Behaviour

Unit 5

This unit should fill approximately **25 periods** of teaching time.

Learning competencies for Unit 5

By the end of this unit students should be able to:

- Explain what is meant by the term behaviour and describe its types.
- Explain the importance of studying behaviour.
- Explain what is meant by innate behaviour.
- Describe and explain the characteristics of innate behaviour.
- Describe and give examples of different types of innate behaviour.
- Describe reflex behaviour in humans.
- Describe instinctive behaviour in non-human animals.
- Describe and explain biological clocks in non-human animals.
- List the different types of learned behaviour.
- Explain how the learning process takes place in each type.
- Describe examples of each type of learning (habituation, classical conditioning, operant conditioning, imprinting, insight learning and latent learning).
- Compare innate and learned behaviour patterns.
- Describe and explain courtship, territorial and social patterns of behaviour.
- Give examples of each type of behaviour.

This section should fill approximately **3 periods** of teaching time.

5.1 An introduction to behaviour

Learning competencies

By the end of this section students should be able to:

- Explain what is meant by the term behaviour and describe its types.
- Explain the importance of studying behaviour.

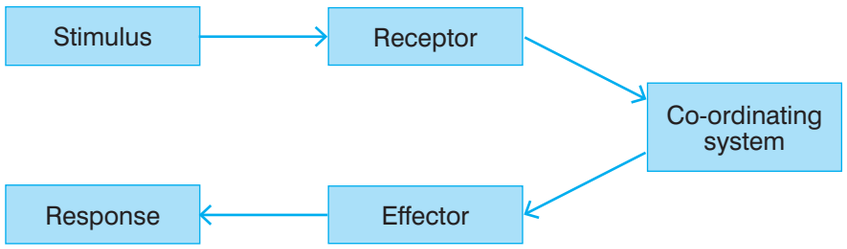
Starting off

Students will frequently assign social implications to the term behaviour. These ideas must be broadened so that they think of behaviour in terms of the definition given in the Students' Book:

The co-ordinated response of an organism to an internal or external stimulus.

Given that definition, there has to be a framework within which students can model any example of behaviour. The framework suggested in the textbook allows the analysis of most examples of behaviour to show their common components.

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Discuss examples of behaviour with the students and get them to work out the various components shown above for the examples discussed.

Teaching notes

Having established the nature of behaviour, it is important that students realise that it is not confined to higher animals. The Students' Book includes examples of orientational behaviour in invertebrates and tropic behaviours in plants. Students must realise that these examples fit our definition of behaviour.

If the practical opportunity in activity 5.3 is undertaken, the students have the opportunity to notice where they collect the woodlice (or other invertebrates) and formulate predictive hypotheses about the likely outcomes of their experiments. It also gives them the opportunity to discuss the ethical issues of experimenting with live animals. Finally they can pool results to give more reliable data and plot bar charts to illustrate their results and help them to draw conclusions.

The reasons for the study of animal behaviour are not all apparent to students. They will probably suggest that it may help us to understand the behaviour of humans and that understanding the behaviour of the animals may help with the conservation of the animals, but some of the other aspects will need considerable leading.

However, it is well worth them using the information, having obtained it, to perhaps make a display of the ways in which the study of animal behaviour can be of a more general benefit.

SA = starter activity MA = main activity CA = concluding activity	
What is behaviour?	
SA	Question and answer to lead students to a definition of behaviour that is a biological definition rather than just a social one.
MA	Students discuss with the teacher the components involved in any behaviour. Use the model shown in the textbook. Students make a copy of the definition of behaviour and take a copy of the model of the components of behaviour. Class to discuss how this model can describe some specific human behaviours (it is easier to start with human behaviours and then broaden the discussion). Include: • the iris reflex • catching a ball thrown at one • dropping a hot object Get students to draw flow diagrams using the model of behaviour to show the components of these (and other) examples of human behaviour. Notes on carrying out this activity are given in the teaching notes at the beginning of this section.
CA	Students review the definition and explanation of the term behaviour.

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How do plants and simple animals respond to stimuli?	
SA	Question and answer to establish a range of plant responses (such as the responses of shoots and roots to light and to gravity). Also, get the students to give some examples of behaviour by small invertebrates. Classify these as: • kineses – responses to changes in intensity of a stimulus that lead to a change in the rate of movement • taxes – responses to changes in direction of a stimulus that lead to a change in the direction of the response.
MA	Students discuss the mechanisms of: • phototropism • photo-kinesis in woodlice. Students explain these by making behaviour flow diagram models in their notes detailing the components involved in each. Students carry out activity 5.1 and activity 5.3, if time.
CA	Students write up activities 5.1 and 5.3. Class reviews examples of non-human behaviour and how they also fit the behaviour flow diagram model.
Why is it important to study behaviour?	
SA	Ask students the question 'Why should we bother to study behaviour in other organisms?' Try to elicit as many reasons as possible.
MA	Students research reasons for studying behaviour in other organisms and make a display.
CA	Class reviews reasons for studying behaviour in non-human organisms.

Answers to review questions

1. D
2. C
3. D
4. C
5. D

This section should fill approximately **5 periods** of teaching time.

5.2 Innate behaviour

Learning competencies

By the end of this section students should be able to:

- Explain what is meant by innate behaviour.
- Describe and explain the characteristics of innate behaviour.
- Describe and give examples of different types of innate behaviour.
- Describe reflex behaviour in humans.
- Describe instinctive behaviour in non-human animals.
- Describe and explain biological clocks in non-human animals.

