

Scientific approach to address biological concepts

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Biology: the science that deals with life

- Science is a process used to solve problem
- Scientific method is a way of gaining information about an event by forming solutions to questions
- Science has to be repeated to determine if the solutions proposed are supported

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Basic assumptions in science

- Specific causes for events observed in the natural world
- These causes can be identified
- There are rules to describe what happens in nature
- What one person observes can be observed by others
- The same nature rules apply regardless of where and when they occur

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Two situations are distinguished by scientists

- **Cause and effect** relationship: lightning causes thunder. Same circumstances occur in the future will lead to the same effect.
- **Merely correlated**: autumn and dropping of leaves

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Scientific method components

- **Careful observation:** with our senses or an extension followed by questions.
- **Type of question is important.** Ex: what motivates a cat to hunt or do cats hunt more when they are hungry? Ex: Why did the cat kill the mouse or is the killing instinctive or learned? Ex: did the cat like the taste of the mouse or if given choice between mice and canned cat food, which would cat choose?

After deciding the right question:

- **Was this question answered before?** By reading publications

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Construction and testing of hypotheses

- Hypothesis is a statement with an answer to question or explanation to observation
- Has to be testable and accounts for all known information
- The hypothesis may be wrong
- Openness to new information and ideas
- Willingness to submit one's idea to the examination of others

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Test hypotheses

- Collect relevant information ex: many people died in same year, you can consult historical newspaper
- Make additional observations ex: birds use cavities in trees as places to build nests, you could observe bird species and kinds of nests, and where they build them
- Devising an experiment with variables i.e. Need to break it down into simple questions (controlled experiment)

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Experiment

- Control group and experimental group in controlled experiment.
- Two variables: dependent (giving drug to rats) and independent (ex male or female) both under same conditions

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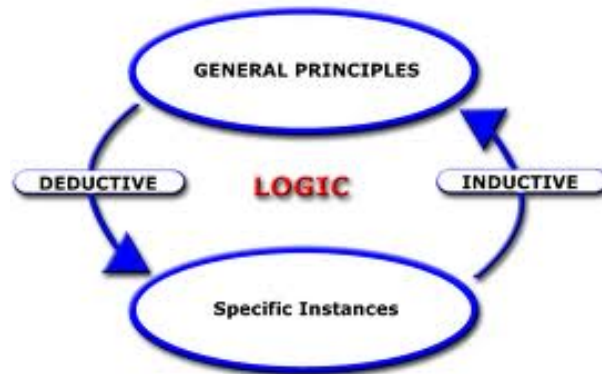
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Development of theories and laws

- Inductive reasoning: process of developing general principles from the examination of many sets of specific facts. Ex all birds lay eggs
- Deductive reasoning: theory established can be used to predict additional observations in nature. Process of using general principles to predict specific facts. Ex. If new bird species, can deduce that it lays eggs

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9/28/2011

- **Theory** is widely accepted general statement about fundamental concepts in science that explain why things happen ex. microorganisms cause infectious disease (germ theory)
- **Scientific law** is a uniform fact of nature that describes what happens in nature, ex: all living things come from preexisting living things
- **Hypothesis** is a statement with an answer to question or explanation to observation

