1. Details of Module and its structure

Module Detail	
Subject Name	Psychology
Course Name	Psychology 01 (Class XI, Semester - 1)
Module Name/Title	Evolutionary Perspective, Overview of Biological and Cultural Roots – Part 1
Module Id	kepy_10301
Pre-requisites	Working knowledge of Biology till class 10
Objectives	After going through this lesson, the learners will be able to understand the following: 1. To understand the evolution of man and biological and cultural roots. 2. To describe the structure and functions of a neuron.
Keywords	Evolution, Natural Selection , Differential reproducation

2. Development Team

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Table of Contents :

Overview of Evolution, Biological and Cultural Roots

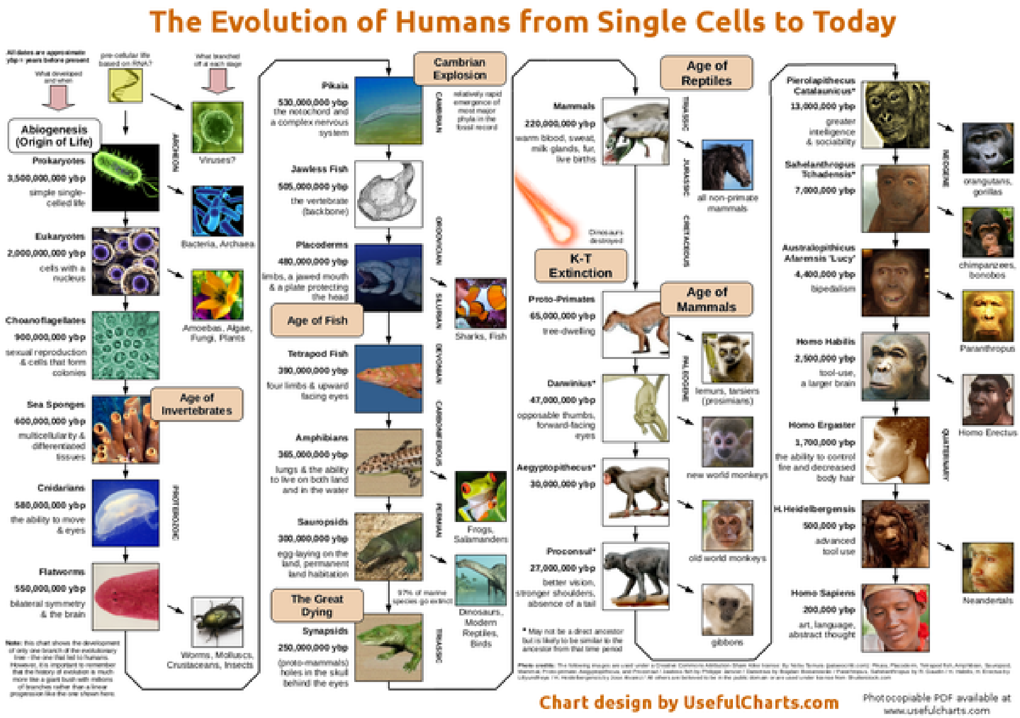
People differ with respect to their physical and psychological characteristics.

Exercise: Look at the following pictures of siblings. Do they look physically similar? Does that tell us anything about how similar they are in behaviour?

Source: https://c1.staticflickr.com/8/7716/17697712221_bbef0ba8ba_b.jpg

The uniqueness of individuals results from the interaction of genetic endowment and environmental demands. There are millions of different species of organisms differing in a variety of ways. Biologists believe that these species were not always like this; they have evolved to their present form from their pre-existing forms. It is estimated that the characteristics of modern human beings developed some 2,00,000 years ago as a result of continuous interaction with the environment.

The journey from the first single celled organism would look something like this!



What is Evolution?

"Evolution" describes the process by which the diversity of life on earth developed over time from common ancestors. Within a population of organisms, there is variation in hereditary traits resulting from changes in the genetic code of individual organisms. A mechanism through which evolution, or change in populations occurs, is through **natural selection**. Evolution occurs with a population because individuals have different sets of these traits that affect their ability to survive and reproduce.

