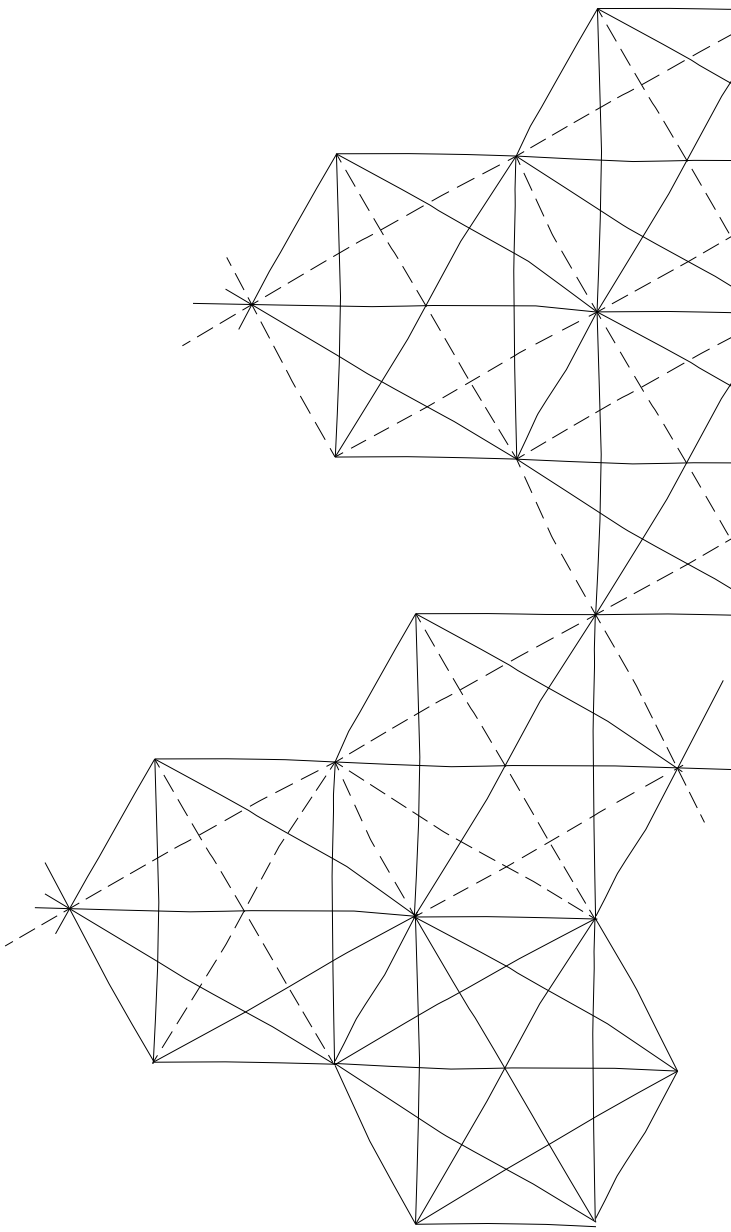
NATURA

Biology for Bilingual Classes



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The Human Senses — Your Ears and Eyes

Solutions

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1.1 The human senses

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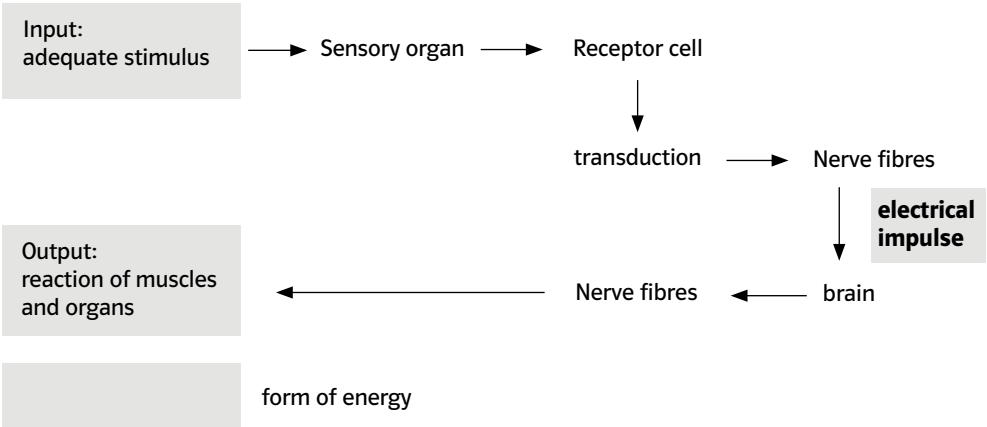
T1 Create a flow chart for the processes that take place in the mouse. Start with the word – "stimulus".

