reaches the stage of validity and is called a *valid* or *scientific hypothesis*. At this stage, a hypothesis becomes a *Law* or *Theory*. We must, however, add that this stage of absolute validity and proof, no longer open to question, is only an *ideal* which may be *realized more and more*, but about which we can never be certain that it has been *fully realized* by a hypothesis. Our knowledge is always growing in its scope and contents, and every advance in it necessitates a revision of our previously accepted hypothesis.

Kinds of Hypothesis.

As the aim of a hypothesis is to explain certain phenomena, it is essentially explanatory in character. But a *distinction* is sometimes made between *explanatory* and *descriptive* hypothesis. A hypothesis is said to be explanatory when it accounts for the facts which it seeks to explain *by finding out their cause*. If, for example, a hypothesis attempts to explain the failure of a strike by pointing out its cause, it will be an explanatory hypothesis. A descriptive hypothesis accounts for facts *by simply describing the manner in which they happen*. If, for example, our hypothesis tells the way in which the strike started, developed and failed, it will be a descriptive hypothesis. Thus, a descriptive hypothesis simply tells us *how* a phenomenon happens, while an explanatory hypothesis also tells us *why* it happens as it does. The former simply describes what is, and the latter, what must be and why it must be. But we should not think that there is any opposition between the two. When a descriptive hypothesis describes the way in which

a phenomenon happens, it *does explain*, to some extent, the cause of that phenomenon and is to that extent explanatory. Similarly, when an explanatory hypothesis refers to the cause of a phenomenon, it *does describe the manner* in which that cause works. Hence, strictly speaking, there is no *essential distinction* between a descriptive hypothesis and an explanatory hypothesis. All hypotheses are descriptive as well as explanatory in character.

Use and Function of Hypothesis.

Hypothesis is useful in many ways. It is clear from the preceding remarks that it is required in every sphere, whether of theory or practice. As a matter of fact, it is the basis of all knowledge and science. We may briefly note the following uses of hypothesis :—

1. *Hypothesis lies at the root of all explanation.* It is natural to make suppositions about every unknown fact that we want to explain. We explain facts by proving their causes, and causes are always *supposed* before they are *proved*.

2. *Hypothesis lies at the root of all inquiry and discovery.* It marks a beginning in the process of investigation. Without some hypothesis in hand, our inquiry must be all haphazard and a leap in the dark. Even Mill, who is disposed to underrate the importance of hypothesis in inductive investigation, speaks of the function of hypothesis as "*suggesting observations and experiments*" and "one which must be reckoned as absolutely indispensable in science. Without such assumptions, science could

never have attained its present state." Again—"It is allowable, useful and often even necessary, to begin by asking ourselves what cause *may* have produced the effect, in order that we may know in what direction to look out for evidence to determine whether it actually *did*". Even an insufficiently verified hypothesis is scientifically useful inasmuch as it opens up a line of inquiry which is seldom fruitless. Jevons writes in his *Principles of Science* : "In later years, Professor Huxley has strongly insisted upon the value of hypothesis. When he advocates the use of 'working hypothesis', he means no doubt that any hypothesis is better that none and that we cannot avoid being guided in our observations by some hypothesis or other."

3. *Hypothesis lies at the root of all laws and theories*. Laws and theories are nothing but proved and established hypotheses. As Mill says : "They are necessary steps in the progress to something certain; and nearly everything which is now theory was once hypothesis."

Fact, Theory and Law.

The word "fact" comes from Latin "*factum*", implying what has been done. "Fact" thus signifies what has been done or what has happened. "Fact", accordingly, covers all those *presentations* (*i.e.*, objects of experience) which are immediately known and whose truth, therefore, cannot be questioned. Theory, on the contrary, comes within the province of *inferential* knowledge—what is legitimately thought out to explain a *class* of facts. Again, "facts" are supposed to be essentially

