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Biology Department

Grade 12

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Unit5: Behaviour

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5.1 An introduction to behaviour

What is behaviour?

- **Behaviour is** the co-ordinated response of an organism to an internal or external stimulus.
- **Components of behavior in a co-ordinated response,**
  1) **Stimuli;** the change in external or internal environment of an organism. E.g. **light, sound, pain , hunger, hormonal change**
  2) **Receptor** a cell or group of cells that detects **change in environment** e.g. **photoreceptors** of the eye detects changes in light
  3) **Coordinating system:** is an organized system that links receptors and effectors and coordinate communication between the two.
  4) **Effector** the part of the body that **produces a response.** such as **muscle or gland**

Plants response

- **Three major type of plant responses.**
- These are:
  1) **photoperiodism,**
  2) **tropism**
  3) **nastic movement**

1. Photoperiodism

- Is generally the development response of plant to photoperiod (day length).
- It is the response to changes in day length that enables plants to adapt to seasonal changes in their environment.
- Particularly, it is the flowering response of different plants to verifying day lengths
- Classified under three groups according to the photoperiods into short day plant, long day plant and day neutral

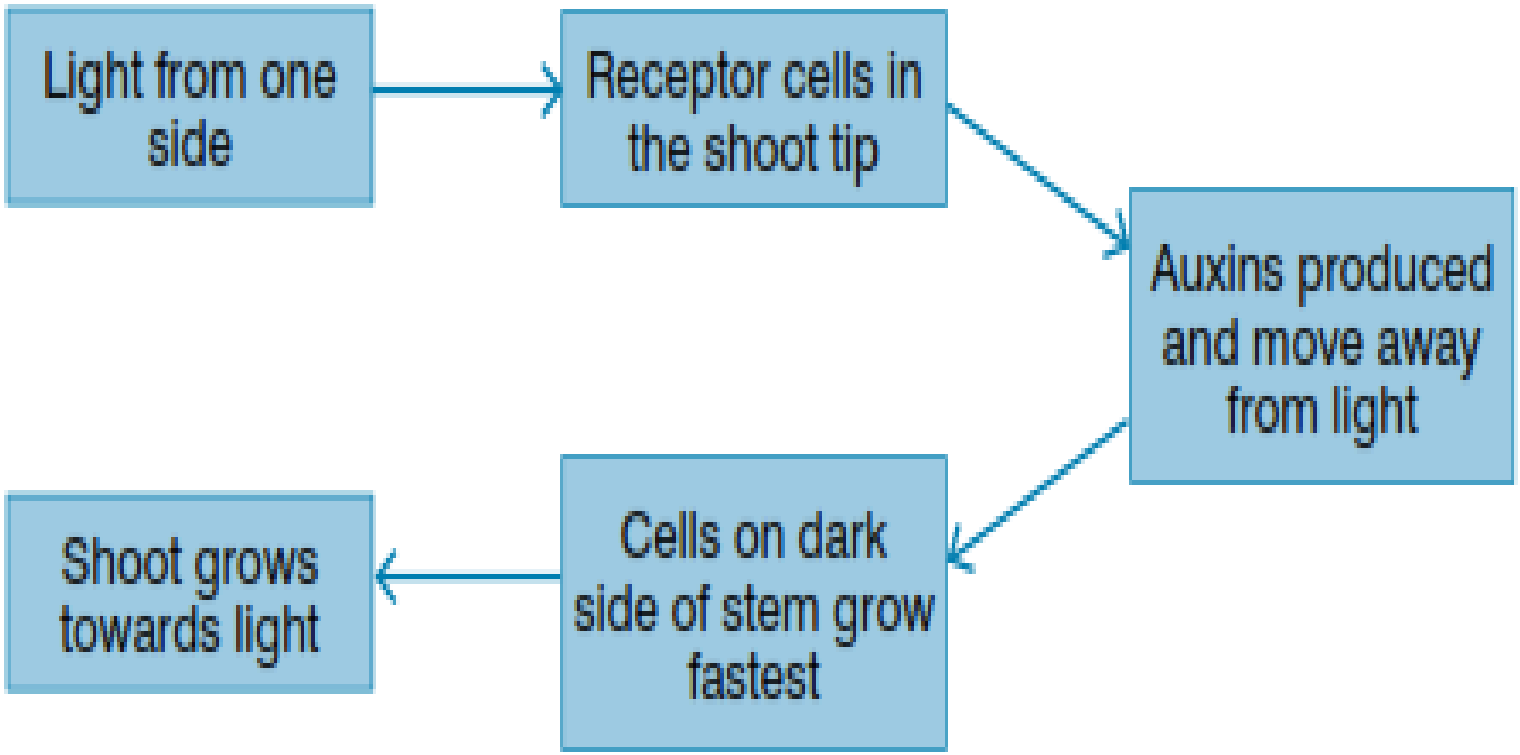
2. Tropism /unidirectional response)