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Starting off

Begin this section by asking the students what they understand by the term innate. Most have a hazy idea and many think of reflex behaviour as the only type of innate behaviour. They need the concept clarifying and widening to include other types of innate behaviour. Try to get them to define instinctive behaviour. Again, it will be a hazy idea that needs clarification and it will probably not occur to them to think of the orientational behaviours of invertebrates, but they will find it obvious that they are innate. Get students to classify some examples of behaviour (other than the ones given in the Students' Book) and record their results in a table such as the one below.

Example of behaviour	Type of innate behaviour

Teaching notes

It is time to deal with the different types of innate behaviour in a little more detail. The orientational behaviours of invertebrates were dealt with in sufficient depth in the introductory section and are not revisited here.

Begin with reflex actions and revise the structure of the nervous system, first encountered in grade 10. Students will be familiar with the division into central nervous system (CNS) and peripheral nervous system (PNS), but probably not with the divisions into somatic and autonomic nervous systems. These will need explaining and the operations of the various components shown in figure 5.9 will need some discussion and clarification.

The organisation of a three-neurone reflex arc will again be revision of grade 10 work, but students should realise that the pathways are genetically programmed to develop and the functions of nearly all reflex arcs are protective.

Autonomic reflexes will be new to the students, yet once they start to think about the example given (control of heart rate) then it becomes obvious that some such mechanism must exist. The text gives detail of the role of both sympathetic and parasympathetic divisions of the ANS in the control of heart rate, without going into detail of the neural pathways.

Biological clocks are not really, in themselves, examples of innate behaviour. A biological clock is a structure or mechanism that is pre-programmed to control behaviours on a cyclical basis. A lot has been written about these structures and there is much more still to find out.

Most students will be aware, with a little leading, of biological clocks governing circadian rhythms, such as sleep, and the applications of this to areas such as jet lag would make an interesting research exercise for the students.

There are so many examples of biological clocks governing behaviour patterns that it is difficult to know what to include and what to exclude. However, ensure the students are aware that circadian changes can be used to govern:

- circadian rhythms, and
- circannual rhythms.

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Other key concepts that they should be aware of are the persistence of circadian rhythms and their entrainment by environmental cues.

An interesting fact sheet on circadian rhythms can be found at:

http://www.nigms.nih.gov/Publications/Factsheet_CircadianRhythms.htm

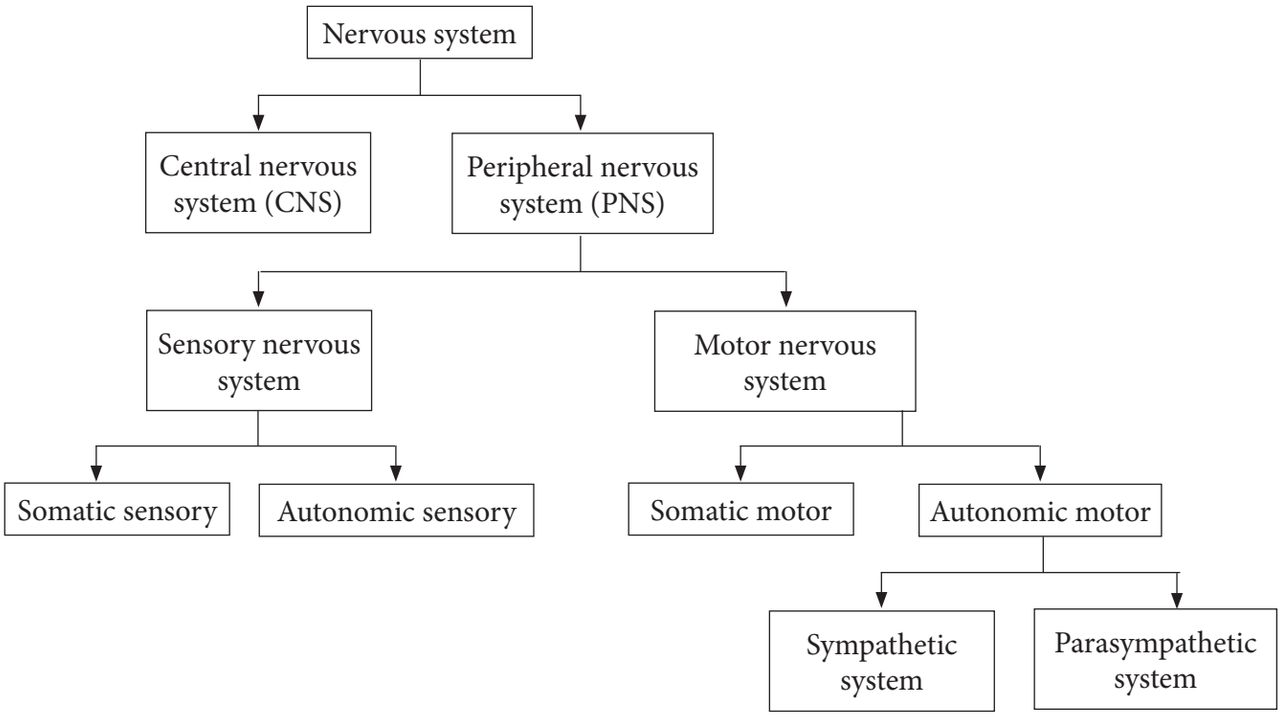
Instinctive behaviour should be presented to the students as the most complex of innate behaviours. Despite this complexity, the fixed action pattern responses are innate and, as such, are performed perfectly on the first occasion. Again, there are so many examples of instinctive behaviour that it is difficult to decide on what to include, but the classic experiment by Niko Tinbergen with sticklebacks provides a typical example of instinctive behaviour, displaying all the features described in the Students' Book.

