SOLVING A BIOLOGICAL PROBLEM

Q1: What is science? How does science work?
Ans: Science:
Meaning:
The word science is derived from the Latin word "Scientia" meaning knowledge.
Definition:
The knowledge which is based on observation and experiment is called science.
Scientific method:
A systematic method used to solve a problem with the help of observation, information and experimentation is called a scientific method.
Science work:
In science first observation is done and then after observation experiments are conducted to check the reality of the observation.
Q2: What is a Biological method? Give its importance.
Ans: Biological method:
Definition:
The scientific method, in which biological problems are solved is termed as biological method.
Importance:
It has played a very important role in biological research for the last 500 years. It has contributed a lot to the progress of biology and up to the current Advancement in all the biological fields such as medicine, ecology and technology etc.
Steps of Biological method:
For solving biological problems, biologists take the following steps.
Step (1): Recognition of biological problem:
Biologists go for adopting biological methods when they encounter some biological problem. A biological problem is a question related to living organisms. It is either asked by someone or comes to the biologist 's mind by himself.
Step (2): Observation and previous research:
After recognizing the biological problem. The biologist makes observations. He also recalls his old observation and also studies previous research on the same problem.
Observations are made with five senses I-e, vision, hearing smell, taste and touch. There are two types of observation.

S/No	Quantitative Observations	Qualitative Observation
1	It deals numbers	It deals with description
2	It can be measured	It can be observed but not measured
3	Length, height, area, temperature, volume, weight, cost etc.	Color, texture, smell, taste etc.
4	**Examples:** The freezing point of water is $0C^0$ and the boiling point is 100 C^0	**Examples:** The freezing point of water is colder than the boiling point.

	A liter of water weight 1000 grams and liter of ethanol weighs 789 grams	A liter of water is heavier than a liter of ethanol.

Step (3): Hypothesis:

Hypothesis is unaltered before experimentation "so a tentative explanation of observation is called hypothesis" Biologist reasoning to formulate a hypothesis. Hypothesis consists of two type reasoning

I. Deductive Reasoning (deduce – take away from total):

Deductive Reasoning is the observation from general to specific.

Example:

If all organisms have cells and humans are also an organism, then conclude that humans should have cells.

II. Inductive Reasoning (induct-lead in):

Inductive reasoning is the observation from specific to general.

Example:

We observe cell in Micro-Organisms so we can conclude that all living organism have cell in their body

Characteristic of a good Hypothesis:

- It is based upon observation made by the biologist
- It is a proposed statement to answer the problem.
- It is testable through experiments.
- It should be kept as simple as possible.
- There is always a way to disprove the hypothesis after experimentation.

Step (4): Deduction:

In this step biologists draw deduction from hypothesis deduction is the logical consequences of hypothesis as true and draw out the expected results called deduction. It involves the use of "if" and "then".

Example:

If all birds have wings, then pigeon is a bird

Step (5): Experiment:

The most important thing about biological methods is experimentation. Biologists perform experiments on his hypothesis and check the deductions.

Through experiment he can find that deduction of some hypotheses has come true while others have not. In this way, the hypotheses are proved as true or false hypotheses are rejected while the true ones are accepted.

In science when doing the experiment, it must be a controlled experiment. The scientist must contrast an experimental group with a control group.

For example,

- Experimental group (patients)
- Control group (Healthy person)

Step 6: Conclusion and Reporting:

Biologist collects data from his experiments. He analyzes the data statistically to reach some conclusion. He publishes his conclusion in the form of research articles in scientific journals and books. Publishing results is an essential part of scientific method.

Q3. Describe the steps involved in the biological method taking malaria as an example? Ans: Malaria

Malaria is a common disease in many countries including Pakistan.

Naming:

The word malaria is the combination of two Italian words:

- "Mala" Mean
- "Area" Mean "air"

Biological problem 1: what is the cause of Malaria

Step 1: Observation:

- Malarial patient experienced recurring attacks of chills and fevers.
- The disease was more common among people who lived in low marshy area.
- Drinking the water of marshes does not cause malaria.

