Raja Narendralal Khan Women's College (Autonomous)

2ND SEM STUDY MATERIAL III (PG) - SM

PHY-203, UNIT-18, MODULE-III

HUMAN PHYSIOLOGY

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BEHAVIOURAL PHYSIOLOGY

BEHAVIOUR:

Behaviour is any observable activity of a living animal. For example, a moth flies toward a bright light, a honeybee flies toward a cup of sugar water, and a housefly flies toward a piece of rotting meat. Bluebirds sing, wolves howl, and frogs croak. Mountain sheep butt heads in ritual combat, chimpanzees groom one another, ants attack a termite that approaches an anthill. Humans dance, play sports, and wage wars. Even the most casual observer encounters many fascinating examples of animal behaviour each day. An animal's behaviour is influenced by its genes and by its environment. All behaviour develops out of an interaction between the two.

Genes Influence Behaviour:

1. Innate Behaviours Can Be Performed Without Prior Experience

One indication that genes influence the development of behaviour comes from behaviours that are performed by new born animals and that therefore appear to be inherited. Such **innate** behaviours occur in reasonably complete form the first time an animal encounters a particular stimulus. For instance, a gull chick pecks at its parent's bill very soon after hatching, which stimulates the parent to feed it. Innate behaviour also occurs in the common cuckoo, a bird species in which females lay eggs in the nests of other bird species, to be raised by the unwitting adoptive parents. Soon after a cuckoo egg hatches, the cuckoo chick performs the innate behaviour of shoving the nest owner's eggs (or baby birds) out of the nest (FIG.1). The gull and the cuckoo benefit from their behaviours. The young gull acquires nutrition, and the young cuckoo eliminates its competitors for food. These examples illustrate a more general point about behaviour: Much of it is adaptive and therefore may have evolved by natural selection.

Fig 1: Innate behaviour (a) The cuckoo chick, just hours after it hatches and before its eyes have opened, evicts the eggs of its foster parents from the nest. (b) The parents, responding to the stimulus of the cuckoo chick's wide gaping mouth, feed the chick, unaware that it is not related to them.

Experiments Show That Behaviour Can Be Inherited

ii) Although the widespread occurrence of innate behaviours provides circumstantial evidence that behaviours can be inherited and are therefore influenced by genes, stronger evidence comes from experiments. One such experiment began when researchers noticed that fruit fly larvae exhibit two phenotypes with respect to feeding behaviour. Some larvae are "rovers" and move about continually to search for food. Others are "sitters" and remain in more or less one place and eat whatever is there. When the researchers crossed adult rovers and sitters, all the offspring were rovers. When these first generation rovers bred with one another, however, the resulting generation contained both rovers and sitters in a ratio of roughly 3:1.

iii) Another cross-breeding experiment, this time with blackcap warblers, showed that these birds have a genetically influenced tendency to migrate in a particular direction. Blackcap warblers breed in Europe and migrate to Africa, but populations from different areas travel by different routes. Blackcaps from western. Europe travel in a south westerly direction to reach Africa, whereas birds from eastern Europe travel to the southeast. If birds from the two populations are crossbred in captivity, however, the hybrid offspring try to migrate due south, which is intermediate between the directions of the two parents. This result suggests that genes influence migratory direction.

Particular genes can be identified that influence behaviour:

To determine which genes affect a behaviour, an investigator may select a candidate gene and then examine the effects of mutations that inactivate the gene. In some species, researchers may be able to engineer "knockout" animals in which the candidate gene is disabled. For example, mice in which the *V1aR* gene has been knocked out exhibit increased levels of risky behaviours, such as lingering in brightly lit, open areas (which normal mice avoid, presumably because risk of predation is higher in such places). *V1aR* codes for a protein that is a receptor for the hormone arginine vasopressin (AVP). When AVP binds to receptors in the brain, it influences behaviour, and mice lacking the receptor fail to respond appropriately to dangerous circumstances.

The Environment Influences Behaviour

The development and expression of behaviour can be influenced by variation in an animal's environment, including both the animal's physical environment and its experiences.

