CHAPTER 2

SOLVING A BIOLOGICAL PROBLEM

Short and Long Questions

Q#1 Define Science.

Ans: Science is a systemized knowledge derived from observations and experiments carried out to determine the principles how nature operates.

Q#2 "Man has always been a biologist". Justify the statement.

Ans: Man has always been a biologist. He has to be a biologist in order to live. Early, in history he was a hunter of animals and a gatherer of fruits, seeds, roots etc. The more he knew about their habitat the more successful hunter he was. The more he knew about plants the better he distinguished between edible and non- edible plants.

Q#3 What is a Biological Method? Give its significance also.

Ans: The scientific methods in which biological problems are solved, is termed as biological methods. It comprises of the steps a biologist adopts in order to solve a biological problem.

Significance of biological method:

The biological method has played an instrumental part in biological research for almost 500 years. From Galileo's experiment back in 1590's till current research, the biological method has contributed to the creation of vaccines and

advancements in medicine and technology. The biological method also ensures quality of data for public use.

Q#4 Describe the steps involved in solving a biological problem by a biologist?

Ans: Solving a Biological Problem:

In solving a biological problem, a biologist takes following steps:

1. Recognition of biological problem
2. Observations
3. Hypothesis formulations
4. Deductions
5. Experimentation
6. Summarization of results (creates tables, graphics etc)
7. Reporting the results

(i) Recognition of a biological Problem:

Biologists go for adopting biological method when they encounter some biological problem. A biological problem is a query that is either asked by someone or comes in biologist's mind by himself.

(ii) Observations:

As the first step in solving a biological problem, the biologists recall his/her previous observations or make new ones. Observations are made with 5 senses of vision, hearing, smell, taste and touch.

Types of Observations:

Observations may be both qualitative and quantitative. Quantitative observations are considered more accurate then qualitative ones

because the former are invariable and measurable and can be recorded in terms of numbers. Examples of qualitative and quantitative observations are given below:

Qualitative Observations	Quantitative Observations
1. The freezing point of water is colder than the boiling point.	**1.** The freezing point of water is 0°C and boiling point id 100°C.
2. A liter of water is heavier than a liter of Ethanol.	**2.** A liter of water weighs 1000 grams and a liter of Ethanol weighs 789 grams.

Note:

Observations also include reading and studying what others have done in past because scientific knowledge is ever-growing.

(iii)Construction and Formulation of Hypothesis:

The tentative explanation of observations is called hypothesis. It may be defined as a proposition that might be true.

Characteristics of Hypothesis:

A Hypothesis should have following characteristics:

1. It should be a general statement.
2. It should be a tentative idea.
3. It should agree with available observations.
4. It should be kept as simple as possible.

5. It should be testable and potentially falsifiable. In other words, there should be a way to show the hypothesis is false; a way to disapprove the hypothesis.

Conditions for Hypothesis:

A great deal of creative and careful thinking is necessary for the construction of a hypothesis. Biologists use reasoning to formulate a hypothesis.

Types of Reasoning:

Reasoning may be of two types.

(i) Inductive Reasoning:

In inductive reasoning specific observations are used to draw general hypothesis. For Example; I observed cells in x, y and z organisms therefore all organisms have cells.

(ii) Deductive reasoning:

Deductive reasoning flows from general to specific. From general observations, a biologist conducts specific hypothesis. For Example; If all organisms have cells and humans are organisms, then humans should have cells.

4. **Deductions:**

The biologists draw deductions from hypotheses. Deductions are the logical consequences of Hypotheses. Deductions are also drawn inductive and deductive reasoning. Generally, in a biological method, if particular hypothesis is true then one should expect a certain result. This involves the use of **"if-then"** logic.

5. **Experimentation:**

Most basic steps of biological methods biologists perform experiments to see if the hypothesis is true. An experiment involves alternative hypothesis. A successful experiment is that which demonstrates one or more alternative hypotheses as incorrect (inconsistent with experimental and observational results). The incorrect hypothesis id rejected and those which prove consistent with experimental results are accepted. An expected hypothesis needs to be valid and useful. It makes further predications that provide an important way to further test its validity.

6. **Summarization of results:**

   The biologists gather actual, quantitative data from experiments. Data for each of the group is then averaged and compared statistically. To draw conclusions the biologists also uses statistical analysis.

7. **Reporting the results:**

   Biologists publish their writings in scientific journals and books, in talks in international seminars and meetings and in seminars at colleges and universities. Publishing of results is an essential part of the scientific methods. It allows other people to verify the results or apply the knowledge to solve other problems.