These observations did not help much for solving the problem I-e "what is the cause of malaria" In 1878 a French physician Laveran examined the blood of a malaria patient under microscope. Five year late, the same microorganisms were observed in the blood of malaria patient and these microorganisms were given the name of **"Plasmodium"**

Step 2: Hypothesis and Deduction:

Hypothesis

Biologist further build upon the ancient observation and the discovery of Laveran the hypothesis made in this case was,

"Plasmodium is the cause of Malaria"

Deduction:

Biologist does not know whether his hypothesis is true or not, but he accepts it may be true and makes a deduction. One of deduction from above hypothesis was,

If plasmodium is the cause of malaria, then all malarial patients should have plasmodium in their blood

Step 3: Experiment and Result:

Experiment:

The next step was to test the deduction through experiments which were designed as,

"Blood of 100 malaria patients was examined under microscope. For the purpose of having a control group, the blood of 100 healthy persons was also examined under microscope"

Result:

It was observed that all the malarial patients have plasmodium in their blood; whereas the blood of healthy persons was free from plasmodium.

Step 4: Conclusion

The result was quite convincing and proved that the hypothesis "Plasmodium is the cause of malaria" was true.

Biological problem 2: How is plasmodium transmitted to human beings? Step 1: Observation:

Biologist were having following observations

- Malaria is associated with marshes
- Drinking water of marshes does not cause malaria.

From these observations it can be concluded that plasmodium was not in the marsh water. But it must be carried by something that comes to marsh water.

In 1883 a physician A.F.A king listed twenty observations. Some important observation of A.F.A king were:

- People who slept in open places suffered from malaria more than the people who slept indoors.
- Individuals who slept near a smoky fire usually did not get malaria.
- Those people who used mosquito nets suffer less from malaria as compared to those who did not use mosquito nets.

Step 2: Hypothesis:

On the basis of this observation king suggested a hypothesis:

"Mosquitoes transmit plasmodium and so are involved in the spread of malaria **Step 3:**

Following deductions were made considering the hypothesis as true:

"If mosquitoes are involved in the spread of malaria then, plasmodium should be present in mosquitoes" OR

"A mosquito can get plasmodium by biting a malarial patient"

Step4: Experiment:

Ronald Ross was a British army physician who worked in India in the 1880s. He performed an important experiment to test the above deduction He allowed a female Culex mosquito to bite sparrows suffering from malaria. Some of the mosquitoes were killed and studied at various time Ross found that plasmodium multiplied in the wall of the mosquito's stomach and then moved into
mosquitoes' salivary glands. He said some mosquitoes need the blood of mammals or birds for the maturation of the eggs. Ross found that the saliva of the infected mosquito contained plasmodium and in these previously healthy sparrows, he found many plasmodia.

Result:

It was observed where sparrows had plasmodium in their blood.

Step 4: Conclusion:

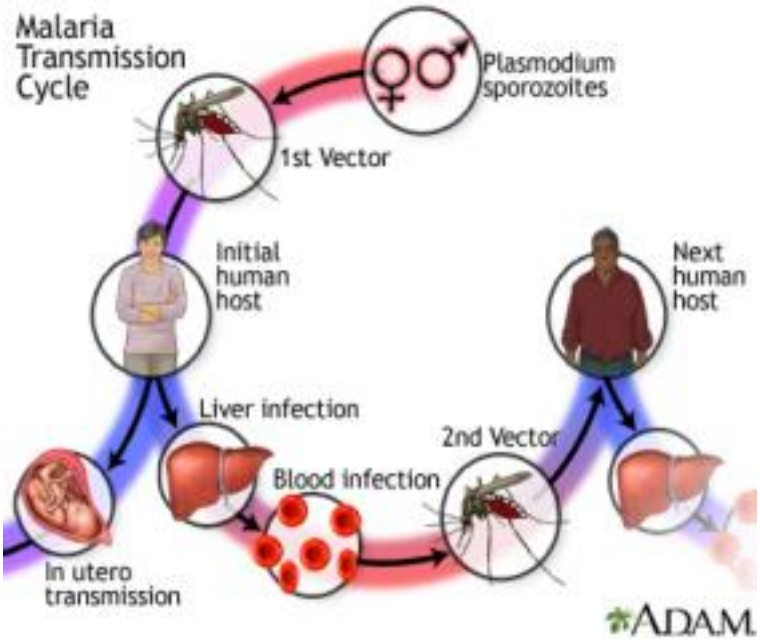
The results were quite convincing and proved that the hypothesis "How plasmodium transmitted to human beings" was true.

Q4: Explain the experiment of malaria on humans?