concrete and *individual*; and, as inference has to deal mainly with *general truths*, "theory" is used in the sense of a *general truth*. In some cases, however, the word 'fact' is also applied to a general truth, when it is proved beyond doubt: for example, when we speak of the "fact" of gravitation, or of the mortality of man. In such cases, the word "fact" is extended to cover general truths simply because these possess the certainty of concrete or individual cases. "Fact" in this sense means what is objectively true or certain. In the words of Whewell "At any one of the steps of Induction, the Inductive proposition is a *Theory* with regard to the *Facts* which it includes, while it is to be looked upon as a *Fact* with respect to the higher generalizations in which it is included. In any other sense, the opposition of *Fact* and *Theory* is untenable and leads to endless perplexity and debate. Is it a Fact or a Theory that the planet Mars revolves in an ellipse about the Sun? To Kepler, employed in endeavouring to combine the separate observations by the conception of an ellipse, it is a Theory; to Newton, engaged in inferring the law of force from a knowledge of the elliptical motion, it is a Fact. There are no special attributes of Theory and Fact which distinguish them from one another. Facts are phenomena apprehended by the aid of conceptions and mental acts, as Theories also are. We commonly call our observations *Facts*, when we apply, without effort or consciousness, conceptions perfectly familiar to us: while we speak of *Theories*, when we have previously contemplated the Facts and the connecting Conception separately, and have made the connection by a conscious mental

act. The real difference is a difference of relation ; as the same proposition in a demonstration is the *premise* of one syllogism and the *conclusion* in another —as the same person is a father and a son." Thus, there is no fundamental separation between facts and theories. What we call facts are but results of previous investigation and theorising as well as the starting point for fresh investigation and theorising. There is, accordingly, a continuity between facts and theories : facts, when carefully examined, lead to theories ; and theories, when proved and generally accepted, are known as facts.

When a theory is well established (*i.e.*, when it proves to be an instrument of satisfactory explanation of various phenomena), it becomes a *law*. As opposed to a fact which is particular or individual, a law is general or universal in nature. In this respect, there is no difference between law and theory, for both refer to general truths : both are expressions of a general relation among facts or phenomena of a particular class. But there is no agreement among scientists about the use of the words "law" and "theory". Some hold that a law stands higher than a theory ; others hold that a theory stands higher than a law. According to the latter, a law is an expression of a general relation among phenomena of a *particular* class; whereas a theory is an attempt at a systematisation of a number of laws : it is a system of laws. For example, we speak of the *law* of reflection and the *law* of refraction, but of the wave *theory* of light (under which these laws are systematised). But

generally, the words "law" and "theory" are interchangeably used : we speak of the *theory* of gravitation as well as of the *law* of gravitation.

SUMMARY

Nature and conditions of Hypothesis.—When we do not know the cause of an event, we have to make suppositions or conjectures. Such suppositions are called hypotheses. So we may define hypothesis as a supposition made in order to explain something ; it is a provisional or temporary explanation, a tentative proof. To start with, a hypothesis may have insufficient evidence, but as our investigation progresses, it goes on becoming either stronger and stronger or weaker and weaker, and is ultimately accepted or rejected. A hypothesis is a hit-or-miss affair and in both cases it is useful. If it hits, well and good ; if it "misses" even then it is useful in so far as it points out the path to be avoided. The truth of every hypothesis is tested. This means that every hypothesis is tried, and, if it errs, it is left out. Then another is taken up and tried in the same way. Thus, every hypothesis is held subject to trial and revision.

There are no rules for making a hypothesis ; it is purely a matter of the investigator's inventiveness or insight.

A hypothesis is a conjecture, but not a silly conjecture ; it is a plausible conjecture. To be valid or legitimate, a hypothesis must fulfil the following conditions : (1) It must be based on facts ; it must start with facts and end with facts The means that it must not be a fanciful guesswork but should be real and should refer to what is called by Newton a *vera causa*, a real cause. (2) A hypothesis must not be self-contradictory. What is self-contradictory cannot be true. For example we cannot suppose that a certain person is a liar and also trustworthy. (3) A hypothesis must not go against an already established truth. We cannot suppose that a man, instead of falling down from a tree, soared to the sky. This would be against the Law of Gravitation which is already established. (4) A hypothesis must be verifiable. This means that it must be capable of being proved or disproved. A hypothesis which can neither be proved nor disproved remains a conjecture for ever and is called a barren hypothesis For example, the hypothesis that the earth is resting on the horns of a bull is a barren hypothesis. If it cannot be disproved, it cannot be proved either. (5) A hypothesis must be adequate. This means that a hypothesis must explain all the facts under investigation and should not leave out or ignore any fact. If a fact cannot be explained by a hypothesis, then the fact should not be left out or distorted to suit the hypothesis, but the hypothesis should be changed. Any discrepancy with facts is fatal to hypothesis. Facts are essential in hypothesis, first and last.

