The Scientific Method

Biology – Leaving Cert

Quick Notes

The Scientific Method

Biology *is the study of living things*

Areas of Biological Study

- **Botany** – study of plants
- **Zoology** – study of animals
- **Ecology** – study of the interrelationships of living things with each other and their environment
- **Microbiology** – study of microscopic organisms e.g. bacteria and viruses

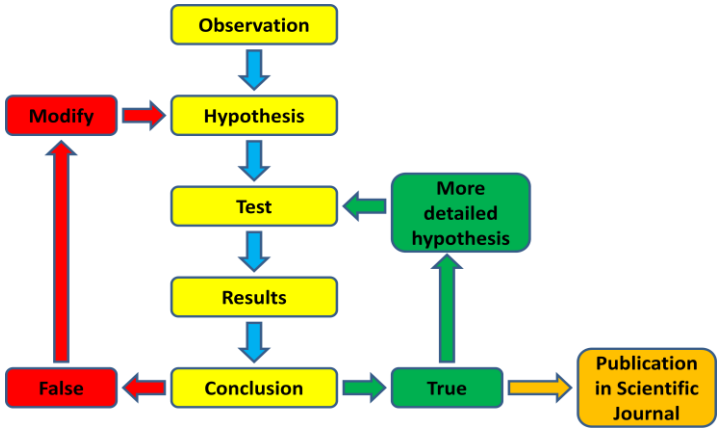
The Scientific Method

An unbiased attempt to discover the workings of Nature

Process of the Scientific Method

1. **Observation:** an **accurate report of a natural event** or circumstance
2. **Hypothesis** an "**educated guess**" as to a possible explanation of the observation
3. **Prediction:** based on hypothesis
4. **Test:** prediction is checked by
   - **Experiment**: **practical test** to examine the prediction containing **all factors** at constant favourable conditions, including the factor being tested.
   - **Control:** everything the same as the experiment **except feature being tested for comparison** with the experiment.
5. **Results: Data – Information** collected in experiment to show if hypothesis false or not
6. **Replication: - Repetition of Test**: to check if the results are consistent and accurate
   - large sample size
   - double blind testing – to remove personal bias
   - random selection
7. **Publication:** in a **Scientific Journal** to allow others to test the hypothesis

8. **Theory;** ***a hypothesis that stands up against all the tests***
9. **Principle or Law:** ***a theory that is successful against long term testing***



Outline of the Scientific Method

Limitations of the Scientific Method.

1. **Insufficient Knowledge**: cause of disease not known due to ignorance of micro-organisms
2. **Method of Investigation**: **inadequate instruments** e.g. Harvey had no microscope in 1628 to see capillaries in the blood system but Malpighi saw them with a microscope in 1660
3. **Inability to Interpret Results:** tall peas crossed with tall peas sometimes produced only tall but other times produced tall and dwarf was mystery until Mendel explained why.
4. **Our changing Natural World:**
    - Myxomatosis controlled European rabbit population for 50 years
    - Antibiotic resistant bacteria have appeared in recent times
5. **Human Error**
    - Improper use of measuring equipment: reading from the top of the meniscus
    - Inaccurate observation: counting the wrong number of plants
    - Mistakes in recording e.g. writing 32.1 instead of 3.21
    - Scientific Fraud: people tell lies
6. **Faulty Conclusions**

- Guinea Pigs get scurvy if they no vitamin C in diet – conclusion rodents need dietary vitamin C.

  False – in fact mice don't need dietary vitamin C

7. **Accidental Discoveries** – serendipity (*luck*)
   - Edward Jenner and smallpox vaccine
   - Fleming and penicillin
8. **Planning and Design** can be poor due to lack of knowledge - poor equipment can lead to errors
9. **Personal Bias** can colour observations and interpretation
10. **Accuracy and Honesty**
    - Must use equipment to its highest level of accuracy
    - All results must be recorded not just those that support the hypothesis

Characteristics of Life

A cell is the smallest entity that has all the characteristics of life.

Living things have the following characteristics

1. **Organisation:** Organisation increases in the following order: **molecules, organelles, cells, tissue, organ, organ system, organism, population, community, ecosystem and biosphere**.
2. **Nutrition:** the process by which an organism **obtains the energy and materials it needs from its environment** to live, grow and reproduce.
3. **Excretion:** the **removal of the waste products of metabolism** that would otherwise interfere with the proper working of the cell or organism.
4. **Response or Sensitivity:** the ability of an organism to **detect and alter its behaviour** to maintain a favourable environment.
5. **Reproduction:** the ability of an organism to **make new organisms**.
6. **Growth:** an **increase in the size or number of cells** of an organism
7. **Movement:** self-generated **change of posture or position** of an organism in response to an external or internal change in its environment.

To remember these use a **mnemonic** such as

O**nly **N**utty **E**lephants **R**un **R**ound **G**rabbing **M**angroves **Respiration

Continuity of Life

- There is the unbroken chain of life since it first evolved about 3.8 billion years ago
- **All living cells are derived from other living cells**

Metabolism: ***All the chemical reactions that take place in a living organism***

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