Anion the end hypothesis was tested by direct experimentation by human beings. In 1898 Italian biologists allowed an anopheles mosquito to bite a malaria patient. The mosquito was kept for a few days and then it was allowed to bite a healthy man. This person later got malaria. In this way, it was confirmed that mosquitoes transmit plasmodium and spread malaria.

Transmission of plasmodium:

When a female mosquito pierces the skin with her mouthparts, she injects a small amount of saliva to prevent the blood from clotting in her food canal.



Q5: Write a comprehensive definition of theory, law or principle.

Ans: Theory: -

When more research is carried out on a hypothesis and all the available evidence favors it, then it becomes theory.

Explanation: -

We know that when a hypothesis has been proved by experiments. Scientists keep on trying to do more experiments on it. When a hypothesis is proved by many experiments, scientists develop

more hypotheses that are proved by many experiments, scientists develop more hypotheses from it and test them experimentally. If the new hypotheses are again proved the original hypothesis becomes a theory.

Example: -

- Darwin theory about evolution
- Lamarck theory about evolution

Law or scientific principle: -

When a theory is accepted again and again and becomes a universal truth is called law. It must be simple, universal and absolute.

Explanation: -

Many biologists take it as a challenge and exert greater efforts to disprove the theory. If a theory survives such a doubtful approach and continues to be supported by experimental evidence, it becomes law or principle. A scientific law is a uniform or constant fact of nature.

Example:

Hardy Weinberg principle and Mendel's laws of inheritance.

Q6: Discuss data organization and data Analysis?

Ans: Data organization and data analysis are important steps in the biological method.

Data organization:

Data;

Data can be defined as

"Data can be defined as

"A piece of information such as name, date or values taken from observation and experimentation"

In order to formulate and then to test the hypotheses, scientists collect and organize data through the use of variables and controls, results can be determined.

a. Variable:

Variables are those factors being tested in an experiment and usually compared to a control.

control;

A control is a known measure to which scientists can compare their results. Prior to conducting an experiment, it is very important for a scientist to describe the data collection methods. It ensures the quality of the experiment. Data is organized in different formats like graphics, tables, flow charts, maps and diagrams.

Data analysis;

Data analysis is necessary to prove or disprove hypotheses by experimentation. The methods involved in testing or analyzing the data are also important since an experiment should be repeated by others to ensure the quality of results. Depending on the type of data and the biological problem, this might include application of statistical methods i.e., ratio and proportion.

aeration:

When a relation between two numbers e.g. 'a' and 'b' is expressed in terms of quotient (a/b), such a relation is the ratio of one number to the other. A ratio may be expressed by putting a division (÷) or Colon (:) mark between the two numbers.

Example:

The ratio between 50 malarial patients and 150 normal persons is 1: 3.

proportion:

Proportion means to join the equal ratios by the sign of equality (=).

Example:

a: b = c: d

is a proportion between the two ratios? This proportion may also be expressed as

a: b:c: d.

In every proportion of two ratios have four terms i. e The first and fourth terms are

called extremes, the second and third are called means.

So, in the above proportions 'a' and 'd' are extremes while 'b' and 'c' are meanings.

The basic rule used to solve problems through ratio and proportion is that the product of the extremes is equal to the product of means. When three values in a proportion are known, the fourth one (X) can be calculated by using this rule.

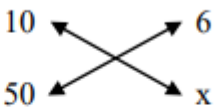
Example: -

If a biologist wants to know how many sparrows would be infected with malaria if he allows Culex mosquitoes to bite 50 sparrows. Previously in one of his findings he already noticed that if allowed Culex mosquitoes to bite 10 sparrows 6 out of them got malaria.

Rule: a: b:c: d

Sparrow: -

Sparrow: -



10x = 50 × 6

Dividing both sides by 10.

$$\frac{10x}{10} = \frac{300^{30}}{10}$$

$$x = 30$$

It means that 30 out of 50 sparrows will get malaria. Proportions are used to draw the conclusion.

Q7: What is the relationship between biology and Mathematics?

Ans: Mathematics as integral part of science:

Mathematics is used in biology in many fields.

Applied mathematics:

Biological methods also involve the use of applied mathematics to solve biological problems. Major biological Problems in which knowledge of mathematics is used include gene finding, protein structure and the modelling of evolution

Bioinformatics:

Bioinformatics refers to the use of algorithms, computational and statistical techniques for the analysis of biological data. Computational biology refers to hypothesis driven investigation of specific biological problem using computer

For Example:

It is used for calculation in the Human genome project. This project is used to determine the gene sequence of a particular organization. Mathematics is also used in ecology and evolution.