The example of behaviour in lovebirds is chosen to illustrate that instinctive behaviour can sometimes be modified by experience.

<table>
<tr><td colspan="2">SA = starter activity MA = main activity CA = concluding activity</td></tr>
<tr><td colspan="2">What is innate behaviour and what types of innate behaviour are there?</td></tr>
<tr><td>SA</td><td>Class to discuss the meaning of the term innate. Get students to give examples of innate behaviour. Students write a definition in their notes.</td></tr>
<tr><td>MA</td><td>Students discuss the three types of innate behaviour that are described in the textbook. Students should summarise these by producing a table like the one below.
<table>
<tr><th>Type of innate behaviour</th><th>Nature of stimulus</th><th>Nature of response</th><th>Examples</th></tr>
<tr><td>Reflex action</td><td></td><td></td><td>1.
2.</td></tr>
<tr><td>Orientational behaviour</td><td></td><td></td><td>1.
2.</td></tr>
<tr><td>Instinctive behaviour</td><td></td><td></td><td>1.
2.</td></tr>
</table></td></tr>
<tr><td>CA</td><td>Students complete activity 5.5.</td></tr>
<tr><td colspan="2">How are human reflexes brought about?</td></tr>
<tr><td>SA</td><td>Students review what is meant by a reflex action. Discuss the differences between somatic and autonomic reflex actions.</td></tr>
<tr><td>MA</td><td>Students discuss the components of the human nervous system.
Give students an unlabelled diagram of all the components of the nervous system and get them to label it, using supplied descriptors. One possible layout is shown on the next page.
The students are to understand the difference between a reflex action and a reflex arc.
Students discuss with the teacher the neural pathways of:
• a three-neurone somatic reflex (e.g. withdrawal reflex)
• the antagonistic action of sympathetic and parasympathetic reflexes in controlling functions such as the heart rate.</td></tr>
<tr><td>CA</td><td>Class reviews the nature of human reflex actions and how they are brought about. Students make notes.</td></tr>
</table>

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Worksheet – The nervous system



Complete the diagram by writing the following descriptors in the appropriate boxes

Rest and repair
Impulses to internal organs
Impulses into CNS
Made of CNS and PNS
Impulses from internal organs
Made of nerves
Impulses from CNS
Impulses from sense organs
Fight and flight
Impulses to muscles
Made of brain and spinal cord

What are biological clocks?	
SA	Introduce the concept of biological clocks by discussing patterns that recur on a daily basis – wake-up time, reduction/increase in heart rate/pressure. Bring in the term circadian rhythm.
MA	Students discuss the nature of biological clocks and analyse the data presented in the textbook. Students make notes on: • the main features of circadian biological clocks • their location in mammals. Discuss also examples of circannual rhythms.
CA	Students research and make notes/a poster about jet lag.
What is instinctive behaviour?	
SA	Students discuss the differences between instinctive behaviour and other forms of innate behaviour.

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<table>
<tr><td>MA</td><td>List the key features of all instinctive behaviours; students make notes.
Students analyse the examples of instinctive behaviour given in the textbook to discover the key stimulus, innate releasing mechanism and the fixed action pattern response.
Students research three other examples of instinctive behaviour and summarise them in a table like the one below.
<table>
<tr><th>Example of instinctive behaviour</th><th>Key stimulus</th><th>Fixed action pattern response</th><th>How the behaviour is adaptive</th></tr>
<tr><td>1.</td><td></td><td></td><td></td></tr>
<tr><td>2.</td><td></td><td></td><td></td></tr>
<tr><td>3.</td><td></td><td></td><td></td></tr>
</table></td></tr>
<tr><td>CA</td><td>Class reviews the features of instinctive behaviour.</td></tr>
<tr><td colspan="2">Innate and instinctive behaviour; review</td></tr>
<tr><td>SA</td><td>Students discuss key features of instinctive and innate behaviours; list them at the front of the class.</td></tr>
<tr><td>MA</td><td>Students split into groups and prepare a poster presentation comparing instinctive and innate behaviours.</td></tr>
<tr><td>CA</td><td>Students highlight key features of their posters to the rest of the class and display them around the classroom.</td></tr>
</table>

Answers to review questions

1. C
2. B
3. A
4. D
5. C
6. B
7. D
8. B
9. D
10. D

This section should fill approximately **10 periods** of teaching time.

5.3 Learned behaviour

Learning competencies

By the end of this section students should be able to:

- List the different types of learned behaviour.
- Explain how the learning process takes place in each type.
- Describe examples of each type of learning (habituation, classical conditioning, operant conditioning, imprinting, insight learning and latent learning).
- Compare innate and learned behaviour patterns.

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Starting off

It is perhaps as well to begin by defining what we mean by learning. Ask the students what they understand by learned behaviour. With a little prodding they will probably suggest that it is acquiring some skill by keeping on trying, an approximation to the definition given in the Students' Book:

The strengthening of existing responses or the formation of new responses to existing stimuli that occurs because of practice or repetition.

It is also perhaps worthwhile formally comparing learned behaviour with innate behaviour at the outset, so that students have a clear idea of the differences between the two. Table 5.2 in the Students' Book, reproduced here for convenience, summarises the main differences between innate and learned behaviour.

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

Teaching notes

The concept of habituation is not difficult for the students to grasp once it is pointed out that it exists. The examples chosen serve to illustrate that animals become habituated only to persistent harmless stimuli – not to harmful ones.

Sensitisation is another phenomenon that students will grasp fairly easily once it is pointed out to them. The research on *Aplysia* is used to illustrate the increased response as a result of the harmful stimulus.

