Unit 22 · Sense Organs

ANSWER KEY · FOR TEACHERS

Full marks 32

Give the marks for the points in the marking scheme; an answer in other words that says the same is right.

1 Key words

1. proprioceptors
2. conjunctiva
3. rhodopsin
4. fovea
5. Schlemm
6. accommodation
7. endolymph
8. Corti

K · 4

Each carries 0.5 mark.

2 Label the diagram

1. malleus
2. incus
3. stapes
4. semicircular canals
5. cochlea
6. Eustachian tube

K · 3

Each carries 0.5 mark.

3 Multiple choice

i. **b.** the fovea centralis — K · 1

The **fovea centralis**, the pit in the middle of the **yellow spot**, has only cones, packed tightly, each nearly with its own line to the brain. The **blind spot** (optic disc) has no receptors at all; the **ora serrata** is the front edge of the retina.

ii. **a.** the macula of the utriculus — K · 1

The **maculae** of the utriculus and sacculus have **otoliths** (crystals of calcium carbonate) on their gel, so they sense **gravity and tilt**. The **cristae** have a jelly **cupula** with no otoliths, and sense **rotation**. The organ of Corti is for hearing; the helicotrema is an opening.

iii. **a.** relaxes, the ligaments tighten and the lens becomes flatter — U · 1

For **far** objects the lens must bend light **less**, so it must be **flatter**. The **ciliary muscle relaxes**, the ring widens, the **suspensory ligaments pull tight** and stretch the lens thin. For near work it is the reverse, and reading for hours tires the contracted muscle.

iv. **a.** myopia, concave lens — A · 1

Near is clear, far is blurred: **myopia**. Light from far objects focuses **in front of** the retina, so a **concave** (diverging) lens is needed to spread it before it enters the eye.

v. **a.** near the base of the cochlea, by the oval window — U · 1

At the **base** the basilar membrane is **narrow and stiff**, so it resonates with **high** frequencies; towards the tip it is wide and floppy and resonates with **low** ones. That is why loud noise, which damages the base first, takes away the high pitches first.

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4 Short answers

a. ANSWER K · 2

Any two: **rods** work in **dim light** and give no color, **cones** work in **bright light** and give **color** vision; rods hold **rhodopsin**, cones **iodopsin**; rods are many, mostly round the edge of the retina, cones are fewer and packed in the **fovea**; cones give sharper detail.

MARKING SCHEME

- ✓ A first correct difference.
- ✓ A second correct difference.

b. MARKING SCHEME U · 2

- ✓ No rods or cones where the optic nerve leaves.
- ✓ The other eye covers it and the brain fills the gap.

c. MARKING SCHEME A · 2

- ✓ The outside pressure changes; the pressure difference pushes the eardrum.
- ✓ Swallowing opens the Eustachian tube and equalizes the pressure.

d. MARKING SCHEME U · 3

- ✓ The lens becomes cloudy (usually with age).
- ✓ Light is scattered and the image blurred.
- ✓ Surgery replaces it with an intraocular lens.

5 Numerical problem

ANSWER A · 4

- Area ratio = $60 \div 3 = \mathbf{20}$.
- Pressure gain = $20 \times 1.3 = \mathbf{26}$.
- Pressure at the oval window = $0.02 \times 26 = \mathbf{0.52\ Pa}$.
- The inner ear is full of **fluid**, which is much harder to set moving than air; without the gain most of the sound would bounce off.

MARKING SCHEME

- ✓ Area ratio 20.
- ✓ Total gain 26.
- ✓ 0.52 Pa at the oval window.
- ✓ Needed to drive the vibration into the fluid of the inner ear.

6 Long answer

ANSWER U · 4

1. The **pinna** collects sound waves; the **ear canal** carries them to the **eardrum**, which vibrates.
2. The **malleus, incus and stapes** carry the vibration across the middle ear, raising the pressure about 20 times; the **stapes** rocks in the **oval window**.
3. Pressure waves pass through the **perilymph** of the scala vestibuli and Reissner's membrane to the **endolymph**, and make the **basilar membrane** vibrate; the **round window** bulges to release them.
4. The **hair cells** of the organ of Corti are bent against the **tectorial membrane** and fire impulses in the **cochlear nerve** (VIII), which carries them to the **auditory area of the temporal lobe**, where they are heard.

MARKING SCHEME

- ✓ Pinna, ear canal and eardrum vibrating.
- ✓ Ossicles carry and amplify the vibration to the oval window.
- ✓ Waves in the perilymph and endolymph move the basilar membrane; the round window releases them.
- ✓ Hair cells bent against the tectorial membrane; impulses by the cochlear nerve to the temporal lobe.

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7 Think

ANSWER HA · 3

During a long spin the **endolymph** in the canals catches up and turns **with** the canals, so the **cupula** of each crista straightens and stops signalling the spin.
When you **stop**, the canals stop but the endolymph **keeps turning** for a few seconds, bending the cupula the **opposite way**.
The hair cells tell the brain you are now **spinning the other way**, while your eyes say you are still, so you feel dizzy.

MARKING SCHEME

- ✓ During the spin the endolymph moves with the canals and the cupula straightens.
- ✓ On stopping, the endolymph keeps moving and bends the cupula the other way.
- ✓ The brain is told of a spin the other way, against what the eyes report.

8 Activity: Find your near point

(not marked)

WHAT STUDENTS SHOULD FIND

A student's near point is usually about **8–15 cm**; an adult over 45 often can't focus closer than **30–50 cm** or more. For near objects the **ciliary muscle contracts** and the lens springs **rounder**. With age the lens becomes **stiffer and less elastic**, so it can't bulge enough: this is **presbyopia**, corrected with convex reading glasses.

Marks by level	Knowledge	Understanding	Application	Higher ability	Total
Marks	11	11	7	3	**32**

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