- **Growth response of plant toward or away** from the stimulus
  - **Positive tropism;** growth response toward the stimulus
  - **Negative tropism:** growth response away from the stimulus
    - I. **Phototropism growth response towards light**
      - Shoot= positive phototropism
      - Root – negative phototropism
    - II. **Geotropism** growth response to **gravity.**
      - Roots are positively gravitropic,
      - Plant shoots are negatively geoitropism

3. Nastic movement= non directional response to stimuli

- **Plant response to** uniformly distributed /**Non-directional/** stimuli
- Independent of stimuli position
- E.g. opening and closing of stomata,

Phototropism in plant shoots



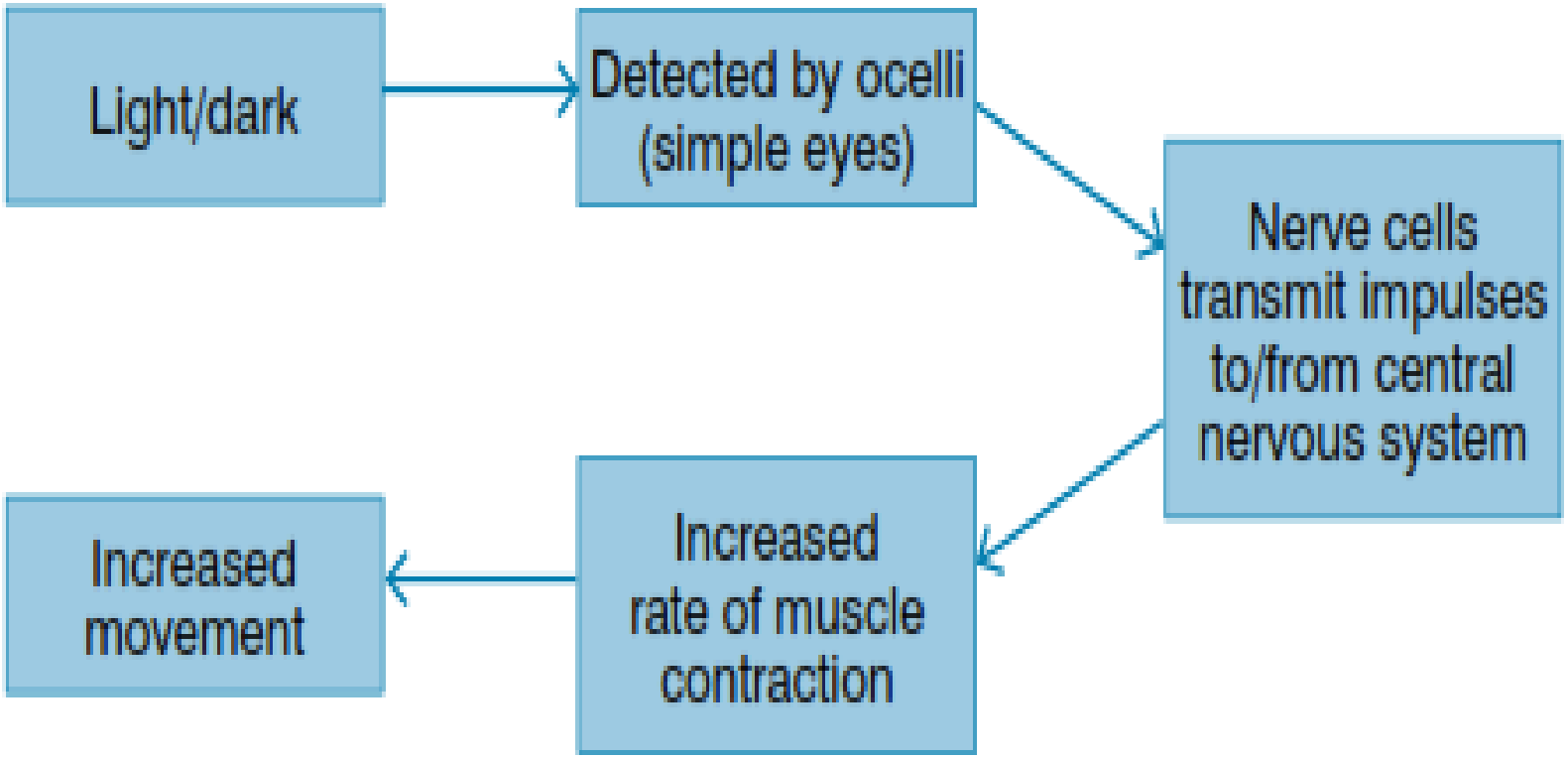
Response in simple animals (Taxis and kinesis)

- Two different types of responses in simple organisms are given below.
- **Taxes** (singular **taxis**),
  - Taxes are **directional movement of an animal**
    - **Toward**s the stimulus (**positive taxis**) or
    - **Away** from the stimulus (**negative taxis**).
  - For example, Euglena swims towards areas of increased light intensity for photosynthesis (positive phototaxis).