Q#5 How Scientists contrast an "experimental group" with a "control group"?

Ans: In science, when doing the experiment, it must be a controlled experiment. The Scientists must contrast an "experimental group" with a "control group". The two groups are treated exactly alike except for one variable being tested.

For example, in an experiment to check the necessity of CO_2 for photosynthesis one can contrast the control group (a plant with freely available carbon

dioxide) with an experimental group (a plant with no available carbon dioxide). The necessity of carbon dioxide would be proved when photosynthesis occurs in the control group and doesn't occurs in the experimental group.

Q#6 What is the observations of Darwin?

Ans: Darwin not only took notes during his voyage but he also reads the work of other naturalists to form his theory of evaluation.

Q#7 Let's consider a hypothesis: "All plant cells have a nucleus". Write the deduction make by the biologists about this hypothesis?

Ans: Biologists can't usually check every situation where a hypothesis might apply. Let's consider a hypothesis, "all plant cells have nucleus". Biologists can't examine every living plant that has ever lived to see if the hypothesis is false. Instead, biologists generate a deduction: "If I examine cells from a blade of grass then each one will have a nucleus".

Q#8 Which one is the effective remedy for Malaria?

Ans: In fact, quinine was the only effective remedy for malaria from the 17th to 20th century.

Q#9 Describe the steps involved in biological method taking malaria as an example.

Ans: See Q#1 from exercise (understanding the concepts)

Q#10 Why female mosquitoes need the blood of mammals or birds?

Ans: Female mosquitoes need the blood of mammals and birds for the maturation of their eggs.

Q#11 Describe the function of saliva in female mosquito.

Ans: When a female mosquito pierces the skin with her mouth parts, she injects a small amount of saliva into the wounds before drawing blood. The saliva prevents the blood from clotting in her food canal.

Q#12 How welts appear after the mosquito leaves?

Ans: The welts that appears after the mosquito leaves is not a reaction to the wound but an allergic reaction to the saliva. In most cases the itching sensation and swellings subside within several hours.

Q#13 While testing the hypothesis that Plasmodium is the cause of malaria, what would be the control group of the experiment? Blood of malarial patients or blood of healthy patients?

Ans: Blood of healthy Persons.

Q#14 How theory, law and principle are formulated?

Ans: The hypothesis that stand the test of time (often tested and never rejected) are called theories. A theory is supported by a great deal of evidence.

Productive theory keeps on suggesting new hypothesis and so testing goes on. Many biologists take it as a challenge and exerts greater efforts to disapprove the theory.

Law and Principle:

If a theory survives such a doubtful approach and continues to be supported experimental evidence, it becomes a law or principle. A scientific law is a uniform or constant fact of nature. It is an irrefutable theory. The examples of biological theory are Hardy-Weinberg law and Mendel's law of inheritance.

Q#15 Define Data?

Ans: Data:

Data can be defined as a single piece of information such as names, dates and values made from observation and experimentation.

Q#16 How the principles of ratio and proportion are used in Biological methods?

Ans: See Q#3 from exercise (Understanding the concepts).

Q#17 Briefly describe data organization and data analysis are important steps in a biological method.

Ans: Data Organization:

1. In order to formulate and then to test the hypothesis scientists collect and organize data. Through the use of variables and controls results can be determined. Variables are those factors being tested in an experiment and are usually compared to a control. A control is a known measure to which scientists can compare their results.
2. Prior to conducting an experiment, it is very important for scientists to describe data collection methods. It ensures the quality of the experiment. Attention must be paid to ensure the data collection methods are kept balance.
3. Data is organized in different formats like graphics, tables, flow charts, maps and diagrams.

   Data analysis:

   Data analysis is necessary to prove or disapprove a hypothesis by experimentation. The methods involved in testing/analyzing the data are also important since an experiment is repeated by others to ensure the quality of results. Depending on the type of data the biological problem, this might include application od statistical methods i.e. ratio and proportion. When a relation between two numbers e.g. 'a' and 'b' is expressed in terms of quotient (a/b), such a relation is a ratio of one number to the other. A ratio may be

expressed by putting a division (+) or colon (:) between two numbers. For Example, the ratio between 50 malarial patients and 150 normal persons is 1:3.

Q#18 Justify Mathematics as an integral part of the scientific process.

Ans: See Q#4 from exercise (Understanding the concepts