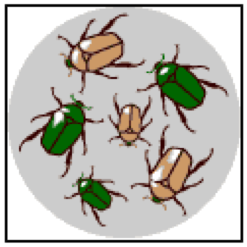
For example, some individuals may be better at finding food, hiding from predators, or attracting mates. Those organisms with traits that help them to survive and reproduce are more likely to pass genes responsible for those traits to the next generation, a process termed **natural selection.**

Natural Selection:

Natural selection is one of the basic mechanisms of evolution, along with mutation, migration, and genetic drift. Darwin's grand idea of evolution by natural selection is relatively simple but often misunderstood. To find out how it works, imagine a population of beetles:

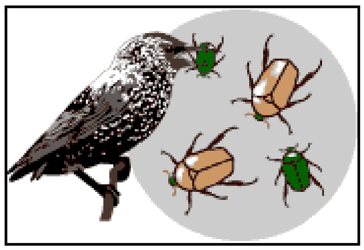
There is variation in traits.

For example, some beetles are green and some are brown.



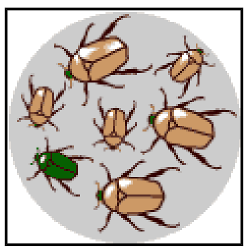
There is differential reproduction.

Since the environment can't support unlimited population growth, not all individuals get to reproduce to their full potential. In this example, green beetles tend to get eaten by birds and survive to reproduce less often than brown beetles do.



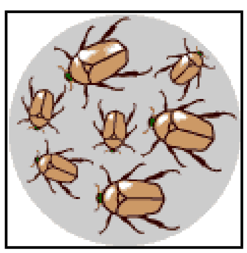
There is heredity.

The surviving brown beetles have brown baby beetles because this trait has a genetic basis.



End result:

The more advantageous trait, brown coloration, which allows the beetle to have more offspring, becomes more common in the population. If this process continues, eventually, all individuals in the population will be brown.



Behavior can also be shaped by natural selection. Human activity has led to environmental changes that have caused populations to evolve through natural selection. A striking example is that of the population of dark moths in the 19th century in England, which rose and fell in parallel to industrial pollution. These changes can often be observed and documented.

When repeated, generation after generation, natural selection leads to the evolution of new species that are more effectively adapted to their particular environment.

This is very similar to the selective breeding of horses or other animals these days. Breeders select the fittest and the fastest male and female horses from their stock, and promote them for selective breeding so that they can get the fittest horses.

Over time, the distribution of characteristics in the population change, reflecting a change in the genetic makeup of the population. This process helps to account for the differences we see within species (microevolution) as well as the emergence of new species (macroevolution).

Evolution thus refers to gradual and orderly biological changes that result in a species from their pre-existing forms in response to the changing demands of the environment.

Physiological as well as behavioural changes that occur due to the evolution process are so slow that they become visible after hundreds of generations.

How did the human evolve?

The Evolution of Man

Three important features of modern human beings differentiate them from their ancestors:

i) A bigger and developed brain with increased capacity for cognitive behaviours like perception, memory, reasoning, problem solving, and use of language for communication,

The increase in size can be seen in the following graph:

Human brain development is evidenced by two facts.

Firstly, the weight of the brain is about 2.35 per cent of the total body weight, and it is the highest among all species (in elephant it is 0.2 per cent).

Secondly, the human cerebrum is more evolved than other parts of the brain.

ii) Ability to walk upright on two legs, and

iii) A free hand with a workable opposing thumb.

These features have been with us for several thousand years. And these evolutions have resulted due to the influence of environmental demands. Some behaviours play an obvious role in evolution.

For example, the ability to find food, avoid predators, and defend one's young are the objectives related to the survival of the organisms as well as their species.

The biological and behavioural qualities, which are helpful in meeting these objectives, increase an organism's ability to pass it on to the future generation through its genes.