Kineses (singular **kinesis**),

- Kineses is **change in the rate of movement** of an organism in response to external stimuli.
- It does **not involve in change in direction**
  - For example, Kineses of **woodlice responding to changes in light intensity and humidity**
  - Woodlice increased movement as the intensity of light increases.
  - Woodlice are small land-dwelling crustaceans that live under logs, stones and bark where it is dark and humid to minimize water loss.
  - Because of its small size, they have large surface area to volume ratio and tend to loss water quickly during high light intensity.

Response of woodlice in response to light



Important to study behaviour

- **Ethology** is the study of animal behaviour in their natural environment.
- **Ethnologists** a biologist who study animal behaviour.
- Studying animal behaviour is important because we can gain information that can be used in:
  1. The human society
  2. Neuroscience
  3. Management of environment resource
  4. Animal welfare
  5. Science education

1. The impact of studying animal behaviour on human society

- Many problems in human society can be related to the interaction of **environment and behaviour, or genetics and behaviour**.
- Animal behaviors may be studied and interpreted to understand human problem: it may help in:
  1. Assessment of the **importance of co-operation** and **reconciliation in social groups..**
  2. **Understanding** the theories of **child development** and **attachment formation**.
  3. **Research on circadian rhythms** in animals has led concept on humans relating to coping with jet-lag or shift-working.

2. The impact of studying animal behaviour on neuroscience

- **Neurology** is the study of brain and nervous system
- **Neuroethology** is the study how behaviour is linked to neural path way
- **Neural path** way is the sequence of nerve cells to bring specific behaviour
  1. The study of animal behaviour may help the determination of: neural pathways
  2. The influence of behaviour demonstrated by social organisation on physiological and cellular processes. Example: variations in social environment can inhibit or stimulate ovulation and miscarriages
  3. The relationship between and social environment has a direct effect on immune system functioning.

3. The impact of studying animal behaviour on management of environmental resources

- The behaviour of animals **provides early clues of environmental damage** and to take action safe guard environment
- Specific examples related to resource management include
  1. Research on how salmon migrate back to their home streams has taught us much about the mechanisms of migration.
  2. knowledge of honeybees' foraging behaviour has given important information about mechanisms of pollination, which in turn has been important for plant breeding and propagation

4. The impact of studying behaviour on animal welfare

- Research and exhibit animal, farm animals, companion animals and endangered species all need care and well-being in the laboratory and in their natural environments.
- To develop reasonable and effective standards for the care and well-being of these animals, etiological information is important.

5.The impact of the study of animal behaviour on science education

- To increase students interests to science education and lead to wider scientific studies

5.2 Innate behaviour

- The word '**innate**' literally means '**inborn**'.
- **Innate behaviour** is behaviour that is present (potentially) at birth or hatching.
- It **does not have to be learned.**
- There are three types of innate behaviour: these are
  1. **Reflex action**
  2. **Orientational behaviour such as Taxis and kinesis**
  3. **Instinctive behaviour**
  4. **Behaviours determined by biological clocks**

1. Reflex actions

- The **simplest** of the innate behaviors;
- A **single action pattern** is performed in response to a specific stimulus.
  1. **Withdrawal of your hand from a hot object,**
  2. **Blinking of eye**
  3. **knee jerk**
  4. **Sneezing**
  5. **Heart rate**
  6. **Breathing rate**

