstein's conclusion. However, simply because Einstein's conclusion has become a theory does not mean testing of this theory has stopped; all science is ongoing. See also the Big Bang theory, germ theory, and climate change.

**Hypothesis:** One might think that a prisoner who learns a work skill while in prison will be less likely to commit a crime when released. This is a hypothesis, an "educated guess." The scientific method can be used to test this hypothesis, to either prove it is false or prove that it warrants further study. (Note: Simply because a hypothesis is not found to be false does not mean it is true all or even most of the time. If it is consistently true after considerable time and research, it may be on its way to becoming a theory.)
<table>
<thead>
<tr>
<th>Purpose</th>
<th>Hypothesis</th>
<th>Theory</th>
</tr>
</thead>
<tbody>
<tr>
<td>testable</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>falsifiable</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Is well maintained</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Data</td>
<td>Usually based on very limited data</td>
<td>Based on a very wide set of data tested under various circumstances.</td>
</tr>
<tr>
<td>Instance</td>
<td>Specific: Hypothesis is usually based on a very specific observation and is limited to that instance.</td>
<td>General: A theory is the establishment of a general principle through multiple tests and experiments, and this principle may apply to various specific instances.</td>
</tr>
<tr>
<td>To present an uncertain possibility that can be explored further through experiments and observations.</td>
<td>To explain why a large set of observations are consistently made.</td>
<td></td>
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Writing hypothesis and predictions

After a problem is identified, you can pose a question – why is this happening?

You can then form a **hypothesis**

- Present tense
- Provides a GENERAL answer to the problem
- In this statement the independent and dependent variables are identified

**Prediction** – If the hypothesis holds true, **then**..............................

MUST BE FUTURE TENSE!
3 Variable types:

1. **Dependent variable** – is the variable being tested and measured *in a scientific experiment*.

   - Scientist has NO control over this variable – it DEPENDS on the experiment.
   - Weight change, how fast a plant is growing, how far a car travels etc.
2. **Independent variable** - a variable whose variation does not depend on that of another. The variable this is going to be tested or changed by the experimenter in a scientific experiment.

- It represents the cause or reason for an outcome.
- Change solution concentrations, wattage of light, distances, different sizes etc.
3. Control variable - (or scientific constant) in scientific experimentation is the experimental element which is constant and unchanged throughout the course of the investigation.

If a control variable changes during an experiment, it may invalidate the correlation between the dependent and independent variable. When possible, control variables should be identified, measured, and recorded. Control groups get placebo’s.
https://www.youtube.com/watch?v=H_9hF0_Hvj0
Video

https://www.youtube.com/watch?v=AfXnC0mvGs0
For example, a scientist wants to see if the brightness of light has any effect on a moth being attracted to the light.

The brightness of the light is controlled by the scientist. This would be the independent variable.

How the moth reacts to the different light levels (distance to light source) would be the dependent variable.

Control may be – keep in same place, same moth, same environment, same measurement tool, same experimenter doing the measuring, same type of lightbulbs just different watts, etc.
Scientific Method

1. Ask a question to a problem in nature
2. Make observations
3. Hypothesis – prediction
4. Experiment – utilize 3 variables
5. Results – analyze and discuss data, sources of error
6. Conclusion
Observations

Question

Hypothesis

Prediction

Test does not support hypothesis; revise hypothesis or pose new one

Test: experiment or additional observation

Test supports hypothesis; make additional predictions and test them
When results are plotted in graphs, the convention is to use the independent variable as the $x$-axis and the dependent variable as the $y$-axis.

The **DRY MIX acronym** can help keep the variables straight:

- **D** is the dependent variable
- **R** is the responding variable
- **Y** is the axis on which the dependent or responding variable is graphed (the vertical axis)
- **M** is the manipulated variable or the one that is changed in an experiment
- **I** is the independent variable
- **X** is the axis on which the independent or manipulated variable is graphed (the horizontal axis)
Worksheet #1 & 2 – Scientific Method

- Identifying variables and types of experimental (Natural vs Manipulative)
Components of Scientific Method: Lab Write-up

- **Problem**: is in the form of a question.

- **Hypothesis**: is written in present tense and generalized as a tentative answer or an educated guess to the problem. If "independent variable:; then :dependent variable"

- **Prediction**: A predicted result which is generated from the hypothesis. These are specific and written in future tense. **If hypothesis holds true, then**...statements.

- **Procedure**: refer to lab manual P.? To P.? State any changes made to the lab procedure here.

- **Results**: Any record of observations. Tables, graphs, biological drawings etc.

- **Discussion**: Must be written in paragraph form. 1) overview/summary of specific results. Discuss any trends. 2) Link results to dependent variable. 3) discuss explanation of results – biological background, definitions that help explain the phenomenon. 4) A discussion of control variable, its significance – if no control – why? 5) sources of error, problem with the experiment

- **Conclusion**: State whether results supported your hypothesis – it may be a restatement of your hypothesis.
How to write a Hypothesis and prediction Activity

- Identify a problem in nature? Write in Question
- Identify DV and IV and usually 3 controls
- Write a hypothesis......Always present tense ..........
- IF........(Independent Variable), THEN...... Dependent Variable.
Develop Experiment –

- make sure to identify the control group
- What will you give to group A (Manipulated)
- When give
- Measuring device
- Identify your control variables (what are you keeping constant?) Always 3 minimum

Make a Prediction: Future tense............. basically rewriting your hypothesis without the If.......... Then............
Assignment # 1

Due Date: Monday September 18th
7 Characteristics of Life

1. All living things are made of cell.

2. Homeostasis - The tendency of the body to seek and maintain a condition of balance or equilibrium within its internal environment, even when faced with external changes.

A simple example of homeostasis is the body's ability to maintain an internal temperature around 98.6 degrees Fahrenheit, whatever the temperature outside.
3. Metabolism - the sum of the chemical reactions that take place within each cell of a living organism and that provide energy for vital processes and for synthesizing new organic material. Energy processing – break down food to make usable energy.
4. Respiration - the act of respiring; inhalation and exhalation of air; breathing. **Biology**. the sum total of the physical and chemical processes in an organism by which oxygen is conveyed to tissues and cells, and the oxidation products, carbon dioxide and water, are given off.
5. Growth - Development is the progression from earlier to later stages in maturation, e.g. a fertilized egg develops into a mature tree. It is the process whereby tissues, organs, and whole plants are produced.
6. Reproduction - (or procreation or breeding) is the **biological** process by which new individual organisms – "offspring" – are produced from their "parents". ..... As a species
7. Evolution - is change in the heritable characteristics of biological populations over successive generations. Evolutionary processes give rise to biodiversity at every level of biological organization, including the levels of species, individual organisms, and molecules.

Darwin Finches

Peppered Moth in Industrial Age

Biological resistance - pests

Evolution of man
Question 1-9