Verification and confirmation of hypothesis.—A hypothesis is verified by an appeal to facts If the conclusions deduced from a hypothesis

agree with facts, the hypothesis is said to be confirmed, or verified; the greater the agreement, the greater the confirmation. Verification may be direct or indirect. When a direct appeal is made to facts, our verification is direct. For example, if I suppose that I have left my books in the class-room and go there to see whether my hypothesis is true or not, it would be direct verification.

Indirect verification is verification by deduction. We deduce consequences from our hypothesis and see whether they agree with actual facts or not. In other words, we say that, if our hypotheses were true, such and such consequences should follow. And if those consequences are actually there, then our hypothesis is verified, otherwise not.

Proof of Hypothesis.—If a hypothesis is verified, it does not mean that it is proved. Verification is not complete proof. A hypothesis is said to be proved or established when it stands as the *only* hypothesis, excluding all other hypotheses which are in the field. So long as there are many hypotheses, even two, in the field none of them is proved. In order to be proved, a hypothesis should not only show that it explains the facts in question but also that no other one does. The proof of a hypothesis requires the disproof of all other hypotheses. Thus, a hypothesis, to be proved, must be the *only* hypothesis to explain the facts in question.

Crucial Instance.—When there are many hypotheses in the field, we search for some fact which should prove one hypothesis and disprove all others. Such a fact is called a crucial instance. So a crucial instance decides the conflict between the various hypotheses. It serves a very important function in so far as it enables us to choose the right hypothesis out of the several hypotheses which explain, or seem to explain, the phenomenon under investigation

A crucial instance may be obtained by simple observation or by experiment.

Development of Hypothesis.—We may note the following stages in the development of a hypothesis. First stage: at this stage, a hypothesis is only a supposition which is made either without any actual evidence, or on evidence that is insufficient. Second stage: at this stage, a hypothesis gathers some evidence in its favour and passes on to a higher stage of probability and is called a working hypothesis. Third stage: at this stage, a hypothesis is verified and confirmed by an appeal to facts and is called a legitimate hypothesis. Fourth stage: at this stage, a hypothesis is finally proved and is called a law or theory. This final stage of absolute validity cannot, however, be perfectly attained by a hypothesis.

Kinds of Hypothesis —There are two kinds of hypothesis, explanatory and descriptive. An explanatory hypothesis explains a fact by pointing out its cause, and a descriptive hypothesis explains a fact not by telling its cause but by telling the manner in which it happened. In other words, an explanatory hypothesis tells us *why* a phenomenon

happens, and a descriptive hypothesis tells us *how* a phenomenon happens

Use and Function of Hypothesis—Hypothesis is useful in many ways : (1) It lies at the root of all explanation. Explaining facts means proving their causes, and causes are always supposed before they are proved. (2) Hypothesis lies at the root of all inquiry and discovery. It marks a beginning in the process of investigation. In our investigations, we are always guided by some hypothesis or other. (3) Hypothesis lies at the root of all laws and theories. Laws and theories are nothing but proved hypothesis. As Mill says : "Everything which is now theory was once hypothesis."

QUESTIONS

1. Explain the use of hypothesis in scientific investigation. When is an hypothesis to be regarded as established ?

2. How is an hypothesis to be verified ? Write a brief explanatory note on the verification of an hypothesis

3. Point out the functions of Hypothesis in the process of scientific dicovery and trace the stages through which an hypothesis must pass before it becomes established as Law.

4. Explain what is meant by Hypothesis in Science. What are the conditions of a Valid Hypothesis ? It is said that all Induction depends on Hypothesis. How far is this true ?

5. Define Hypothesis and indicate its value for scientific investigation. Distinguish the different kinds of Hypothesis, giving one example of each.

6. Distinguish between a Working Hypothesis and an Established Hypothesis so as to bring out the conditions on which the latter depends.

7. Write a note on Crucial Instance.