Two main kinds of reflex actions

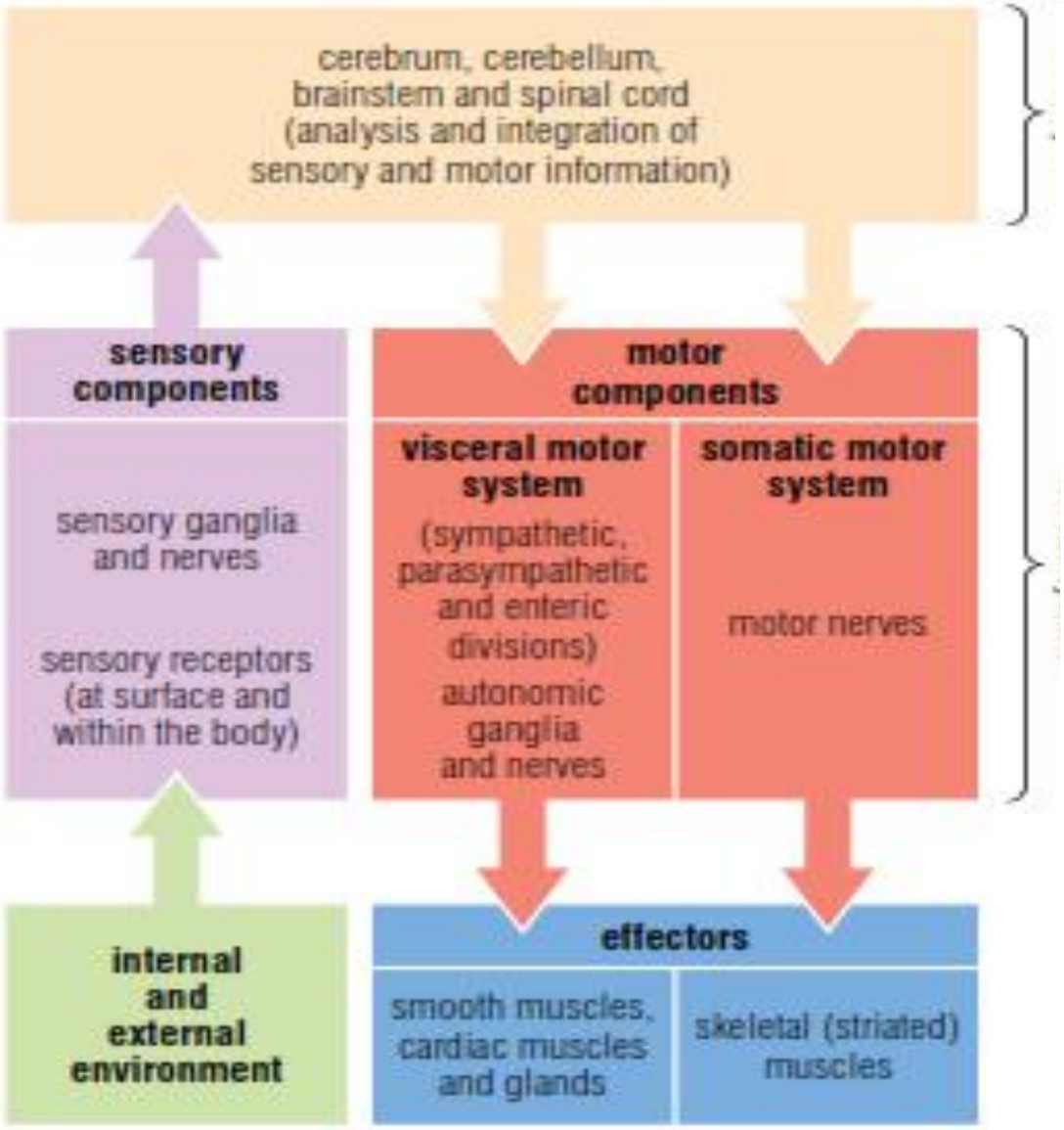
1. **Somatic reflexes**
   - Involves special senses (eyes, ears, pressure detectors, etc.)
   - Somatic reflexes are usually protective based on skeletal muscle contraction. .
   - **Example**: ‘knee-jerk reflex’ and the ‘withdrawal from heat’ reflex.
2. **Autonomic reflexes**
   - Autonomic reflexes control the rate of working of internal organs.
   - **Example:** heart rate and breathing rate.

The structure of the nervous system.

1) **The nervous system is divided physically into two major components:**
   - **Central nervous system (CNS),** consists brain and spinal cord,
   - **Peripheral nervous system (PNS),** consists cranial and spinal nerves.
2) **Functionally nervous system divided into:**
   - **Somatic nervous system (SNS:** integrates information from the special senses to produce responses in skeletal muscles
   - **Autonomic nervous system (ANS):** integrates information from receptors found in internal organs and produces responses in the same or other organs or glands.

The autonomic nervous system is further subdivided into:

1. **Sympathetic division**
   - Transmits impulses from the central nervous system to the organs.
   - Generally preparing the body for ‘fight or flight’ during dangerous situation.
   - Increasing cardiac output and pulmonary ventilation.
2. **Parasympathetic division**:
   - Acts as antagonistically to the sympathetic division
   - Prepares the body for ‘rest and repair’, decreasing cardiac output and pulmonary ventilation



Central Nerve System

Peripheral Nerve System

Functional organization of nerve system

2. Instinctive behaviour

- Instinctive behaviors are pre-programmed patterns of behaviour that involves a complex actions
- **Characteristics of instinctive behaviors**
  1. **Common to all members** of a species
  2. **Fully functional** from the beginning without prior experience
  3. There is a **key stimulus** that triggers the behaviour
  4. **Innate releasing mechanism** that link stimulus to the response by the nervous and hormonal system
  5. Shows a **fixed action pattern** in response to the key stimulus
  6. **Adaptive** : retained by natural selection and have survival value

Examples of instinctive behaviour

1. **Spinning of a web by spider** (Weaving a web)
2. **Nest-building,**
3. **Imprinting**
4. **The aggression stickleback fish**: male stickleback is very territorial, and attacks any male that invades.
5. **Nesting behaviour in lovebirds.**

6. The feeding behaviour of young herring gulls picks at the orange spot a beak of adult gall to receive food



Imprinting

- **Imprinting** the process by which animals acquire their first forms of behaviour, particularly their attachment to their mother
- Imprinting **is an instinctive behavior** in newly born (or hatched) organisms to **attach themselves to the first object** they sea after birth.
- Many evolutionary psychologists believe that a similar pattern of behaviour is found in human infants.
- It Involves strong emotional bond (**attachment formation**) between an infant and its primary caregiver (often mother)

Imprinting….