SHORT QUESTION

B. Give short answers to the following question?

Q1. What is science? How does science work?

Ans. See Q NO 1

Q2. Control group is important for scientific study, How?

Ans. Control group:

It is a group that remains constant throughout the experiment to test a hypothesis. But other variables are compared with it.

Importance:

1. To find a more accurate and acceptable result of the experiment.
2. To compare the result with it.
3. To know the effect of treatment.

Q3. What deductions were developed during the study of Malaria?

Ans. Biologist does not know whether his hypothesis is true or not, but he accepts it may be true and makes a deduction.

I. "If Plasmodium is the cause of malaria, then all malarial patients should have plasmodium in their blood"

ii. "if mosquitoes are involved in the spread of malaria and Plasmodium should be present in mosquitoes"

iii. "A mosquito can get plasmodium by biting a malarial patient"

Q4: How Ronald Ross conducted the experiment to prove that mosquitoes are involved in the spread of malaria?

Ans: Ronald Ross Experiment:

Ronald Ross was a British army physician who worked in India in 1880's. He performed an important experiment to test the above deduction. He allowed a female Culex mosquito to bite sparrows suffering from malaria. Some of the mosquitoes were killed and studied at various times. Ross found that Plasmodium multiplied in the wall of the mosquito's stomach and then moved into mosquito's salivary glands.

He kept some mosquitoes alive and allowed them to bite healthy sparrows. Female mosquitoes need the blood of mammals or birds for the maturation of their eggs. Ross found that the saliva of the infected mosquito contained Plasmodium and these entered the sparrow's blood. When he examined the blood of these previously healthy sparrows, he found many Plasmodium.

Q5: At what stage of the biological method, Hypothesis, is accepted or rejected?

Ans: The stage of the biological method, in which a hypothesis is accepted or rejected is an experiment. The most basic step of a biological method is experimentation. After experimentation the incorrect hypotheses are rejected and the one which proves correct is accepted.

LONG QUESTION

Give Detailed answers to the following Questions.

Q1: Differentiate between inductive reasoning and deductive reasoning? Ans: See Q No. 2

Q2: Explain how biologists use scientific methods to solve the mysteries of addressing the malarial problem?

Ans: See Q No. 3
Q3: Explain how mathematics can be used to interpret the data obtained through experimentation.
Ans. See Q No. 6(See ratio, proportion and solved example)

Different Type Notes Please Check This

Biology Chapter 2 (Solving a Biological Problem) Understanding The Concepts

Q.1) Describe the steps involved in the biological method taking malaria as an example.
Steps involved in biological method:

In the last part of the nineteenth century, many different causes of malaria were being suggested.

Observations about malaria:

By that time there were four major observations about malaria.

1. Malaria and marshy areas have some relation.
2. Quinine is an effective drug for treating malaria.
3. Drinking the water of marshes does not cause malaria.
4. Plasmodium is seen in the blood of malarial patients.

Hypothesis about malaria:

The hypothesis made in this case was;

"Plasmodium is the cause of malaria"

Scientists do not know whether their hypothesis was true or not, but they accept it may be true and make deductions. One of the deductions from the above hypothesis was;

"If plasmodium is the cause of malaria, then all person ill with malaria should have Plasmodium in their blood".

An experiment about malaria:

The next step was to test the deduction through experiments which are designed as,

"Blood of 100 malarial patients was examined under the microscope. For the purpose of having a control group, the blood of 100 healthy persons was also examined under the microscope".

Results about malaria:

The results of the experiments showed that almost all malarial patients had plasmodium in their blood while 07 out of 100 healthy persons also had plasmodium in their blood (now we know that Plasmodium in the blood of healthy people was in incubation period i.e. the period between the entry of parasite in host and appearance of symptoms). The results were quite convincing and proved that the hypothesis "Plasmodium is the cause of malaria" was true.

Q.2) If a test shows that some people have Plasmodium in their blood but they do not show any symptoms of malaria, what hypothesis would you formulate to answer this problem?