One of the best examples of sensitisation in humans is to be found in the pain response and could be worth pursuing with students. Following tissue damage by, say burning or cutting, the damaged tissue is hypersensitive to heat (or sharp objects) for some time. This has two effects:

- Stimuli that usually produce a pain response now produce a much more intense pain response (hyperalgesia).
- Stimuli that would not normally produce a pain response now do so (allodynia).

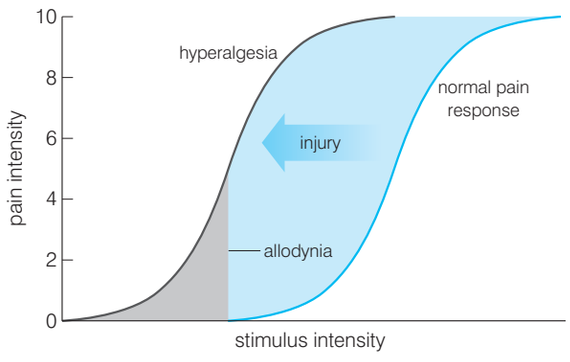


Figure 5.1

These are largely due to peripheral sensitisation in which receptors and neurones become hypersensitive.

This is an adaptive response, as it keeps the damaged and repairing tissue out of contact with potentially damaging stimuli. Once the repair is complete, the pain response normally desensitises and 'resets' itself to normal levels.

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An excellent account of sensitisation to pain can be found at:

http://www.wellcome.ac.uk/en/pain/microsite/science4.html

Classical conditioning is something that probably most of the students will have encountered, even if they are not aware of the term. Most will have heard of Pavlov's investigations, and these make a good basis for the study of this form of associative learning.

An important idea to stress about this form of learning is that the continuance of the behaviour depends upon the association being maintained. In the Pavlov example, when the dogs continued to hear the bell, but no food was presented, the salivation response diminished and eventually disappeared.

Students need to become familiar with the terms unconditioned stimulus, unconditioned response, conditioned stimulus and conditioned response.

The example of 'Little Albert' is included to illustrate that classical conditioning can also occur in humans.

Another example of classical conditioning in humans can be seen in a trip to the dentist. On a first visit, the sound of the drill signifies nothing to the person – until the dentist begins to use the drill! The pain and discomfort of having a tooth drilled are then associated by the person with the sound of the drill. On a subsequent visit, the sound of the drill is enough to produce a feeling of anxiety and discomfort even before the dentist has begun to use the drill.

Operant conditioning is the second form of associative learning to be studied. Here, behaviour is modified by the consequences of the behaviour. These consequences are the operants. Students will readily identify this kind of learning with much of our behaviour modification in human society.

Ask students to describe ways in which they think their own behaviour might have been modified by operant conditioning and write the changes in the flow chart model of operant conditioning shown in figure 5.21.

Present the students with an account of the work of B F Skinner and his operant conditioning of rats and pigeons and other animals. The diagram of the Skinner box in figure 5.22 will help in their understanding of the work. There is scope here for a debate about Skinner's experiments and their relevance:

- Were they ethically sound?
- Are the results from experiments on rats generalisable to humans?
- Are the experiments too simplistic to allow generalisation about operant conditioning?

Students could also make a flow chart/display about shaping. They could analyse the steps a trainer might go though to achieve a specific behaviour in an animal and present this as a flow chart with reinforcers and modified behaviour patterns clearly identified.

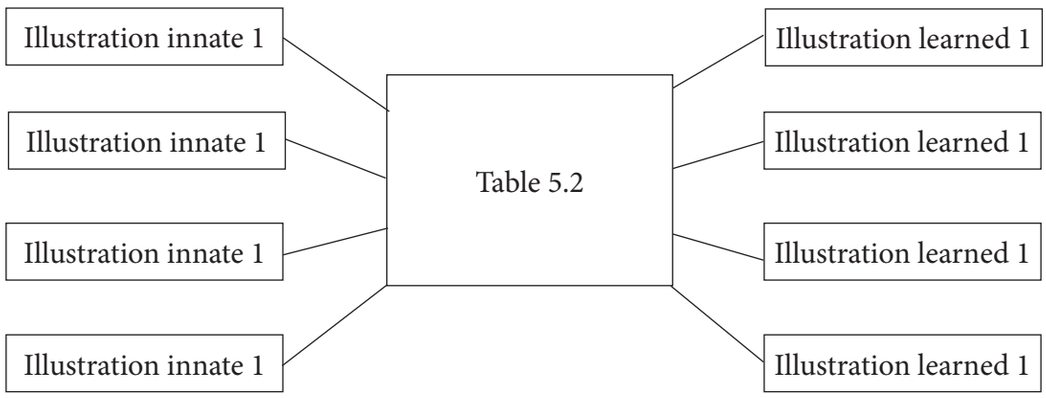
Latent learning is one of the less obvious forms of learning, but students will find it straightforward once the concept is pointed out. Some of the work of Tolman on latent learning is presented in the Students' Book as a research background to the concept. Students should analyse these data and ensure that they understand how they demonstrate latent learning.

Latent learning is associated with implicit memory, i.e. long-term memory, usually for skills and procedures that is acquired without specific deliberate inputs.

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Insight learning provides a fascinating glimpse into how other animals can solve problems by, apparently, abstract reasoning. The work of Kohler with chimpanzees was pioneering work in this area and gives students a good idea of the nature of insight learning.