Konrad Lorenz and the geese that had imprinted on him



Infants form attachments with their caregivers



Imprinting occurs in three stages:

1. **0–2 months** – **pre-attachment**; the infant prefers people to objects but does not really discriminate between different people
2. **2–7 months** – **indiscriminate attachment**; the infant begins to show a preference for familiar people, and
3. **7 months onwards** – **true emotional attachment** to one person initially, although multiple attachments often form soon afterwards.

3. Biological clocks

- Biological clocks are **internal regulatory mechanism** that controls various **cyclical responses** in living things.
- They are **genetically programmed.**
- The clocks evolved independently in different organism and are **example of convergent evolution.**

Type of rhythms

- **Circadian rhythms (control daily cycle)**
  - Is a behavioral response that occur in daily basis.
  - The circadian clocks have two major features.
    - Persist with a period of about 24 hours in the absence of environmental cues.
    - Synchronize to a 24-hour cue, such as light and darkness, this is called **entrainment.**

- **Lunar (controls a monthly cycle)**
- **Circannual rhythms (controls a yearly cycle)**
  - Are yearly cycle that synchronize seasonal variation such as summer, winter,
  - Many animals show **circannual rhythms** in behaviors such as:
    1. **Reproduction of animal** (e.g. hamster, a long day bread) An increase in the dark–light ratio can have regression of testes in long-day breeding animals
    2. **Migration** (for example, swallows)
    3. **Hibernation** (for example, hedgehogs)
    4. **Coat growth** (for example, arctic foxes)
    5. **Camouflage coloring** (for example, arctic foxes)

Exercise

What is the type of innate behavior of each of the following examples?

1) Maggots moving into a more humid environment
2) Geese moving eggs that have rolled out of the nest back to the nest
3) Producing tears when dust gets in your eye
4) Small aquatic crustaceans accumulating at the surface of the water
5) A newborn human grasping a rope strongly enough so that he can be lifted by it

5.3.Learned behaviour

- Learned behaviour behavior that is **acquired through experience** (such as trial and error) or **by insight**
- The **strengthening of existing responses** or the **formation of new responses to existing stimuli** that **occurs because of practice or repetition**
- Unlike innate behaviors, learned behaviour patterns are **rarely fully functional the first time they are performed**.

Comparison of innate and learned behaviour

Innate behaviour	Learned behaviour
1. Genetically determined and common to all members of a species 2. Behaviour is fully functional at the first attempt 3. There is, generally, no modification of the behaviour 4. Adaptive behaviour that has been retained as a result of natural selection	1. The behaviour is changed by, or develops through, experience and may vary from individual to individual 2. The animal develops the behaviour through trial and error or by insight 3. The behaviour may be modified by new experiences 4. Behaviour is learned a new by each member of the species and may not be adaptive

- **There are many different kinds of learned behaviour, including:**
  1. Habituation
  2. Sensitisation
  3. Insight learning
  4. classical conditioning
  5. Operant condition
  6. Latent learning

Associative learning

1. Habituation

- Habituation is a process which results in a **decreased response to a stimulus after repeated exposure to that stimulus** over a period of time.
- **For example,**
  1. The **decrease in response of quite strong smell** on entering a room through it is present
  2. **The habituation of prairie dogs to the presence of human** that is regularly visiting the area
  3. **Animal in the national parks stop running away from humans** when they realize that human are harmless to them
  4. Ordinarily sea slug Aplysia withdraws its gill if it is touched gently on the siphon. However, repeated stimulation of the siphon results in the gill-withdrawal reflex diminishing.

2. Sensitisation

- Sensitisation is **an increase in the response to a harmless stimulus when that stimulus occurs after a harmful stimulus.**
- **Peripheral sensitisation**: results from changes in neurones of the peripheral nervous system.
- **Central sensitisation**: results from change in neurones of the central nervous system.
- **Examples**
  1. Sea slug *Aplysia* gill withdrawal become stronger to a gentle touch following mild electric shock at the tail.
  2. **A boy who had seen a snake crossing his way** earlier jumped up violently when grass touched his legs.

3. Classical conditioning

- In classical conditioning a naturally occurring stimulus becomes associated with a different stimulus and produces the same response.
- **The various stimuli and responses are**:
  1. **The unconditioned stimulus (US),** is natural stimulus that automatically produce response. **For example, smelling a favorite food**
  2. **The unconditioned response (UR)** unlearned response to the unconditioned stimulus. **Example: salivation at smell a favorite food**
  3. **The conditioned stimulus (CS): neutral** stimulus does not initially produce the unconditioned response. But, after association with the unconditioned stimulus, it triggers the same response. E.g. bell ringing
  4. **The conditioned response (CR)** The conditioned response is the response to neutral stimulus. E.g. **Salivation of dog to bell ringing**

Phases of classical conditioning

Before conditioning

Unconditioned stimulus	→ Unconditioned response
Neutral stimulus	→ No unconditioned response