- **Behaviours Are Influenced by the Physical Environment:** The environment in which an animal develops can affect its adult behaviour. Consider, for example, the zebrafish. This species is found in diverse habitats, including fast flowing streams in which the water contains ample oxygen and stagnant ponds in which oxygen levels are very low. In an experiment, genetically similar zebrafish were reared from eggs in two different conditions: oxygen-rich or oxygen- poor water. When the fish grew up, the experimenters measured their response to **aggression,** or antagonistic behaviour, from another fish in both an oxygen-rich and an oxygen-poor environment. In the high-oxygen environment, the behaviour of fish that were reared in a high oxygen environment was much more aggressive. In the low-oxygen environment, however, the most aggressive fish were those reared in a low-oxygen environment. It appears that the environment in which a fish develops causes the fish to develop the ability to behave appropriately in the environment that it is most likely to encounter as an adult. An animal's behaviour can also be influenced by the living part of its environment, especially its interactions with other animals. For example, in prairie voles (a small rodent), pups raised by a single mother receive less licking and grooming than do pups raised by a mother and father together. In adulthood, the mating and parental behaviour of voles varies, depending on their experience as pups. Those cared for by two parents mate sooner and provide more attentive parental care than do voles raised by a single parent.

- **Behaviours Are Influenced by the Experiential Environment:** The capacity to make relatively permanent changes in behaviour on the basis of experience is called **learning.** This deceptively simple definition encompasses a vast array of phenomena. A toad learns to avoid distasteful insects; a baby shrew learns which adult is its mother; a human learns to speak a language; a sparrow learns to use the stars for navigation. Each of the many examples of animal learning represents the outcome of a unique evolutionary history, so learning is as diverse as animals themselves. Nonetheless, it can be useful to categorize types of learning, keeping in mind that the categories are only rough guides and that many examples of learning will not fit neatly into any category.
- **Habituation Is a Decline in Response to a Repeated Stimulus:** A common form of simple learning is **habituation,** defined as a decline in response to a repeated stimulus. The ability to habituate prevents an animal from wasting its energy and attention on irrelevant stimuli. For example, a sea anemone will retract its tentacles when first touched, but gradually stops retracting if touched repeatedly. Prairie dogs, which are ground-dwelling rodents, utter loud alarm calls and race to their burrows when potential predators approach their colony (FIG.2). But prairie dogs habituate to repeated approaches by animals that prove to be nonthreatening, such as people on a well-used hiking path that passes near the colony, and stop responding with alarm calls. The ability to habituate is generally adaptive. If a prairie dog ran to its burrow every time a harmless human passed by, the animal would waste a great deal of time and energy that could otherwise be spent on beneficial activities such as acquiring food. Habituation can also fine-tune an organism's innate responses to environmental stimuli. For example, newborn chicks instinctively crouch when any object moves over their heads, but birds that are a few weeks old crouch down when a hawk flies over but ignore harmless birds such as geese. The birds have habituated to things that soar by harmlessly and frequently, such as leaves, songbirds, and geese. Predators are much less common, and the novel shape of a hawk continues to elicit instinctive crouching. Thus, learning modified the innate response, making it more advantageous. Researchers may intentionally induce habituation in animal subjects so they can be studied. For example,

Fig 2: Habituation (a) When a prairie dog detects the approach of a potential predator, it may produce a loud alarm call. However, if harmless intruders approach repeatedly, as when (b) human hikers routinely pass by, prairie dogs learn to stop responding with an alarm call.

Fig 3: Chimpanzees habituate to researcher's scientific investigation of animal behaviour often relies on animals that have habituated to human presence.

most of what we know about the social behaviour of primates such as chimpanzees, gorillas, and baboons comes from studies of wild populations in which animals have been laboriously habituated to human presence. Only then can researchers approach closely enough to observe behaviour (FIG.3).

- **Imprinting Is Rapid Learning by Young Animals:** Learning often occurs within limits that help increase the chances that only the appropriate behaviour is acquired. Such constraints on learning are perhaps most strikingly illustrated by **imprinting,** a form of learning in which an animal's nervous system is rigidly programmed to learn a certain thing only during a certain period of development. The information learned during this *sensitive period* is incorporated into behaviours that are not easily altered by later experience. Imprinting is best known in birds such as geese, ducks, and chickens. These birds learn to follow the animal or object that they most frequently encounter during an early sensitive period. In nature, a mother bird is likely to be nearby during the sensitive period, so her offspring imprint on her. In the laboratory, however, these birds may imprint on a toy train or other moving object (FIG.4). Imprinting is a concern for conservationists who aim to preserve endangered species by rearing animals in captivity for release into the wild. Such programs often go to great pains to ensure that captive-reared animals do not imprint on their human caretakers (FIG. 5a), so that released animals will be attracted to others of their species and not to people. However, conservationists can also take advantage of imprinting to help ensure that captive-reared animals develop behaviours necessary for survival (FIG.5b).