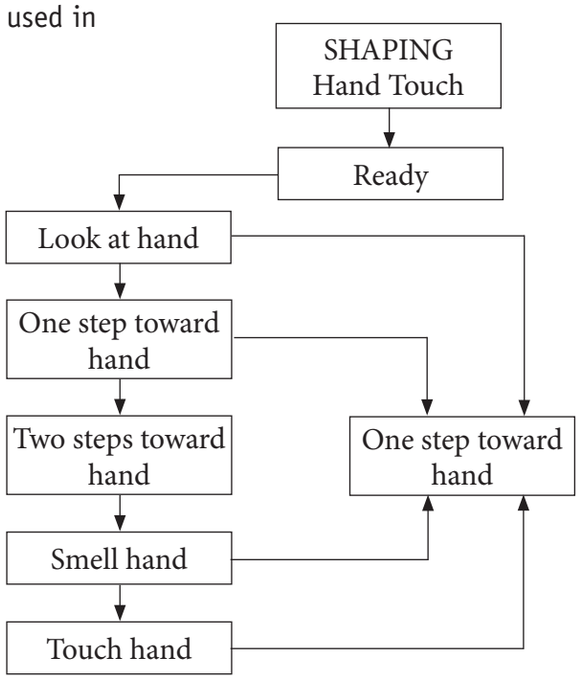
It is perhaps worthwhile discussing with the students that later work (by Schiller in particular) showed that many of the behaviour patterns observed by Kohler (stacking, making double sticks, poking sticks to retrieve objects) were behaviours that were seen in chimpanzees who were not being presented with 'lures' but just in normal play. However, others have suggested that this does not disqualify the solutions to the problems as insight. Being able to remember an action performed in play and apply that in a new situation is also a kind of insight.

SA = starter activity MA = main activity CA = concluding activity	
What is learned behaviour?	
SA	In question and answer, students have difficulty in explaining learned behaviour without using the word 'learning'. Try to lead them away from this and towards the sort of definition in the textbook.
MA	Students discuss the differences between innate and learned behaviour. Students research learned behaviour and make an expansion of table 5.2  Each illustration expands on the relevant point in table 5.2
CA	Class reviews the differences between innate and learned behaviour and the teacher outlines the four main types of learned behaviour: • habituation • sensitisation • associative behaviour • insight learning. Students examine why imprinting is sometimes classified as learned behaviour.
What is habituation? (1)	
SA	Introduce the topic by relating the name 'habituation' to 'habit'. Students discuss: • the consequences of habituation on the habituated behaviour • possible ways in which the habituated response is brought about Students write brief notes, quoting examples from everyday life.
MA	Students analyse habituation in *Aplysia* by: • describing the unmodified response • describing the habituated response • explaining why this modification is considered an example of habituation.

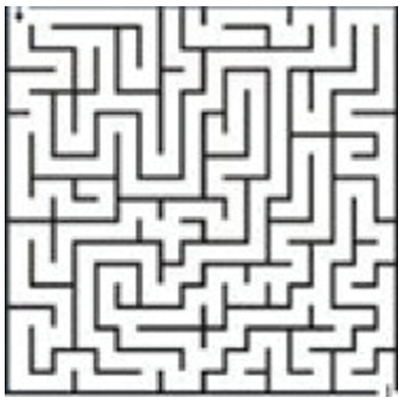
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<table>
<tr><td>CA</td><td>Class reviews habituation and the circumstances under which it occurs.</td></tr>
<tr><td colspan="2">What is habituation? (2)</td></tr>
<tr><td>SA</td><td>Class reviews the nature of habituation and understands that it happens in many different animals. Students compare habituation with sensitisation.</td></tr>
<tr><td>MA</td><td>Students carry out activity 5.6 – Habituation of mosquito larvae. This may need to be done as a demonstration to students by the teacher depending on the availability of equipment. The teacher should read the detailed instructions for the experiment in the textbook carefully before explaining to the students and setting up the equipment.</td></tr>
<tr><td>CA</td><td>Students write up their investigation.</td></tr>
<tr><td colspan="2">What is classical conditioning?</td></tr>
<tr><td>SA</td><td>Teacher introduces the topic of associative learning where behaviour is modified by association with some event. Outline the difference between classical conditioning and operant conditioning.</td></tr>
<tr><td>MA</td><td>Students examine the work of Pavlov in classical conditioning and the concepts of:
• unconditional stimulus (US)
• unconditional response (UR)
• conditioned stimulus (CS)
• conditioned response (CR)
Class to discuss the example of Little Albert and get the students to identify and indentify US, UR, CS and CR.</td></tr>
<tr><td>CA</td><td>Students study the following examples (US, UR, CS and CR are highlighted here for convenience):
1. Fred has a fluffy down pillow with some of the down sticking out of the fabric. When he first tries out the pillow, a piece of down tickles his nose and he sneezes. This happens every time he goes to bed. Soon he sneezes every time he lie down on any kind of pillow.
2. Every time you take a shower, someone in the house flushes the toilet causing the water to turn cold and you to become cold. Now every time you hear a toilet flush, you get cold.
3. It is springtime and the pollen from the flowers causes you to sneeze. Soon you are sneezing every time you see a flower.
4. In order to treat bedwetting, a pad that is sensitive to dampness is placed under the sheets. When this pad becomes wet, it sounds an alarm and you wake up. Eventually you don't need the alarm to wake up and your full bladder will wake you up.
5. People receiving chemotherapy often vomit during or shortly after the procedure. After several chemotherapy sessions, people begin feeling sick at the sight of the treatment room.
Students produce a table to summarise each:
<table>
<tr><th>Example</th><th>US</th><th>UR</th><th>CS</th><th>CR</th></tr>
<tr><td>1.</td><td></td><td></td><td></td><td></td></tr>
<tr><td>2.</td><td></td><td></td><td></td><td></td></tr>
<tr><td>3.</td><td></td><td></td><td></td><td></td></tr>
<tr><td>4.</td><td></td><td></td><td></td><td></td></tr>
<tr><td>5.</td><td></td><td></td><td></td><td></td></tr>
</table>
</td></tr>
</table>