T2 Use different colours to show wheather you are thinking of a structure or a form of energy.



T3 Explain, why do you think transduction takes place.
– *Transduction takes place because the physical stimulus is turned into another form of energy (electrical impulse).*

1.2 The ear

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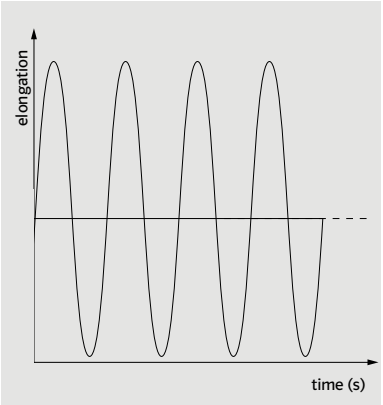
T1 Draw a diagram like the one above. Find a sensible scale and add the curve of a 4 Hz sound wave.



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T1 Write down the four elements which are obligatory for the cricket's hearing process.
– ***Airfilled*** *space behind* ***tympanum*** *with* ***receptor cells*** *connected to the nervous system by* ***nerve fibres***

T2 Make a technical drawing of the tympanal organ.
– *individual solutions.*

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T1 Make a chart for the three functional areas of the ear. Name the structures involved and explain how they work.

Function	Structures involved	How it works
Collection	pinna ear canal	Pinna focusses sound waves into the outer ear, ear canal leads the sound waves on.
Transmission	eardrum ear bones oval window	Eardrum is moved by arriving sound waves, is connected to a chain of ear bones which are also moved. The last of the ear bones transfers the movement to the oval window.
Transduction	cochlea auditory nerve	The fluid which fills the cochlea is set in motion by the movement of the oval window. Cells in the cochlea transform this movement into electrical energy.

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T1 Find the mistakes in the following sentences and write a correct version of each of the statements.

"The cochlea increases the force of vibrations inside the ear".

- *"The small size of the oval window in relation with the eardrum increases the force of vibrations inside the ear."*

"The tectorial membrane is the ear's transducer".

- *"The Organ of Corti is the ear's transducer."*

"A sound is transported through the cochlear fluid in the form of electrical impulses".

- *"A sound is transported through the cochlear fluid in the form of a pressure wave."*

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T1 Look at the pictures. What's different in the functional and non-functional organ of Corti?

- *The hair cells which are damaged have lost connection to the tectorial membrane and in consequence, the extensions will not be moved, therefore transduction will not take place in the respective hair cells.*

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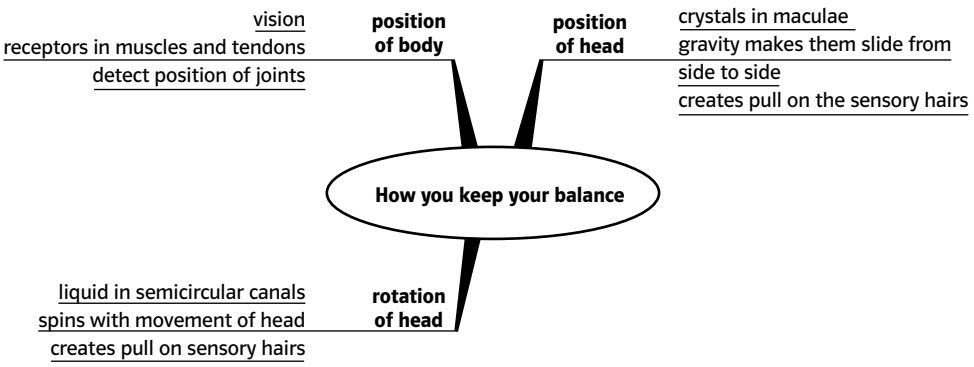
T1 Create a mind map for the three factors that help you keep your balance.

T2 Describe how these three factors work on their own and in combination.