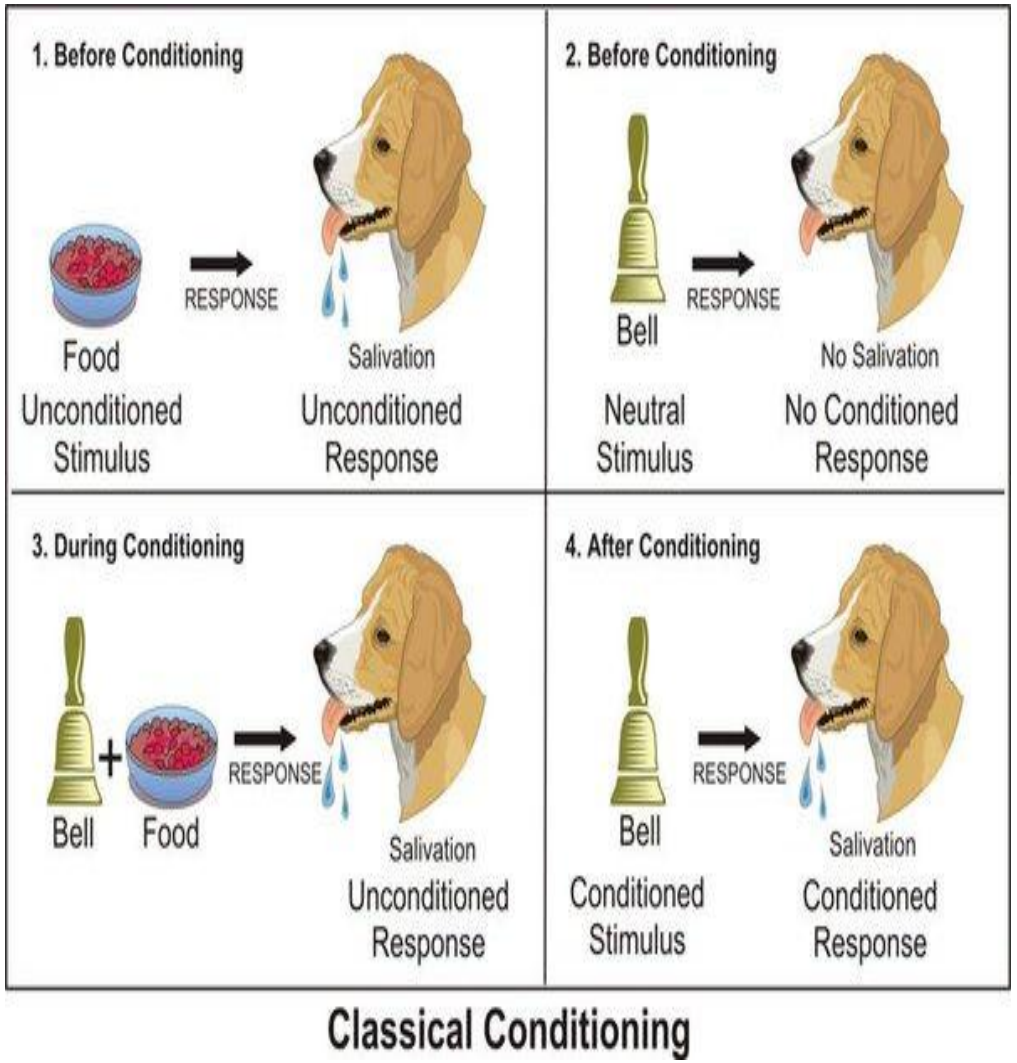
During conditioning

Neutral stimulus + Unconditioned stimulus	→ Unconditioned response

After conditioning

Conditioned stimulus	→ Conditioned response

Pavlov's experiment on classical conditioning



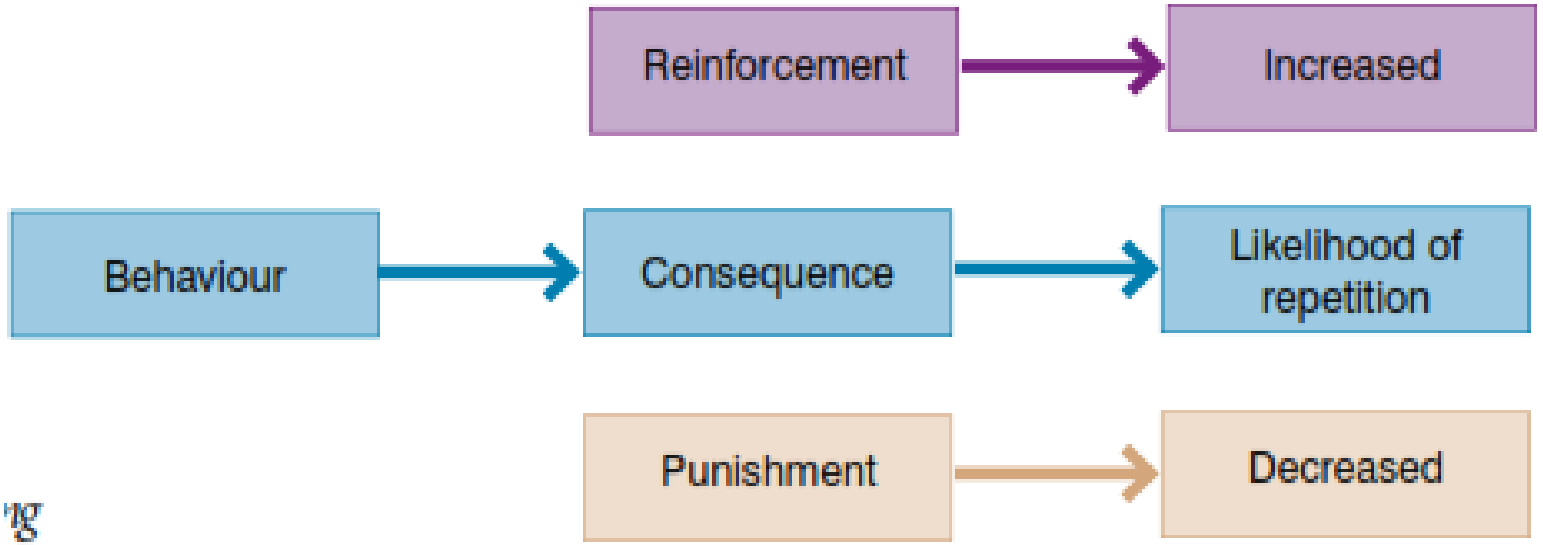
Classical Conditioning

4. Operant conditioning

- Operant conditioning, in which a behaviour is **strengthened or weakened as a result of the consequences** (operants) of that behaviour;
  - **Reward will strengthen** (reinforce) the behaviour,
  - **Punishment will weaken** (extinct) the behaviour
- Operant conditioning is used in **training an animal behaviour by associating with a consequence** (reward or punishment)
- It is learning through trial and error
- It was first used by **B.F. skinner**, a behavioral psychologies