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What is operant conditioning?	
SA	Students examine the fundamental difference between classical and operant conditioning – operant conditioning alters behaviour by association with the consequences of actions. Figure 5.21 summarises this, students should have a copy of this or similar in their notes together with a description of the different kinds of operants.
MA	Students discuss and analyse the work of Skinner. Students should consider: • the design of the Skinner box • the way in which Skinner used reward and punishment. Give students an unlabelled diagram of a Skinner box and ask them to name the parts and write descriptions of their functions. Get students to analyse two or three examples of where their own behaviour has been altered by operant conditioning. They should present these in the same format as figure 5.21.
CA	Students discuss how operant conditioning is used in shaping the behaviour of animals. The flow chart shows one example of this. When desirable behaviour is 'marked' a reward is given. Get students to discuss how they would ensure progression from one stage to the next by using only rewards. 
Comparing classical and operant conditioning (1)	
SA	Students review the differences between the two processes.
MA	If internet connections are available then students can try an exercise to identify whether behaviour is being modified by classical or operant conditioning. http://www.ar.cc.mn.us/biederman/courses/p1110/conditioning2.htm If not, the exercises can be printed out and given as a paper exercise.
CA	Students discuss the answers to the exercises with the teacher and the reasoning behind each.
Comparing classical and operant conditioning (2)	
SA	Students complete activity 5.7 individually.
MA	Students divide into groups to discuss their findings from activity 5.7 and produce wallcharts showing the examples they agree on.
CA	Students write down a single sentence definition of each type of learned behaviour they have encountered so far in this section.

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What is latent learning? (1)	
SA	With no warning, give students a maze to track (a suitable one is printed here – it must not be too hard or too easy). Get them to work in pairs and time how long it takes for each one to complete the maze. Work out a class mean. 
MA	Students review conditioning, habituation and sensitisation and identify the role of some kind of association in all of these. Students discuss in class how latent learning differs from these, giving examples and making brief notes.
CA	Re-test the class with the maze. It is likely that the class mean time will now be shorter, showing some support for insight learning.
What is latent learning? (2)	
SA	Students discuss what they remember from the previous lesson, teacher summarises the points they make on the board.
MA	Students split into pairs and complete activity 5.8.
CA	Each pair presents its findings to the rest of the class.
What is insight learning	
SA	Students discuss with the teacher the nature of insight learning.
MA	Class to analyse the work of Kohler and how it provides support for the concept of insight learning. Several videos of can be obtained by searching YouTube for 'Kohler and insight learning'. A powerpoint presentation on this research is available at: www.markville.ss.yrdsb.edu.on.ca/history/society/kohler.ppt Students make notes on: • the nature of insight learning • the work of Kohler.
CA	Class to review insight learning and Students try to think of everyday examples.

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Answers to review questions

1. A
2. D
3. C
4. D
5. C
6. D
7. C
8. B
9. C
10. D

5.4 Examples of behaviour patterns

This section should fill approximately **7 periods** of teaching time.

Learning competencies

By the end of this section students should be able to:

- Describe and explain courtship, territorial and social patterns of behaviour.
- Give examples of each type of behaviour.

Teaching notes

The three types of behaviour are discussed in some detail in the Students' Book together with illustrative examples.

Courtship behaviour is likely be associated with elaborate ritual in the students' minds. Discuss the generally accepted definition of courtship behaviour with them – *courtship behaviour is any activity that precedes and results in mating and reproduction* – before discussing other, simpler examples of courtship behaviour that clearly fit this definition.

It is worth pointing out that, often, seemingly elaborate courtship behaviour consists of a set of fixed action patterns in which one FAP response by one animal becomes the key stimulus for another FAP in the courtship behaviour by the other organism. This is illustrated by the courtship behaviour in zebra fish, shown in figure 5.26 and analysed in figure 5.27.

Territorial behaviour will be appreciated by the students as a means of defending a territory. However, it should be pointed out that it also includes actually defining the territory. Possessing a territory has several advantages to the owner, such as access to foraging areas, mates, nesting areas, etc., that a non-owner would not have.

The Students' Book does not differentiate between different types of territories, for example, between those used for foraging, mating and rearing compared with those just used for mating. A good account of different types of territory (together with examples of associated behaviour) can be found at:

http://people.eku.edu/ritchisong/birdterritories.html

Students should appreciate that territorial defence expends a great deal of energy on the part of the owner and this is a measure of the benefit of owning a territory. They should also appreciate that, through natural selection, defence of a territory has been reduced to rituals that replace actual fighting and are ended as soon as one animal shows submissive behaviour. This is adaptive, as it reduces energy expenditure by both animals.

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Students will probably have a restricted idea of what constitutes social behaviour. They should discuss what they understand by the term and what the benefits might be. Hopefully they will arrive at an approximation to the description given in the Students' Book – *a set of interactions that occur between two or more individuals of the same species that modify the behaviour of individuals of the same species in a way that is usually beneficial to the group as a whole.*

They will not think of all the benefits of social behaviour, and so some of the less obvious examples should be explained to them.

Social behaviour in honey bees is described in some detail to illustrate how the social interactions, in this case based on a rigid caste system, ensure the smooth functioning of the nest/hive.