Fig 4. **Konrad Lorenz and imprinting Konrad Lorenz, a pioneer in the scientific study of animal behaviour, is followed by goslings that imprinted on him shortly after they hatched. They follow him as they would their mother.**

Fig 5. Imprinting and endangered species (a) To prevent young California condors from imprinting on humans, caretakers use a condor puppet to feed them. When the captive-reared birds are released to the wild, they will be drawn to other condors rather than to people. (b) Early in life, captive-reared whooping cranes are exposed to and imprint on ultralight aircraft. The young cranes later follow an ultralight to learn the route for their southward migration.

- Conditioning Is a Learned Association Between a Stimulus and a Response: Behaviours generally occur in response to a particular stimulus, and many animals can learn to associate a behaviour with a different stimulus. For example, in a classic experiment conducted by Ivan Pavlov, dogs that normally salivated in response to the sight of food were trained to salivate in response to hearing a ringing bell. This kind of learning, in which an animal learns a new association between a stimulus and an innate response, is known as **classical conditioning.** For example, lemon damselfish perform innate predator avoidance behaviour—hiding and scanning their surroundings—in response to a chemical alarm signal released by other damselfish. After experimenters repeatedly exposed young damselfish to the alarm signal mixed with the scents of several unfamiliar fish species, the damselfish performed the alarm response when exposed only to the scent of any of the