- Skinner identified three type of response that he called operant:
  1. **Neutral response**; neither increase nor decrease the probability of behaviour being repeated
  2. **Reinforcer**: increase the probability of behaviour being repeated
  3. **Punisher**: decrease the probability of behaviour repeated

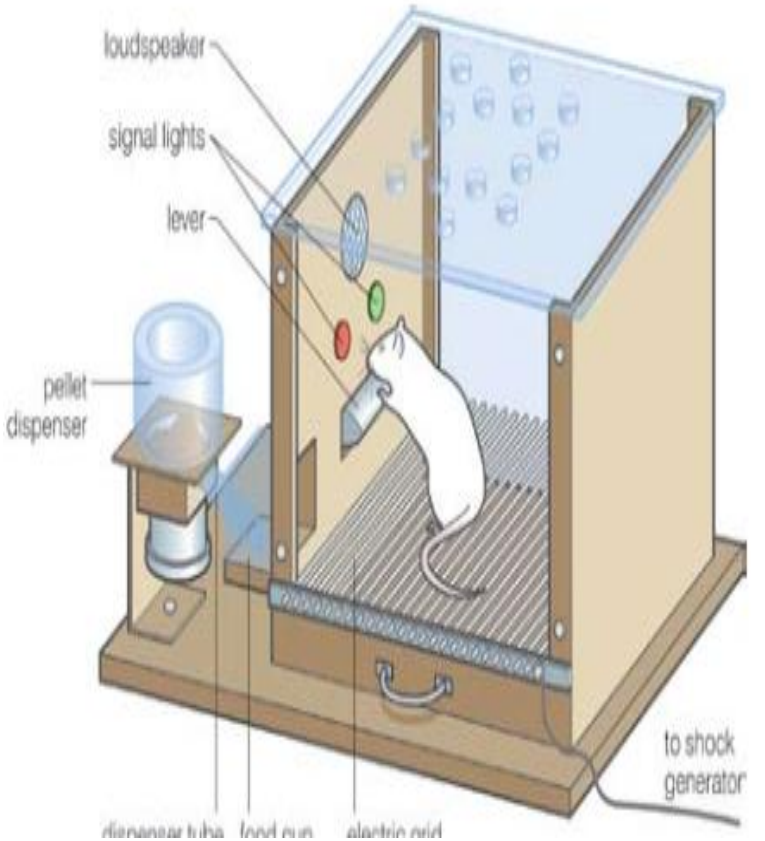
Operant…….

- **For example,** many people start to smoke so that they will be accepted by a certain peer group. Acceptance by this peer group acts as a positive reinforcer for the smoking
- **Animal training (shaping) is based on operant conditioning**
  1. training to guide dogs for the blind
  2. training horses
  3. training dolphins and killer whales at marine parks
  4. training zoo animals



Operant…….