Important determinants of behaviour are the **biological structures** that have been inherited from our ancestors in the form of a developed body and brain. The relevance of such biological bases becomes obvious when we observe cases in which brain cells have been destroyed by any disease, use of drug or an accident. Such cases develop various kinds of **physical and behavioural disabilities.** Many children develop other intellectual deficiencies and abnormal symptoms due to transmission of a faulty gene from the parents.

As human beings, we not only share a biological system, but also certain cultural systems. These systems are quite varied across human populations. All of us negotiate our lives with the culture in which we are born and brought up. Culture provides us with different experiences and opportunities of learning by putting us in a variety of situations or placing different demands on our lives. Such experiences, opportunities and demands also influence our behaviour considerably. These influences become more visible as we move from infancy to later years of life.

Thus, besides biological bases, there are cultural bases of behaviour.

Now read the following case study on the fastest case of evolution according to scientists!

Case Study*: *Scientists Cite Fastest Case of Human Evolution

https://i.vimeocdn.com/video/505185517_1280x853.jpg

Tibetans live at altitudes of 13,000 feet, breathing air that has 40 percent less oxygen than is available at sea level, yet suffer very little mountain sickness. The reason, according to a team of biologists in China, is human evolution, in what may be the most recent and fastest instance detected so far.

Comparing the genomes of Tibetans and Han Chinese, the majority ethnic group in China, the biologists found that at least 30 genes had undergone evolutionary change in the Tibetans as they adapted to life on the high plateau. Tibetans and Han Chinese split apart as recently as 3,000 years ago, say the biologists, a group at the Beijing Genomics Institute led by Xin Yi and Jian Wang.

When lowlanders try to live at high altitudes, their blood thickens as the body tries to counteract the low oxygen levels by churning out more red blood cells. This overproduction of red blood cells leads to chronic mountain sickness and to lesser fertility — Han Chinese living in Tibet have three times the infant mortality of Tibetans.

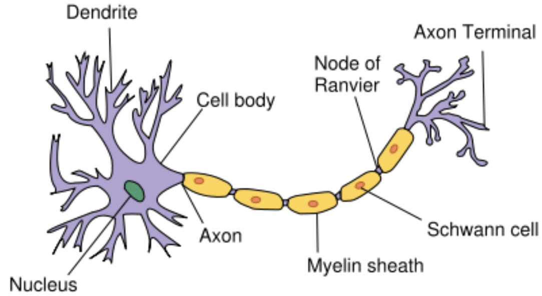
Biological Basis of Behaviour

Neurons

Neuron is the basic unit of our nervous system. Neurons are specialised cells, which possess the unique property of converting various forms of stimuli into electrical impulses. An **electrical impulse** is a surge of electricity, that is, a large flow of electrons or charged particles occurring spontaneously after experiencing a stimulus. The nervous system works by a series of electrical impulses to and from the brain that stimulate muscles and other organs.

Neurons are also specialised for **reception, conduction and transmission** of information in the form of electrochemical signals. They receive information from sense organs or from other adjacent neurons, carry them to the **central nervous system (brain and spinal cord),** and bring motor information from the central nervous system to the **motor organs (muscles and glands)**. Nearly 86 billion neurons are found in the human nervous system.

The Structure and Function of a Neuron



Source:https://upload.wikimedia.org/wikipedia/commons/thumb/b/b5/Neuron.svg/640px-Neuron.svg.png

They are of many types and vary considerably in shape, size, chemical composition, and function.

Despite the differences, they share in common three fundamental components, i.e. 1) Soma, 2) Dendrites 3) Axon.

The soma or cell body is the main body of the nerve cell. It contains the nucleus of the cell as well as other structures common to living cells of all types.

The genetic material of the neuron is stored inside the nucleus and it becomes actively engaged during cell reproduction and protein synthesis. The soma also contains most of the cytoplasm (cell fluid) of the neuron.