1.3 The eye

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T1 Explain what for human and animals need their vision.
- *Humans and animals need their vision to orientate themselves, to perceive dangers and to react to them in time and to find their food.*

T2 How do blind people compensate for their loss of vision?
- *Blind people compensate for their loss of vision by improving their other senses, especially their sense of hearing and their sense of touch.*

T3 Is your school suitable for blind people? Why/Why not? If not, how could it be made suitable for blind people?
- *different possible solutions*
  Some possibilities to make a school suitable for blind people:
- *to get rid of stairs, install elevators*
- *to put up signs in braille in front of the different rooms*
- *to install "guiding lines" (shallow grooves blind people can follow with their blindman's stick) on the floor (you can see such "guiding lines" at some pedestrian crossings in bigger cities)*
- *not to use the blackboard any longer*

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T1 Write a report about your experiment with the earthworm.
- *individual solutions (general outline of a report: see p. 6 "How to write a report")*

T2 Are there any problems in the experiment that could have influenced your results?
- *individual solutions*
  one problem: If you put the light source very near to the earthworm, the earthworm registers the heat of the light source, as well. In this case, you do not only observe the reaction of the earthworm to light, but its reaction to heat, also.

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T1 Explain what happened with the bat in the experiment.
- *During the experiment, the bat disappeared, then it appeared again.*
  When the bat disappeared, it's image on the retina fell directly on the "blind spot" – where there are no light receptor cells at all. And since there are no light receptor cells as well, you did not "see" the bat.

T2 Copy the table below into your exercise book, then fill it in. After that, discuss it with your neighbour.

Structure of the eye	Function
cornea	refraction of light protection against damage
front chamber of the eye	contains a fluid which refracts light
iris	controls the amount of light entering the eye
lens	refraction of light accommodation to objects in different distances
ciliary muscle and suspensory ligament	accommodation of lens to objects in different distances
vitreous body	refraction of light
retina	contains light receptor cells
fovea	spot where visual acuity is best
blind spot	spot where the optic fibre leaves the eye
optic fibre	sends information of light receptor cells to the brain
pigment layer	absorbs light rays and thus prevents reflection of light rays back into retina

choroid	contains blood vessels which supply other layers of the eye with oxygen, nutrients ...
sclera	keeps the eye in form and protects the eye against damage
eye muscles	move the eye in different directions [see T3]

T3 At any given moment, only the image of a tiny part of our surroundings falls on the fovea. But nevertheless, we see a huge part of our surroundings in very sharp focus. Explain this phenomenon.

– *We move our eyes all the time with the help of our eye muscles – without consciously realizing this. By moving our eyes, every fraction of a second an image of a different part of our surroundings falls on the fovea. Our brain puts these different bits of information together to create one larger image – and we see a large part of our surrroundings in very sharp focus.*

T4 Describe what other reflex apart from the pupillary reflex helps to protect our eyes from damage?

– *Apart from the pupillary reflex, our eyes are protected by the blinking reflex. By blinking, we disperse tears on our cornea to make sure that our eye does not dry out. Tears also contain an enzyme, lysozyme, that kills bacteria. Additionally, tears, in combination with blinking, remove substances from the cornea (e.g. sand). Blinking also protects our eyes against wind and against mechanical damage.*

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T1 Explain the phenomenon that when you focus on a star in the night sky, the star seems to disappear.

– *When you focus on an object, the image of this object falls on the fovea, the spot of the retina where the visual acuity is best. The fovea only contains cones, no rods. As long as it is light outside and the cones get enough light to be able to work, this works out fine. But when you focus on a star in the night sky, the light reflected from the star onto the fovea is too dim to stimulate the cones in the fovea. Since the cones are not stimulated, they do not send any information towards the brain – and you do not see the star any longer. If you do not focus on the star, the image of the star falls on an area of the retina outside the fovea, where there are rods that are stimulated even by dim light – and the star appears again.*

T2 Copy the table below into your exercise book and fill it in. Afterwards, discuss it with your neighbour.

	Cones	Rods
Form	thick and short	small and long
Function	colour vision	vision in dim light no colour vision
Number	6 million	125 million
Distribution	in the fovea the further away from the fovea, the less cones not at the edges of the retina	not in the fovea

T3 Explain how we are able to distinguish between different colours.

