

1 The Study of Life

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2 Characteristics of Life

- Presence of DNA
 - It is signature molecule found only in living organisms
 - DNA codes ultimately for amino acids which make up proteins
 - DNA is the heredity molecule passed from parents to offspring
 - All cells have DNA – (human red blood cells have lost their nucleus)
 - Some viruses (retroviruses) have RNA (relative to DNA) which is converted to DNA with host cells

3 Characteristics of Life

- All living things require some form of energy for life
 - Energy provides the power to do work
 - It is needed to grow, build new parts, repair old parts, breakdown food, move, etc.
 - Metabolism is the sum total of molecule building (anabolism) and molecule breakdown (catabolism)
 - ATP is the main energy currency in the cell

4 Characteristics of Life

- Response to stimuli is needed to detect energy in the environment
 - Some stimuli are harmful
 - There are also beneficial stimuli
 - The same stimulus may be viewed in differing ways by different organisms
 - Stimuli were are able to detect:
 - Sounds
 - Smells
 - Tastes

5 Characteristics of Life

- Organization – living things display distinct structural development
 - Organisms are heterogeneous – made up of a variety of substances put together in a specific fashion (non-random)
 - This level of organization would not be possible by chance

6 Characteristics of Life

- Growth – increase in both size and complexity

7 Characteristics of Life

- Reproduction – production of offspring (completely new individuals or different ones)


8 Characteristics of Life

- Evolution – change over time is a hallmark of living things


9 Levels of biological organization

- Molecules – 2 or more atoms chemically bonded together
- Organelles – small sub-cellular structures which perform tasks within cells
- Cells
- Tissues
- Organs


- Systems
- Organism
- Population – group of organisms of the same kind in one place
- Community – all populations of all species living in the same place
- Ecosystem – the community with non-living abiotic environment
- Biosphere – All regions of the earth's atmosphere, waters and crust in which organisms live

10  **Organisms are interdependent**

- Photosynthesis
 - Photosynthesis is the production of oxygen and glucose using light energy
 - Plants are producers or autotrophs
 - The green plant pigment chlorophyll is involved

11  **Organisms are interdependent**


- Respiration
 - Respiration is NOT breathing; it is the breakdown of glucose in the presence of oxygen
 - The process yields energy (ATP) to organism
 - Animals are consumers of plants and/or animals and are also known as heterotrophs

12  **Organisms are interdependent**

- Energy flows from the sun to autotrophs to heterotrophs and back to the environment
- Energy and chemicals are constantly cycled through the environment
- The degree of interdependency is amazing!

13  **Scientific Method**

- Orderly set of steps which biologists use to study life

14  **Steps in the scientific method**

- Observe something in nature, research the topic or phenomenon and identify a problem or frame a question
- Form a hypothesis – educated guess about possible answers to your question
- Using the hypothesis make a prediction (if-then)
- Devise ways to test the hypothesis
- Test and refine tests (you may be wrong)
- Re-test and refine tests. Same results must be seen
- Analyze the results and report findings in scholarly, peer-reviewed journal

15  **Scientific Method**

Controls vs. experimental groups

- Control – identical to experimental group except one variable condition
- Experimental group – the group has the one change your experiment wishes to test

16  **Scientific Theory vs. Fact**

- All scientific results that are verified continually and form a constant are woven into a theory.
- The term theory is stronger than commonly thought

- It has never proven wrong YET
- Scientists are required to change thinking if ever proven wrong – or at least test more after questions arise

17  **Scientific Theory vs. Fact**

- There are numerous times in scientific history where theories have been altered or thrown out
 - The coelacanth was considered extinct until found
 - Theory of Acquired Traits
this theory stated that if you need to change a body part, you just changed it and your offspring acquired this changed part
 - Theory that earth was the center of the universe

18  **Microscopes**

- Glorified magnifying glasses
- A microscope like this was made famous by Antonie van **Leeuwenhoek**

19  **Microscopes**

- Samples of modern microscopes

20  **Microscopes**

- Usually have two lenses, hence are called compound microscopes
- University/college scopes use visible light and are called light microscopes
- The lens near eye is the eyepiece while the ones near the specimen are objectives
- Objective magnifications vary from 1x – 100x
- Eyepieces are usually 10x, but can be 5x or 8x

21  **Microscopes**

- Magnification – the degree which the specimen is enlarged
 - Each lens has a magnification
 - Compound scopes use two lenses and the product of the magnifications is the total magnification
 - Eyepiece 10x and objective 10x
(10x X 10x = 100x)
 - Magnifications range from 2x to 5,000x with light microscopes

22  **Microscopes**

- Contrast – the difference in tone or color between the background and the specimen
 - The best lenses have the highest contrast
 - Often biologists use stains or dyes to increase contrast
 - Some types of microscopes use optical interference to raise contrast

23  **Microscopes**

- Contrast – the difference in tone or color between the background and the specimen

24  **Microscopes**

- Resolution – the ability to see two closely-spaced objects as separate structures

25  **Microscopes**

- Resolution = $R = 0.61/N.A. \times \lambda$ *
 - N.A. = numerical aperture
 - Each objective has a numerical aperture like 0.25, 0.40 or 0.73
 - λ stands for the wavelength of light
 - λ is also a color when it falls within the visible spectrum of light (400 – 750 nm)

26  **Microscopes**

- Example: numerical aperture of .25
and a wavelength of light = 450 nm

- Resolution * = $R = 0.61/N.A. \times \lambda$

$$R = 0.61/.25 = 2.44 \times \lambda$$

Do the division first! *

$$R = 2.44 \times 450 \text{ nm} = 1098 \text{ nm}$$

show the units *

27  **Microscopes**

- Resolution – the ability
to see two closely-spaced objects as separate structures
- Smaller resolution numbers
are better! *
- Larger resolution
numbers are less desirable in scientific images *
(= blurry images)