The Myelin Sheath

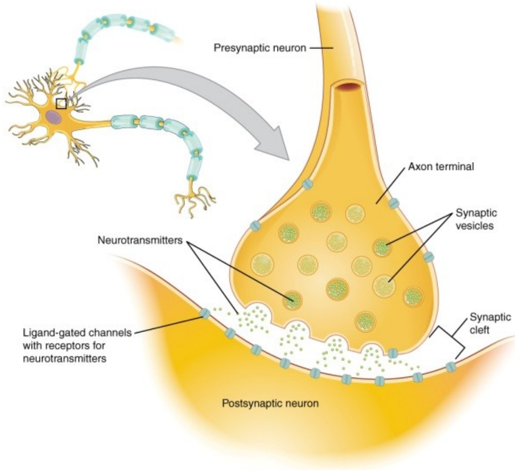
The **soma** is the cell body of a neuron. The nerve cells in the body have a protrusion extending out of the soma that we call an axon. The axon transmits information via electrical impulses from the soma to another cell. The axons that can transmit information the fastest have an electrically insulating layer wrapped around the axon that increases the speed of electric conduction; is called this layer the **myelin sheath**.

Dendrites

Dendrites are the branchlike specialised structures emanating from the soma. They are the receiving ends of a neuron. Their function is to receive the incoming neural impulses from adjacent neurons or directly from the sense organs.

On dendrites are found specialised receptors, which become active when a signal arrives in electrochemical or biochemical form. The axon conducts the information along its length, which can be several feet in the spinal cord and less than a millimetre in the brain.

At the terminal point the axon branches into small structures, called **terminal buttons.**



Source: https://upload.wikimedia.org/wikipedia/commons/3/37/1225_Chemical_Synapse.jpg

These buttons have the capability for transmitting information to another neuron, gland and muscle. Neurons generally conduct information in one direction, that is, from the dendrites through soma and axon to the terminal buttons. The conduction of information from one place to another in the nervous system is done through nerves, which are bundles of axons.

Nerves are mainly of two types: sensory and motor. **Sensory nerves**, also called afferent nerves, carry information from sense organs to central nervous system. On the other hand, **motor nerves**, also called efferent nerves, carry information from central nervous system to muscles or glands. A motor nerve conducts neural commands which direct, control, and regulates our movements and other responses. There are some **mixed nerves** also, but sensory and motor fibers in these nerves are separate.

What is nerve impulse? And how does information travels

Nerve Impulse: Information travels within the nervous system in the form of a nerve impulse. When stimulus energy comes into contact with receptors, electrical changes in the nerve potential start.

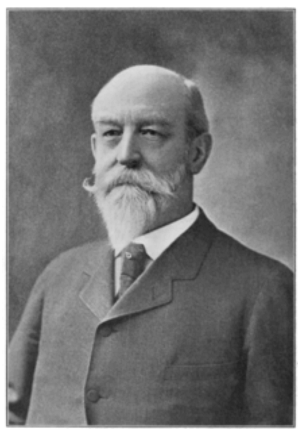
Nerve potential is a sudden change in the electrical potential of the surface of a neuron.

When the stimulus energy is relatively weak, the electrical changes are so small that the nerve impulse is not generated, and we do not feel that stimulus. If the stimulus energy is relatively strong, electrical impulses are generated and conducted towards the central nervous system. The strength of the nerve impulse, however, does not depend on the strength of the stimulus that started the impulse.

The nerve fibres work according to the **"all or none principle",** which means that they either respond completely or do not respond at all. The strength of a response of a nerve cell or muscle fibre is not dependent upon the strength of the stimulus. If a stimulus is above a certain threshold, a nerve or muscle fibre will fire. Essentially, there will either be a full response or there will be no response at all.

How Was the All-or-None Law Discovered?

The all-or-none law was first described in 1871 by physiologist **Henry Pickering Bowditch**.



Source:
https://upload.wikimedia.org/wikipedia/commons/3/38/PSM_V78_D628_Henry_Pickering_Bowditch.png

How Does the All-or-None Law Work?