A good account of all types of behaviour can be found at:
http://kentsimmons.unwinnipeg.ca.mht

SA = starter activity MA = main activity CA = concluding activity	
What is courtship behaviour? (1) – the role of communication	
SA	Students discuss with the teacher what they think the purpose of courtship behaviour is. Most will think it is just to attract a mate. Explain that it can also help to strengthen already established pair bonds.
MA	Students discuss some examples of communication in courtship and explain why some kind of communication is essential. Students discuss the examples of communication given in the textbook and make brief notes on these and three other methods of communication (with examples). Students research the role of communication in courtship behaviour in elephants and lions. The links below will be a useful starting point. http://www.pbs.org/wnet/nature/unforgettable/communication.html http://people.eku.edu/ritchisong/behavecolnotes9.htm
CA	Class to review the methods of communication used in courtship behaviour.

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What is courtship behaviour? (2) – analysis of courtship behaviour patterns

SA

Students discuss with the teacher what animals must do to get a mate to reproduce.

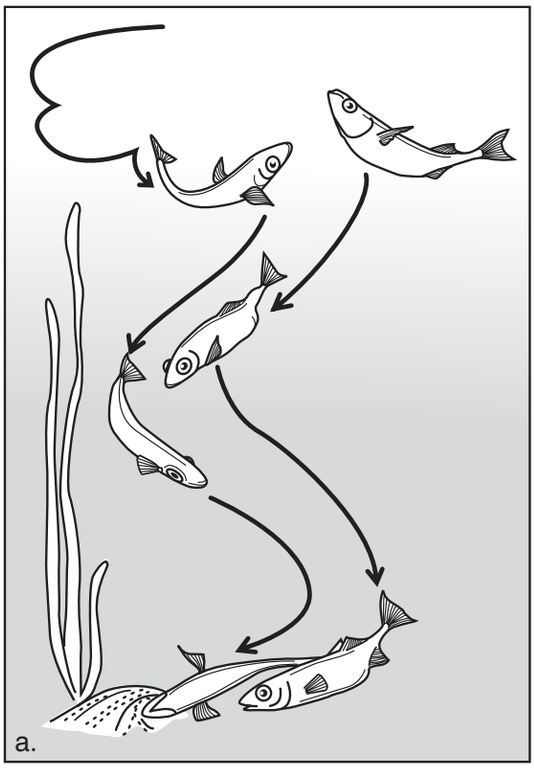
MA

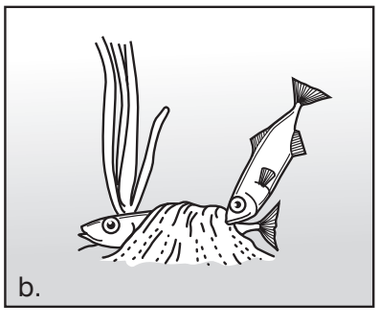
Students analyse the courtship behaviour of zebra fish. Get students to complete a table like the one below to summarise the behaviours.

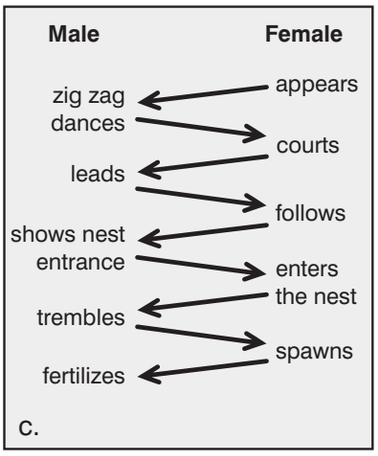
Stage	Male behaviour	Female behaviour	Purpose of behaviour
1		Approach	
2	Chase/tail-nose		
3		Escort	
4	Encircle	Present	
5		Lead	
6	Quiver or zigzag	Egg lay or present	

Get the students to use this example to describe how one fixed action pattern can act as a key stimulus.

Students analyse the courtship behaviour of three-spined sticklebacks.







CA

Class to review the roles of the behaviours and how key stimuli and FAPs interact.

What is territorial behaviour? (1)

SA

Students discuss what actually constitutes an animal's territory.

MA

Students discuss with the teacher ways in which animals can define their territory and the benefits of maintaining a territory.
Students carry out activity 5.9.
Students discuss with the teacher why fighting is usually a last resort that has few benefits.
Students make notes on this.

CA

Class to review the nature of territorial behaviour and its benefits.

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What is territorial behaviour? (2) – some examples	
SA	Students review the nature of territorial behaviour.
MA	Let the students watch videos of specific examples of territorial behaviour (there are many available on YouTube and others can be found by simply searching 'territorial behaviour examples video').
CA	Students make notes on one or two examples, pointing out the ways in which the different animals defend their territories and the main benefits to these animals of this defence.
What is social behaviour?	
SA	Question and answer to introduce the concept of social behaviour. Students should write down a definition/explanation of the term in their notes.
MA	Students discuss with the teacher the 'benefits' of social behaviour, set against some of the 'costs'. Students could research the example of zebras living in social groups as an example and produce a cost–benefit analysis of this. Expect them to produce most of the following: Disadvantages (potential costs): - increased competition - increased risk of infection - higher risk that offspring will be killed by other members of the group - increased risk of being spotted by predators Benefits: - increased ability to detect, repel predators - higher hunting efficiency (more chances to spot patchy food resources) - advantages in the potential for division of labour - conservation of energy - more likely to find mates What are the costs and benefits of behaviour? - behaviours are beneficial if successful, but each requires investment (a 'cost') - energy (can only be spent once) - time (which can't be spent doing other things) - risk (injury or death may result).
CA	Students could produce an annotated display of their cost–benefit analysis.
What is eusocial behaviour and how is it managed in social insects?	
SA	Students discuss with the teacher the main features of eusocial behaviour: • co-operation in care of offspring • several generations living together • division of labour.
MA	Using the example of bees, students make a display to illustrate: • the role of the different castes • the way in which the queen controls the hive • communication between workers about the source of nectar (both wag-dance and sound production).
CA	Class reviews displays.