- **The behaviour of the rats in a Skinner box shows operant conditioning because they may:**
  - associate pressing the lever when only one light flashes with reward (positive reinforcement)
  - not press the lever when one light flashes because it is linked with an electric shock (punishment)



Operant conditioning differs from classical conditioning in that:

Classical conditioning	Operant conditioning
1. Is learned associating two stimuli together to produce new response	1. associating a behaviour and a consequence for that behaviour
2. modifying innate behaviour	2. modifying learned behaviour.
3. Not involve rewarding behaviour	3. Involve rewarding behaviour
4. Neutral stimulus become a CS through association with US	4. probability of making a response is altered by consequence following it

5. Latent learning

- This is a **hidden learning** when it occurs. But, **it manifests, without reinforcement**, at the time is needed.
- An example of this could be:
  1. One teacher drives his friends to school every day. Then, on one day, the ‘driver’ is ill. The other teacher drives himself to school without getting lost.
  2. A student studying very hard but not sure of his knowledge until he/she answers the exam question correctly.
- Latent learning is different from learning through operant conditioning because it does not require reinforcement

6. Insight learning

- Insight learning is **problems are solved by mental processing, rather than by trial and error.**
- **Example:**

1. Chimpanzees pills up boxes and climbs on it to reach a bunch of banana hanging from ceiling

2. A chimpanzee choosing a long stick over a short one to retrieve food from outside a cage.



Exercise

What type of learned behaviour is described in each of the following examples? Give a reason for each of your answers.

1. A dog is trained to herd stock animals.
2. A snail is moving along a bench; an experimenter taps the bench and the snail withdraws into its shell. After several repeats of this, the snail just keeps on moving.
3. After a painful blow, even relatively light pressure feels painful.
4. You walk into a room where there is a loud noise and start to read a book. Initially, the noise is disturbing, but after a while you do not notice it.
5. A boy watches his father changing a plug on a lamp. Some time later, he is able to carry out the same task himself without instruction.

5.4 Examples of behaviour patterns

1. Courtship behaviour

- Courtship behaviour is an **activity that precedes and results in mating and reproduction**
- Allows members of a species to recognise each other
- preventing or reducing attempts at interbreeding between different species.

❖ **Courtship behaviour may involve:**

- Secretion of **sex pheromones**
- Courtship **vocalizations.** e.g. courtship songs of frogs
- Touch
- Complex **displays** involving a series of fixed action patterns

Pheromones

- **Pheromones are** hormone secreted by animal, usually the female, to produce a behavioral response
- There are many different pheromones, including:
  - **alarm pheromones** are secreted by animals when attacked and **produce the response of flight or aggression** by others of the same species
  - **releaser pheromones** are highly volatile and **can attract a mate** from a distance of two miles or more
  - **territorial pheromones** are used to mark the boundaries of a territory by the owner; **dog urine contains a powerful territorial pheromone**
  - **sex pheromones** that signal the availability of a female for mating

2. Territorial behaviour

- **Territory** is an area that an animal or a group of animals reserves for itself so as to exclude other members of the same species
- **Males are usually the territorial sex**, but in some species (such as fiddler crabs) females maintain a territory also. .
- **Territorial behaviour is any behaviour that is used to defend an area that gives access to:**
  1. **good foraging**
  2. **increased mating chances**
  3. **reduces vulnerability to predators**
  4. **a den or similar**

Territorial behaviour can involve:

- **Marking the area** (containing pheromones)
  - The Ethiopian wolf (*Canis simensis*) maintain a group territory by marking with urine (containing pheromones).
- **Threatening vocalizations**
- **Threat displays** (exaggerating size or displaying weapons)\
- **Ritual fighting**
  - **Ritual fighting** behaviour in which the acts of fighting are displayed, without any physical contact. Example:
    1. exaggerate an animal's size by the fluffing up of feathers or fur
    2. Show off the animal's weapons.

3. Social behaviour

- Social behaviour is the set of interactions that occur between two or more individuals of the same species
- **Some of the benefits of social behaviour:**
  1. **Form stable groups** and reduce intra-specific aggression
  2. **Improve the effectiveness of reproduction** and/or parenting
  3. **Forage more efficiently** – especially if sources of food are localised
  4. **Protect themselves against attack more effectively**
     - Fish and birds moving in groups to protect from predator
     - Baboons co-operate to fight off a leopard.

Social behaviour…..

5. Protect themselves against attack more effectively

- increase the chance of surviving migration

6. Some birds travel in large groups, for example, many geese fly in a ‘V’ formation, which reduces the total wind resistance on the birds;

7. Increase the chance of surviving extreme conditions

- some birds huddle together in very cold weather, this effectively reduces the overall surface-area-to-volume ratio and can reduce heat loss up to 50%;

8. Communicate across long distances.

9. Increase the chance of surviving migration

10. Penguins ‘huddling’ to reduce heat loss



Social behaviour in bees

- Honeybees and bumblebees and other species of insects exhibit what is called **eusociality.**
- **Eusociality has three main features:**
  1. Co-operation in caring for the offspring;
  2. The presence of several generations in the colony
  3. Division of labour

Social behaviour…..

- **There are three different types or castes of bees in a nest.**

1) **The queen;** reproductively active female (1st caste)
   - The queen maintains the social structure of the colony by secreting pheromones and by aggressive attacks on maturing worker bees.
2) **Workers;** non-reproductively active females (2nd caste)
   - Worker bees communicate with each other by perform a **'wag-dance'** on the honeycomb to inform other workers of the direction of the nectar source and its distance.
3) **Drones:** reproductively active males (3rd caste)