In order to understand how the all-or-none law works, it is important to first learn a bit more about what an **action potential** is and how it takes place. An action potential occurs when a neuron sends information down an axon away from the cell body and toward the synapse. Changes in cell polarization result in the signal being propagated down the length of the axon.

Authors Levitan and Kaczmarek explain, "The all-or-none law guarantees that once an action potential is generated it is always full size, minimizing the possibility that information will be lost along the way."

The intensity of a stimulus does not determine the strength of an action potential. Once the necessary threshold has been reached, a neuron will fire and an action potential will be transmitted from one end of the axon to the other. This means that there is no such thing as a "strong" or "weak" action potential.

In order to gauge stimulus intensity, the nervous system relies on the rate at which a neuron fires and how many neurons fire at any given time. A neuron firing at a faster rate indicates a stronger intensity stimulus. Numerous neurons firing simultaneously or in rapid succession would also indicate a stronger stimulus.

If you take a sip of your coffee and it is very hot, the sensory neurons in your mouth will respond at a rapid rate. The rate and number of neurons firing provides valuable information about the intensity of the original stimulus.

How does the Nerve Impulse travel down the length of the neuron?

Neurons send messages **electrochemically**. This means that chemicals cause an electrical signal. Nerve cells are surrounded by a membrane that allows some ions to pass through and blocks the passage of other ions it is **semi-permeable**.

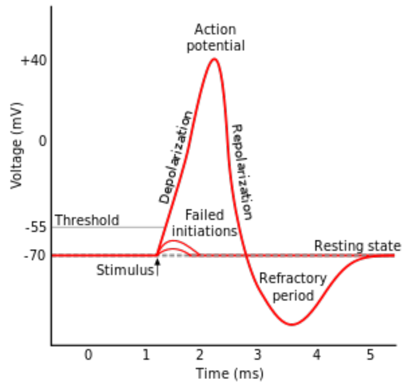
1. Resting Membrane Potential:

When a neuron is not sending a signal, it is "at rest."

When a neuron is at rest, the inside of the neuron is negative relative to the outside. Although the concentrations of the different ions attempt to balance out on both sides of the membrane, they cannot because the cell membrane allows only some ions to pass through channels (ion channels).

At rest, there are relatively more sodium ions outside the neuron and more potassium ions inside that neuron.

2. **Action Potential:**



Source:https://upload.wikimedia.org/wikipedia/commons/thumb/4/4a/Action_potential.svg/486px-Action_potential.svg.png

An **action potential** occurs when a neuron sends information down an axon, away from the cell body. Neuroscientists use other words, such as a "spike" or an "impulse" for the action potential. The action potential is an explosion of electrical activity. This is the **threshold**. If the neuron does not reach this critical threshold level, then no action potential will fire.

When the threshold level is reached, an action potential of a fixed sized will always fire...for any given neuron, the size of the action potential is always the same. There are no big or small action potentials in one nerve cell - all action potentials are the same size. Therefore, the neuron either does not reach the threshold or a full action potential is fired – Which, is the "**ALL OR NONE"** principle.

The strength of the nerve impulse remains constant along the nerve fibre.

Synapse

Information is transmitted from one place to another within the nervous system in the form of a neural impulse. A single neuron can carry a neural impulse up to a distance covered by the length of its axon. When the impulse is to be conducted to a distant part of the body, a number of neurons participate in the process. In this process, one neuron faithfully relays the information to a neighbouring neuron.

The axon tip of a preceding neuron makes functional connections or synapse with dendrites of the other neuron. A neuron is never physically connected with another neuron; rather there is a small gap between the two. This gap is known as synaptic cleft. The neural impulse from one neuron is transmitted by a complex synaptic transmission process to another neuron. The conduction of neural impulse in the axon is electrochemical, while the nature of synaptic transmission is chemical. Synaptic transmission is therefore slower than nerve transmission. The chemical substances are known as neurotransmitters.