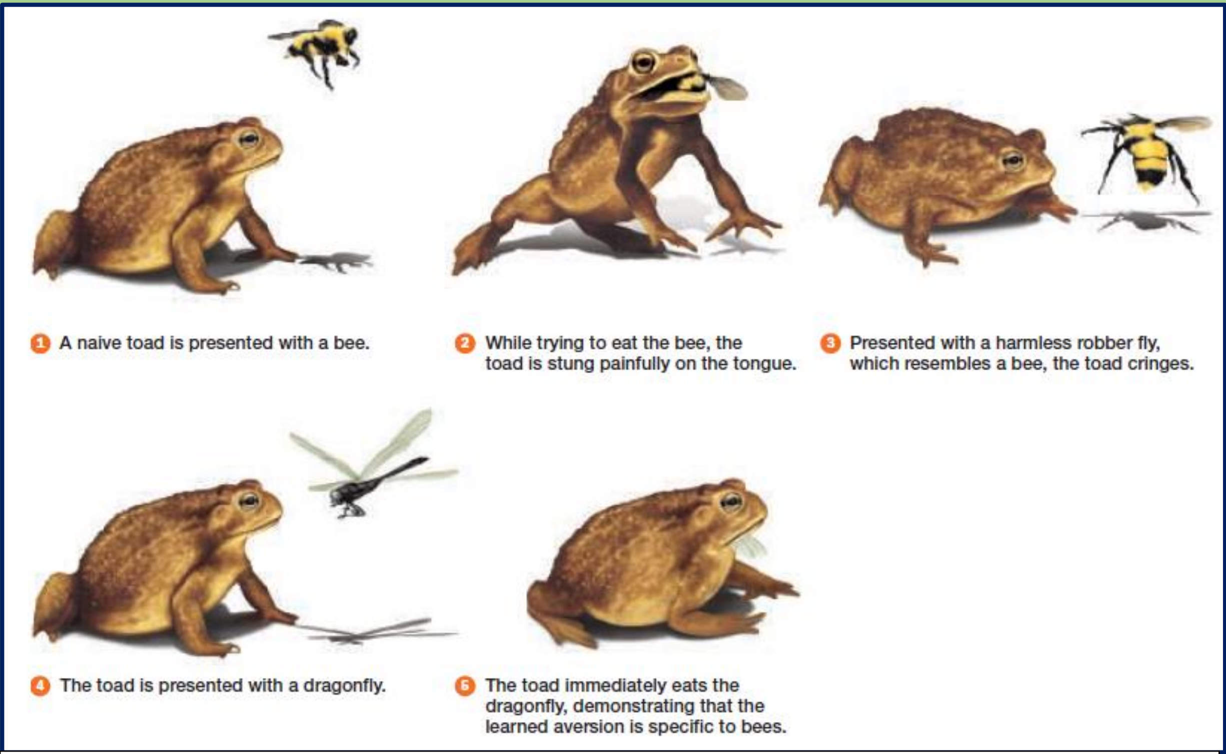

Fig 6. Trial-and-error learning in a toad

previously unfamiliar species. As the damselfish experiment suggests, learning by classical conditioning can result in adaptive behaviour, such as avoiding novel predators. A more complex form of learning is **trial-and-error learning,** in which animals learn through experience to associate a behaviour with a positive or negative outcome. Many animals are faced with naturally occurring rewards and punishments and learn to modify their behaviour in response to them. For example, a hungry toad that captures a bee quickly learns to avoid future encounters with bees (FIG. 6). After only one experience with a stung Trial-and-error learning is sometimes known as **operant conditioning,** especially when the learning results from training in a laboratory setting. For example, an animal may learn to perform a behaviour (such as pushing a lever or pecking a button) to receive a reward or to avoid punishment. This technique is most closely associated with the psychologist B. F. Skinner, who designed the "Skinner box," in which an animal is isolated and allowed to train itself. The box might contain a lever that, when pressed, ejects a food pellet. If the animal accidentally bumps the lever, a food reward appears. After a few such occurrences, the animal learns the connection between pressing the lever and receiving food and begins to press the lever repeatedly.

- **In Social Learning, Animals Learn from Other Animals**: In **social learning,** animals learn behaviours by watching or listening to others of their species. By observing and copying the behaviour of others, animals may learn which foods to eat, where to find food or breeding sites, or how to avoid predators. Songbirds of many species acquire their songs by copying the songs of other birds. In animals that use tools, information about how to use them is usually gained by watching other animals use them. For example, some dolphins in Shark Bay, Australia, use sponges to help protect their snouts as they dig for prey in the stony seabed (FIG. 7a). Young dolphins learn this behaviour by watching their mother perform it. Similarly, chimpanzees may use stones to crack open nuts or sticks to fish termites out of their mounds (FIG. 7b). These skills are transmitted from one chimpanzee to another by social learning.

Fig 7. **Social learning Animals may learn helpful behaviours from other animals. By observing others, (a) bottlenose dolphins learn to use a sponge plucked from the seafloor as a snout protector, and (b) chimpanzees learn to use a twig to extract termites from a mound.**

- **Insight Is Problem Solving without Trial and Error:** In certain situations, animals seem able to solve problems suddenly, without the benefit of prior experience. This kind of sudden problem solving is sometimes called **insight learning,** because it seems at least superficially similar to the process by which humans mentally manipulate concepts to arrive at a solution. We cannot, of course, know for sure if non-human animals experience similar mental states when they solve problems. One species that seems to be good at solving problems is the New Caledonian crow. These birds not only use tools, but also manufacture them, shaping twigs and leaves into hooks that the birds use to extract insects from their hiding places.

Fig 8. **Insight learning New Caledonian crows learn to solve fairly complex problems without prior training. Here, a crow obtains a reward by selecting the object that is most effective for raising the water level in a tube.**

In a lab experiment, a New Caledonian crow was presented with a straight piece of wire and a bucket of meat that had been placed down a well, so the bird could not reach it. The crow quickly used its beak to bend the wire into a hook, which the bird used to lift the bucket up so it could eat the meat. New Caledonian crows also readily solved, on the first try, a multistep puzzle that required them to use a short stick to reach a long stick that was in turn used to reach a food reward. In experiments that tested crows' ability to gain access to food rewards floating on water at the bottom of a clear, vertical tube, researchers found that crows quickly reacted by dropping objects into the tube so that the water level rose, bringing the food to within the birds' reach (FIG.8). What's more, the crows dropped solid objects that would sink rather than hollow objects that would float.

SOCIAL COMMUNICATION:

Sociality, the tendency to associate with others and form groups, is a widespread feature of animal life. Most animals interact at least a little with other members of their species. Many spend the bulk of their lives in the company of others, and a few species have developed complex, highly structured societies.