– *There are three different types of cones in our retina. Each of these types only reacts to light of certain wavelengths. One type of cone reacts to red light, the second one to green light and the third one to blue light. Depending on the wavelength of the light entering the eye, these three types of cones are stimulated in different degrees. Depending on how much the different cones are stimulated, they send different information to the brain. Our brain processes these different pieces of information and we "see" a certain colour. If the "red" and the "green" cones are activated and send information to the brain while the "blue" cones are not activated (and thus do not send information to the brain), our brain perceives this as "yellow".*

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T1 Explain in detail why you could not focus on your pencil and your teacher at the same time.

– *When focused on the pencil, the eyes were accommodated to the pencil directly in front of me: The ciliary muscles of both eyes were contracted, the suspensory ligaments of the eyes were relaxed and the lenses were rather fat. Since the lenses were rather fat, the light rays falling into the eyes were refracted very strongly. This enabled me to see the pencil in sharp focus.*
In order to see the teacher in sharp focus, the eyes had to accommodate to the teacher – who stood much further away from me than the pencil. In order to focus on the teacher, the ciliary muscles of both the eyes had to relax, the suspensory ligaments were then pulled tight and forced the lenses to become thinner. Since the lenses became thinner, the light rays falling into the eyes were refracted less strongly – and could see the teacher in sharp focus.
This means that because of the different ways of accommodation it simply was not possible to see the pencil and the teacher in sharp focus at the same time.

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T1 Short-sighted people can not see distant objects clearly because their eyeballs are too long. What kind of glasses do these people need, and why?

– *These people need glasses with diverging lenses. Since their eyeballs are too long, the sharp images of distant objects appear in front of the retina. Diverging lenses scatter light, and thus the sharp images of distant objects do not appear in front of the retina any longer, but directly on the retina – and thus short-sighted people are able to see distant objects in sharp focus, again.*

T2 Elderly people sometimes suffer from a bad eyesight because the lenses of their eyes become less and less flexible. Are these people short-sighted or long-sighted? Give reasons for your answer.

– *These people are long-sighted. If their lenses become less flexible, this means that the lenses can not become very fat any longer when the eyes accommodate to near objects. But light has to be refracted very strongly for the sharp image of a near object to appear directly on the retina. If this is not possible any longer, because the lenses are not flexible enough, the sharp image of a near object appears behind the retina – and thus out of focus.*

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T1 Have a look at figure 2 above. What do you see in it? Compare your impressions with those of your classmates.

– *You can either see a young woman or an old woman in the picture*

T2 Have a short look at the two horizontal lines in figure 3. Which of them is shorter?

– *The line at the bottom seems to be shorter.*

Then measure their length with your ruler. What do you say now?

– *Both lines have the same length.*

Explain what this experiment tells you about how our brain deduces the size of objects?

– *This experiment shows that our brain uses its experience when it deduces the size of objects. Spatial vision plays an important role here: Although the images of both lines are of equal size on the retina, the brain thinks that the line above is further away and threfore longer (seems so because of the falling lines righthand and lefthand) and that the line which is nearer is shorter – because of its experience with spatial vision.*

T3 What do you see in figure 4?

– *In figure 4 you can see a Dolmatiner dog.*

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T1 Describe the differences between the visual fields of a wolf and a hare. In what way might these differences be adaptations to the different ways of life of wolves and hares?"

– *The overall visual field of a wolf is much smaller than that of a hare. But the common visual field of both eyes, where there is very good spatial vision, is much bigger with wolves than with hares. Wolves are predators for whom it is very important to have a good spatial vision because this makes it easier for them to catch their prey. Apart from humans, wolves have not got any*

enemies. This means that it is not important for them to "watch their back" all the time. In contrast to that, hares are prey for predators and are in constant danger of being eaten. This means that it makes sense for them to "watch their back" all the time. This is much more important for hares than to have a huge common visual field of both eyes with good spatial vision – hares do not need excellent spatial vision to find grass and herbs to feed upon.

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T1 Explain how a bat can calculate its distance to an object, e.g. a tree?

- *Bats can calculate their distance to an object by measuring the time between their sound and the echo belonging to this sound. The shorter this period of time, the nearer is the bat to the object.*

T2 Find other animals that use ultrasonic waves to perceive their environment.

- *dolphins*
- *some seals*

T3 Draw a conclusion from this method of orientation. What might be special about the rivers African knifefish live in? At what time of the day might they be active? Give reasons for your answer.

- *The rivers African knifefish live in rivers which are rather muddy. They are nocturnal animals (i.e. they are active at night). Reasons: Otherwise they could orientate themselves with their eyes.*