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<table>
<tr><th colspan="2">Eusocial behaviour in other insects – a research project</th></tr>
<tr><td>SA</td><td>Students discuss with the teacher other examples of social insects – any of the ones below would make suitable examples.
<table>
<tr><th>Insect</th><th>Specifics</th><th>Example Species</th></tr>
<tr><td>Ants</td><td>All ants are eusocial. They have morphologically distinct workers and queens. In some ants, the workers do not even have ovaries. Other workers can lay male eggs.</td><td>Fire ants, Solenopsis invicta
Pharoahs ants, Monomorium minimum
Carpenter ants, Camponotus
Pseudomyrmex in acacia galls
Leaf-cutter ants, Atta</td></tr>
<tr><td>Bees</td><td>Many bees are not social at all.</td><td>Sweatbees, Lasioglossum
Bumblebees, Bombus
Honeybees, Apis mellifera
Carpenter bees, Xylocopa</td></tr>
<tr><td>Wasps</td><td>Some wasps are eusocial, but many are not.</td><td>Paper wasps, Polistes
Yellowjackets, Vespula
Stenogastrine wasps
Tropical wasps, Epiponines, Polybia</td></tr>
<tr><td>Termites</td><td>All termites are social. They have male and female workers and, unlike most social insects, are diploid rather than haplodiploid. Often they have a king and a queen.</td><td></td></tr>
<tr><td>Aphids and thrips</td><td>Some aphids and thrips are are eusocial. When they form a gall, some soldiers will not reproduce. This form of eusociality tends to be restricted to a few soldiers, because the sterile forms only defend and do not care for the young.</td><td></td></tr>
</table></td></tr>
<tr><td>MA</td><td>Students research one of the social insects and make a display.</td></tr>
<tr><td>CA</td><td>Class reviews displays.</td></tr>
</table>

Answers to review questions

1. D
2. D
3. D
4. D
5. C
6. A
7. C
8. D
9. C
10. B

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Answers to end of unit questions

1. a) Co-ordinated response to change in external or internal conditions (plus two suitable examples.

   b) Three of:

   impact on human society

   impact on neurosciences

   impact on environment/resource management

   impact on animal welfare

   impact on science education

   three marks for examples + three for suitable qualifications

2. a) Two suitable examples of somatic reflexes, and two suitable examples of autonomic reflexes.

   b) i) They are both automatic/do not involve conscious thought; they are both actioned by reflex arcs.

   ii) Origin of stimulus (external/internal); nature of effector (skeletal muscle/internal organ).

3. a) i) The orange spot on the beak stimulates FAP.

   ii) Pecking is carried out in response to the orange spot/key stimulus.

   b) i) At the start, 50% pecking of both models; the herring gull pecking increases with time in the nest; the laughing gull pecking decreases with time in nest, more sharply after 4 days.

   ii) No initial learning is required; fully functional on hatching.

   iii) Herring gull pecking increases; have associated this with experience in nest (pecking at real herring gull gives food).

4. a) Operant conditioning/shaping: correct behaviour is rewarded/reinforced.

   b) Habituation: response to harmless stimulus is diminished.

   c) Sensitisation: reduced stimulation produces same response.

   d) Habituation: response to a harmless stimulation is reduced.

   e) Latent learning: skill is acquired without reinforcement.

5. a) Access to food/foraging; access to mates; defence against predators (each one further qualified).

   b) Marking a territory; vocalisations; ritual displays; ritual fighting.

6. a) First set up a box to deliver food on any press of a lever; this establishes pressing behaviour; then food is delivered with any light flashing; associates food with light; then food is delivered with only the red light flashing; electric shock given when green light flashes; teaches discrimination between lights.

   b) Any aspect of behaviour that is represented in final behaviour is rewarded; then only more closely matching behaviours are rewarded; successive approximations become more precise (with two suitable examples).

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7. a) Problem-solving behaviour; without trial and error; uses mental processing (two suitable examples).

   b) i) No association needed in insight learning; modifies learned behaviour not innate behaviour.

   ii) Insight behaviour not modified by operants; no trial and error in insight learning; mental trials; solution often appears suddenly.

8. Award marks in the following categories:

Category	Marks	Descriptors
Breadth	0–2	Student involves all the main aspects of the topic in reasonable detail
Relevance	0–2	Student does not bring in irrelevant material, although some extra, related, biology is acceptable
Communication	0–2	Essay is well written and logically presented, making good use of scientific vocabulary
Biological accuracy	0–5	Biological content is not at the required level and may contain significant misconceptions
	6–10	Biological content is essentially correct and of an acceptable standard although there may be an occasional slight error
	11–15	Essay is of a high standard with no significant errors

Answers to end of unit crossword puzzle

Across

1 insight
3 reflex arc
6 learned
8 latent
10 classical
11 receptor
13 circadian
14 instinctive
16 courtship
17 behaviour
18 stimulus
20 habituation
21 phototropism
22 ethology

Down

2 social
4 autonomic
5 reflex
7 effector
9 territorial
10 choice chamber
12 kinesis
15 operant
19 innate

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Further resources

http://www.practicalbiology.org/area-index-pages/animal-behaviour/ – practical exercises on animal behaviour

http://sciencevideos.wordpress.com/options/option-e-neurobiology-and-behaviour/e3-innate-and-learned-behaviour/ – video resources on aspects of innate and learned behaviour in animals

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