Group Living Has Advantages and Disadvantages

Living in a group has both costs and benefits, and a species will not evolve social behaviour unless the benefits of doing so outweigh the costs. Benefits to social animals include the following:

- Increased abilities to detect, repel, and confuse predators.
- Increased hunting efficiency or increased ability to spot localized food resources.
- Advantages resulting from the potential for division of labor within the group.
- Increased likelihood of finding mates.

On the negative side, social animals may encounter:

- Increased competition for limited resources.
- Increased risk of infection from contagious diseases.
- Increased risk that offspring will be killed by other members of the group.
- Increased risk of being spotted by predators.

Reciprocity or Relatedness May Foster the Evolution of Cooperation

In the animal societies we have described, individuals sometimes behave in ways that help others but seem to place the helper at an immediate disadvantage. A baboon helps defend another, putting itself at risk of injury. A social spider spends time and energy capturing insects for other spiders to eat. Worker bees spend their lives doing hard labor but do not reproduce. There are many other examples: Vampire bats may regurgitate part of a blood meal to feed another bat that did not find food; ground squirrels may risk their own safety to warn the rest of their group about an approaching predator; young, mature Florida scrub jays, instead of breeding, may remain at their parents' nest and help them raise subsequent broods. At first glance, such cooperative behaviour appears to be **altruism**—behaviour that decreases the reproductive success of one individual to benefit another. But true altruism presents an evolutionary puzzle. If individuals perform self -sacrificing deeds that reduce their survival and reproduction, why aren't the alleles that contribute to this behaviour eliminated from the gene pool? One possibility is that cooperative behaviours that reduce an individual's fitness over the short term actually increase it over the longer term. For example, helping another individual now may pay benefits later when the favour is returned. Such *reciprocity* is most likely to be the basis of cooperation in groups that remain together for an extended period of time and in which individuals recognize and remember one another.

Cooperation may also be favoured when other members of the group are close relatives of the cooperating individual. Because close relatives share alleles, the altruistic individual may promote the survival of its own alleles through behaviours that maximize the survival of its close relatives. This concept is called **kin selection.** Kin selection is believed to underlie cooperation in many animal societies, perhaps including those of social insects like honeybees, whose distinctive system of sex determination produces female workers that are very genetically similar to one another.

HUMAN BEHAVIOUR:

The behaviours of humans, like those of all other animals, have an evolutionary history. Thus, the methods and concepts that help us understand and explain the behaviour of other animals can help us understand and explain human behaviour as well.

1. The Behaviour of Newborn Infants Has a Large Innate Component

Because newborn infants have not had time to learn, we can assume that much of their behaviour is innate. The rhythmic movement of an infant's head in search of its mother's breast is an innate behaviour that is expressed in the first days after birth. Sucking, which can be observed even in a human fetus, is also innate. Other behaviours seen in newborns include grasping with the hands and feet and making walking movements when the body is held upright and supported. Another example is smiling, which can occur soon after birth. Initially, smiling can be induced by almost any object looming over the newborn. This initial innate response,

Fig 9. A) **A human instinct Thumb sucking is a difficult habit to discourage in young children because sucking on appropriately sized objects is an instinctive, food-seeking behavior. This fetus sucks its thumb at about 4 months of development.**

B) Newborns prefer their mother's voice Using a nipple connected to a computer that plays audio tapes, researcher William Fifer demonstrated that newborns can be conditioned to suck at specific rates in order to listen to their own mothers' voices through headphones. For example, if the infant sucks faster than normal, her mother's voice is played; if she sucks more slowly, another woman's voice is played. Researchers found that infants easily learned and were willing to work hard at this task just to listen to their own mothers' voices, presumably because they had become used to her voice in the womb.

however, is soon modified by experience. Infants up to 2 month old will smile in response to a stimulus consisting of two eyesized spots, which at that stage of development is a more potent stimulus for smiling than is an accurate representation of a human face. But as the child's development continues, learning and further development of the nervous system interact to limit the response to more correct representations of a face. Newborns prefer their mothers' voices to other female voices. Even in their first 3 days of life, infants can be conditioned to produce certain rhythms of sucking when their mother's voice is used as reinforcement. The infant's ability to learn his or her mother's voice and respond positively to it within days of birth has strong parallels to imprinting and may help initiate bonding with the mother.

2. Young Humans Acquire Language Easily
3. Humans May Respond to Pheromones

If you encounter any problem/ doubt while going through this study material you can contact me.