Outline the functions of all life:

Metabolism- conversion of organic molecules through chemical reactions in an organism

Reproduction- production of similar cells/organisms from existing ones

Homeostasis- regulating/maintaining a constant/stable environment

Growth- increase in size/mass/number of cells within an organism

Response- react to stimuli

Excretion- elimination of waste products

Nutrition- process by which organisms take in and make use of food/nutrients

Cell Theory

The cell is the basic unit of life.

All living things are composed of cells.

Cells come from preexisting cells.

Evidence for Cell Theory

Subcellular components have never been seen to perform the functions of life whereas full cells have.

From the 17th century on, biologists examined tissues from both plants and animals (later from fungi, bacteria and protists) and saw that every specimen contained at least one or more cells.

We have observed cells coming from other cells, but never observed spontaneous generation.

Atypical Cells

Giant algae can be huge, single celled organism with a single nucleus (like in umbrella algae, Acetabularia). Some consider the giant algae to be acellular because they are larger than a typical cell yet still carry out all life functions! Discrepancy: a large single celled organism!

There are cells, like mammal skeletal muscles cells, that are large and have multiple nuclei. Discrepancy: a eukaryotic cell with more than one nucleus!

Fungal hyphae are sometimes not divided up into individual cells (called aseptate hyphae), resulting in a continuous cytoplasm along the length of the hyphae. Do you know what a hyphae is? If not, read this! Discrepancy: Aseptate hyphae are not made of clearly defined individual cells.

Pre-existing Cells Forming Cells

Implication #1: We can trace the origin of all the cells in our body back to the first cell; the zygote produced by the fertilization of a sperm and egg.

Implication #2: The origins of all cells can be traced back through billions of years of evolution to “LUCA” the last universal common ancestor of all life on Earth.

Implication #3: There must have been a first cell that arose from non-living material.

Polymerization

Polymerization is the process in which relatively small molecules, called monomers, combine chemically to produce a large chainlike molecule, called a polymer.

Polymerization is an anabolic reaction, in which complex molecules form from simpler molecules by condensation reactions

Miller and Urey

The Miller-Urey experiment (1953) tested the first step of the Oparin-Haldane hypothesis; whether simple organic molecules can form from inorganic compounds.

Boiled water evaporates and moves into the larger flask, where it combines with .... … methane, ammonia and hydrogen gases in a large flask. Sparks are fired between electrodes to simulate lightning. A cooling condenser turns steam back into liquid water, which drips down... ….into the trap, where organic molecules produced in the reactions also settle.

Organic molecules, including amino acids, can form from inorganic compounds* Organic molecules could have formed on prebiotic Earth

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Spontaneous Origin of Cells

Synthesis (creation) of simple organic molecules from inorganic compounds

Simple organic molecules polymerize/assemble into polymers;

Molecules can self-replicate

Simple molecules become isolated from the surroundings/enclosed in membranes

Pasteur's Experiments

Pasteur's experiment consisted of two parts. In the first part, the broth in the flask was boiled to sterilize it. When this broth was cooled, it remained free of microbial contamination. In the second part of the experiment, the flask was boiled and then the neck was broken off. The broth in this flask became contaminated with microbes.

If a life force was responsible for microbial growth within the sterilized flasks, it would have access to the broth, whereas the microorganisms would not. However, because the broth in the flask remained clear, Pasteur's experiment showed that air does not contain a "vital force" that creates life. Life could not spontaneously generate.

Fatty Acids

Similar to phospholipids, fatty acids have a hydrophobic tail and hydrophilic head, and can thus form the same types of structures, such as vesicles (a), micelles (b) and bilayers (c).

Tools

With improved observational tools and a focus on controlled experiments, we now know that cells only come from existing cells.

Paramecium & Life Functions

The paramecium is a single-celled eukaryotic organism . The paramecium is a heterotroph, and eats smaller unicellular organisms in order to obtain energy and matter. The cytoplasm contains dissolved enzymes that catalyze metabolic reactions such as digestion and synthesis of cellular structures. The paramecium can control beating of cilia to move in different directions in response to changes in the environment.

Paramecium & Life Functions (cont)

The cell will grow until it reaches a maximum surface area to volume ratio), at which point it will divide. The nucleus of the cell divides via mitosis to make another nuclei before the cell reproduces asexually. Two paramecium can also fuse before dividing to carry out a form of sexual reproduction. Waste products from digestion are excreted through an anal pore, an example of exchanging matter with the environment. To maintain homeostasis, excess water within the cell is collected into a pair of "contractile vacuoles" which alternately swell and expel water through an opening in the cell membrane.

Theory

In scientific use: a theory has been shown to be true through repeated observations and experiments. There is no current doubt*. As of yet, no evidence has been collected that does not support the idea.

Trend & Discrepancy

Trend: a prevailing tendency, a generalization.	Discrepancy: does not fit the general trend, a variation from the trend.
Trends lead to the development of predictions of what we expect to observe.	Discrepancies from trends can lead to scientific questions. "Why is it like that? "How did this happen?" Answering those questions can lead to new discoveries and a deeper understanding of how the world works.
A trend is that all living things are composed entirely of true cells. A trend is that cells are small. There are trends in typical cell structures.	Giant algae can be huge, single celled organism with a single nucleus --> A large single celled organism!
	Mammal skeletal muscles cells are large and have multiple nuclei -->
	A eukaryotic cell with more than one nucleus!

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Trend & Discrepancy (cont)

Aseptate fungal hyphae are not divided up into individual cells --> An organism not made with clearly defined individual cells.

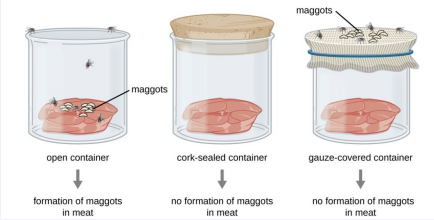
Spontaneous Generation

The theory, now discredited, that living organisms can routinely emerge from nonliving matter independently of other living matter.

Redi experiment

In 1668, Francesco Redi, an Italian scientist, designed an experiment to test spontaneous generation of maggots. Redi is credited with performing one of the first controlled experiments.

Redi experiment



Redi experiment

Redi placed meat three different jars. One jar was left open; the other two were covered. Later, the open jar contained maggots, whereas the covered jars contained no maggots. He did note that maggots were found on the exterior surface of the cloth that covered the jar (attracted to the smell). Redi successfully demonstrated that the maggots came from fly eggs and were not spontaneously generated.

Spallanzani experiment.

In 1768, Lazzaro Spallanzani , an Italian priest and scientist, designed an experiment to test spontaneous generation of microbes.

Spallanzani put broth in a flask, sealed the flask so that way no air could get in, and boiled it. No organisms grew in that flask. This suggested that microbes were introduced into these flasks from the air. In response to Spallanzani's findings, others argued that life originates from a "life force" that was destroyed during Spallanzani's extended boiling.

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RNA

RNA can self-replicate, the third step of the Oparin-Haldane hypothesis. RNA can serve as a genetic code for protein synthesis between generations. RNA can act as a catalyst, speeding up the polymerization of amino acids to form proteins.

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