If some people have Plasmodium in their blood but they do not show any symptoms of malaria, then plasmodium is present in them but it is under incubation period (incubation period is the time between catching an infection and symptoms appearing). So a hypothesis made in this case would be,
"Plasmodium under incubation period doesn't show malarial symptoms in its host"

Q.3) How the principles of ratio and proportion are used in biological methods.

Proportion means to join two equal ratios by the sign of equality (=). For example; a:b = c:d is the proportion between the two ratios. This proportion may also be expressed as a:b:: c:d. In every proportion of two ratios, there are four terms i.e. the first and fourth terms are called extremes, the second and third are called means. So in the above proportion, 'a' and 'b' are extremes while 'b' and 'c' are means. The basic rule used to solve the problems through ratios and proportion is that the product of extremes is equal to the product of means. When three values in a proportion are known, the fourth one (X) can be calculated by using this rule.

Example:

A biologist can calculate how many birds would get malaria when he allows infected mosquitoes to Bite 100 healthy sparrows. In an experiment, he noted that when he allowed mosquitoes to bite 20 sparrows, 14 out of them got malaria. Now he uses the proportion rule.

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Q.4) Justify mathematics as an integral part of the scientific process.

Mathematics as an integral part of a scientific process:

The biological method also involves the use of applied mathematics to solve biological problems. Major biological problems in which knowledge of mathematics is used include gene finding, protein structure, and protein-protein interactions, and the modeling of evolution.

Bioinformatics:

Bioinformatics refers to the use of algorithms, computational and statistical techniques for the analysis of biological data.

Computational biology:

Computational biology refers to the hypothesis-driven investigation of a specific biological problem using computers.

Short Questions fbise biology Class 9th Notes

Q.1) Differentiate between theory and law.

Theory:

The hypothesis that stands 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 hypotheses and so testing goes on. Many biologists take it as a challenge and exert greater efforts to disprove the theory.

Law and principle:

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

Q.2) Quantitative observations are better in the biological method. How?

Answer:

Quantitative observations are considered more accurate than 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
The freezing point of water is colder than the boiling point. A liter of water is heavier than a liter of ethanol.	The freezing point of water 0^0 C and the boiling point is 100^0 C. A liter of water weighs 1000 grams and a liter of ethanol weighs 789 grams.

Initiating And Planning

Q.1) Identify and pose meaningful, answerable scientific questions.

Answer:

Scientific questions:

1. Is an Electron larger than a molecule?
2. Does Filtration separate mixtures based upon their particle size?
3. Can molecules have atoms from more than one chemical element?
4. Do plants need light to grow?

Q.2) For a given biological problem;

- • Formulate and test a working hypothesis.
- • Write instructions for conducting investigations.
- • Organize data appropriately using techniques such as tables and graphs.
- • Analyze data to make predictions, decisions, or draw conclusions.
- • Confirm, modify, or reject a hypothesis using data analysis.
- • Use ratio and proportion in appropriate situations to solve problems

Answer:

Light and Growth

Observation: Plants usually grow in lighted areas.

Question: Can plants grow without light?

Hypothesis: Plants cannot grow without light for photosynthesis.
Prediction: Seeds germinated inside a box (without light) will not grow well, will be smaller than plants grown in light, and may even die.

Materials:

- Six bean seeds
- · Six pots
- · Plant sprayer
- · Potting soil
- · Shelf
- · Cupboard
- · Ruler
- · Notebook
- · Pencil

Procedure:

1. Fill each pot with soil.
2. Plant one bean seed in each pot. Make sure you gently cover each seed with a shallow layer of soil.
3. Place three of the pots outside in a spot that receives lots of sunshine. If the weather is too stormy or overcast, position the pots under the light.
4. Place the remaining three spots in a dark cupboard.
5. Think about what you know of plants and light. Why do you think plants might need light? Why do you think they might be able to do without it?
6. Remember the question of this experiment: Do plants need light to grow? Write down your guess, often called a hypothesis, in your notebook.
7. Spray all your planted seeds gently with the mister.
8. Now it's time to wait. To get the best results, you'll want to observe your seeds for at least three weeks. Make sure you use the mister every couple of days.
9. At the end of each week, take a close look at each of your pots. Write down what you see in your notebook.
10. Once a full three weeks have passed, read through your notes. Did the absence of light make a difference?

Results:

The seeds in the cupboard, away from the light, will not grow. Only the plants that received light will sprout.

Decision:

Hence the hypothesis, "Plants cannot grow without light for photosynthesis" is confirmed.