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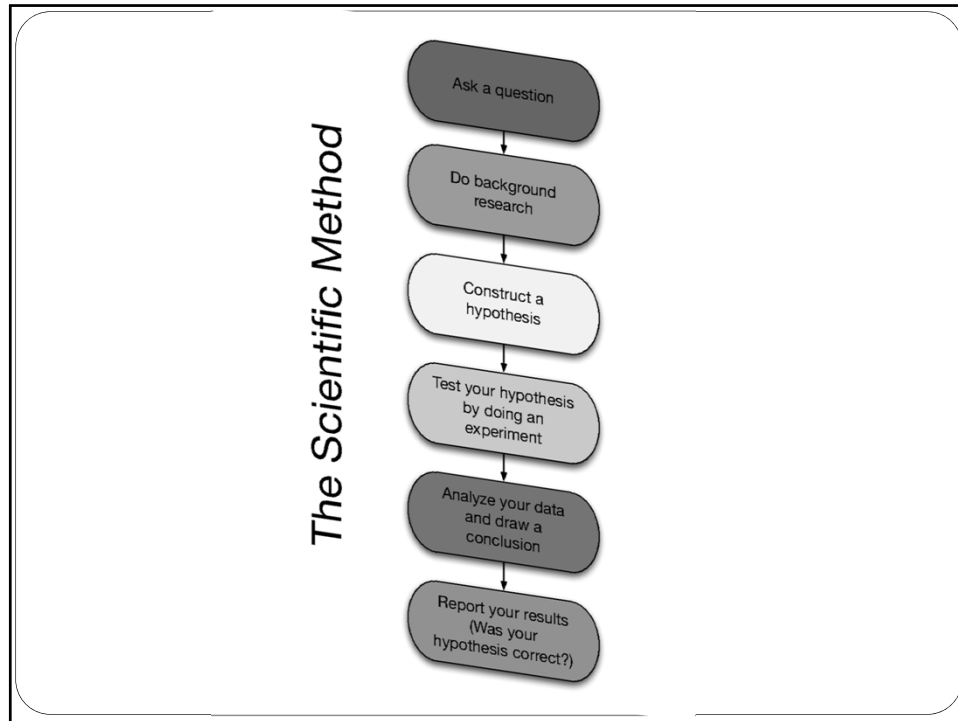
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Scientific method

- Observation
- Questions
- Explore other sources of information
- Form hypothesis
- Test hypothesis
- Find agreement with existing scientific laws
- Form conclusion and communicate it

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Theoretical and applied science

- Theoretical and applied science: ex. DNA discovery led to genetically modified organisms
- Pasteur for preservation of food and vaccination

- Science, Nonscience, and pseudo science
- Science can't answer all questions
- Science is flexible

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The Science of Biology

- As a wide definition: it is the study of living things
- Biological studies could be theoretical, ex. Animal behavior or practical ex. Medicine
- The ability to interact with the surroundings to manipulate energy and matter is unique to living things
- **Energy** is the ability to do work or cause things to move
- **Matter** is anything that has mass and takes space

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Characteristics of living things

- **Metabolic process:** chemical reactions and energy changes within an organism. Set of reactions is called **metabolism**. Metabolic process involves: nutrient uptake, processing, and waste elimination
- **Generative process:** activities that result in increase in size of organism (growth), or increase in number of individuals in population (reproduction- sexual and asexual)
- **Responsive process:** allow organism to react to changes in their surroundings in meaningful way.

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Responsive processes

- **Irritability:** individual's ability to respond to stimulus directly. Ex. Response to loud sound
- **Individual adaptation:** slower than irritability. Ex. Varying hare has brown fur in summer and in autumn white hair grows.
- **Evolution:** involves changes in the characteristics displayed within a population. Ex. Climate changes lead to extinction of certain plants.

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- **Control processes:** mechanisms to ensure that an organism will carry out all metabolic activities in the proper sequence (coordination) and at proper time (regulation).
- **Unique structural organization:** cells are the fundamental structural units of all living things. Organism is any living thing that is capable of functioning independently, whether it is one cell or complex of interacting cells.

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Levels of Biological organization

- Atoms: Hydrogen, oxygen
- Molecules: water, protein, carbohydrate
- Cell: nerve cell, some organism one cell
- Tissue: muscle cells, skin layers
- Organ: eyes, blood vessels
- Organ system: circulatory system (heart, arteries, and veins)
- Organism: human, or yeast (1 cell)
- Population: human
- Community: population of trees, insects.. Interact in any location
- Ecosystem: group of populations
- Biosphere: human affect climate change

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Future of biology

- Ecology
- Relationship between heredity and diseases