Activity 8A: Excretion in animals

1. Distinguish between excretion and egestion.
2. Explain the role of excretion in animals.
3. Explain the role of excretion in osmoregulation.
4. Explain the role of kidneys in maintaining homeostasis.
5. Explain why excretory systems are closely associated with circulatory systems.
6. Explain why most multi-cellular animals need an excretory system.
7. Compare and contrast the nephridia system of earthworms with the kidney system of mammals.
8. Compare and contrast the Malpighian system of insects with the kidney system of mammals.
9. The metabolic processes of cells produce a large number of waste products. Discuss the ways in which the animals of three named taxonomic or functional groups have solved the problem of removing these wastes.
10. Select three different taxonomic or functional groups, and, using named animals as examples, discuss the structure of their excretory systems and the reasons for their differences. In your answer:
    - describe the system for each of the named animals
    - explain how each of these systems operates
    - explain the differences in the systems in relation to the different ways of life of the three animals.

Activity 8A answers: Excretion in animals

1. Excretion is the removal of *metabolic wastes* and excess chemicals from the body, egestion is the removal of *food that cannot be digested* (which forms the faeces).
2. Excretion removes waste products from the body's metabolic reactions as well as chemicals in excess of the body's needs (e.g. H_2O, salts). This allows *homeostasis* – i.e. maintaining a stable (within a narrow range) internal environment so that life processes/metabolic reactions/cell reactions can occur.
3. Excretion acts in osmoregulation by *removing excess water* from the body. High water levels create osmotic pressure and water will enter cells from the surrounding fluid. To maintain a balance, excess water is filtered from the blood by the excretory organs (e.g. kidneys) and passed to the outside environment.
4. The kidneys help maintain homeostasis by removing *excess chemicals and metabolic wastes* from the body/blood. The kidneys *filter* excess chemicals from the blood and these then pass out of the body. Needed chemicals are *reabsorbed* from the kidney tubules into the blood and stay in the body. These two processes (filtration and reabsorption) keep the amounts of chemicals (e.g. glucose, salts, nutrients, ions) in the body/blood stable – homeostasis.
5. Excretory systems remove waste products and excess chemicals from the blood, which is why the two systems need to be in close contact. The excretory organs need to be in close association with the blood because they have to *filter* the chemicals from the blood. Needed chemicals are then *reabsorbed* into the blood. Neither of these processes could work unless the blood was in close contact with the excretory organs.

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6. Small, relatively inactive animals with a simple body construction (e.g. cnidaria) are able to rely on *simple diffusion* from cells to the environment for the removal of their metabolic wastes. As animals have become larger, more active and more complex, simple diffusion with the environment is no longer effective to meet excretory needs. Therefore, an excretory system is needed to filter wastes from the blood and then remove the wastes to the outside.

7. *Comparisons* of the two systems could include the following.

- Excretory organs filter substances from the blood (mammals) and coelomic fluid (earthworms); both reabsorb needed substances into the blood capillaries.
- Excretory organs remove metabolic waste (including N compounds) and excess chemicals from the body; CO_2 is excreted from gas-exchange surfaces.
- Both nephridia and kidneys have a filtration section followed by a reabsorption section.

Contrasts of the two systems could include the following.

- Large numbers of *nephridia* (reflecting the segmental body structure) of earthworms, compared with the paired *kidneys* of mammals.
- Mammal kidneys are large and very complex structures compared with nephridia (reflecting the size, complexity and greater activity of mammals). Detailed description of the structures are needed as part of the answer.
- Nephridia lie free in coelomic fluid and filter substances from the fluid, while kidneys filter substances directly from the blood (glomerulus in Bowman's capsule). Detailed description of the functioning is needed as part of the answer.
- Excretory fluid in mammals is urine (dilutes the urea); storage organ (bladder) is present.

Correct terms should be used in all answers (e.g. nephridia, glomerulus, metabolism, filtration, reabsorption).

8. *Comparisons* of the two systems could include the following.

- Both types of excretory organ filter substances from blood, and both reabsorb needed substances back into the blood.
- Both types of excretory organ remove metabolic waste (includes N compounds) and excess chemicals from body, CO_2 excreted via a gas-exchange systems. Detailed description of the functioning is needed as part of the answer.

Contrasts of the two systems could include the following.

- There are a large numbers of Malpighian tubules compared with the paired kidneys of mammals.
- Mammal kidneys are large and very complex structures, compared with the Malpighian tubules (reflects the size, and complexity, of mammals). Detailed description of the structures is needed as part of the answer.
- Malpighian tubules lie free in coelomic fluid and filter substances from the fluid/haemolymph/'blood', while kidneys filter substances from the blood capillaries (glomerulus in Bowman's capsule).
- Closed circulatory system of mammals gives more rapid filtration/reabsorption of substances from/to blood than is possible from the open circulatory system of insects.
- Excretory organs in insects attach to the gut and the excretory products leave the body with the egested material. In mammals, the excretory system is separate from the gut.

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- Excretory fluid in mammals is urine (dilutes the urea), storage organ (bladder) is present. Insects excrete uric acid – a solid (important in conserving water).

Correct terms should be used in all answers (e.g. nephridia, glomerulus, metabolism, filtration, reabsorption).

9. Three clearly different taxonomic (e.g. earthworms, insects, mammals) or functional groups (e.g. nephridial system, Malpighian system, kidney system) need to be selected. For *each* group:

- Identify the metabolic wastes (e.g. ammonia, urea, uric acid), then *describe* the ways in which the animals remove them from the blood (filtration) and pass them out of the body. Include the *structures* concerned (e.g. nephridia, Malpighian tubules, kidneys, Bowman's capsule, glomerulus, kidney tubules, bladder, urethra and ureter).
- *Explain* the ways in which the animals filter the wastes then reabsorb needed chemicals – filtration, reabsorption – where and how each occurs (e.g. diffusion, filtration pressures, active transport). Which products are wastes (e.g. ammonia) and why (e.g. toxicity); which are needed (e.g. glucose), and why (respiration, energy needs); the need for osmoregulation; homeostasis.
- *Discuss* the ways in which the animals remove the metabolic wastes. This *compares* the groups of animals and gives *reasons for similarities and differences*, e.g. whether the animals are aquatic or terrestrial, the need to conserve water, the toxicity of the wastes, whether circulatory systems are open or closed, comparative activity of the animals, and comparative size of the animals.

10. Three clearly different taxonomic (e.g. earthworms, insects, mammals) or functional groups (e.g. nephridial system, Malpighian system, kidney system) need to be selected. For *each* group, the *structures* associated with the *obtaining and removal of* (named) *metabolic wastes* need to be *described fully and carefully*, *using correct terms*, e.g. the following.

- Detailed descriptions – e.g. Malpighian tubules (insects), nephridia (earthworms), kidneys (mammals), and their location.
- Description of circulatory system relevant to filtration and reabsorption.
- How surface area is maximised for filtration and absorption.
- Wastes and excess substances identified, needed substances identified.
- Other excretory surfaces and products, e.g. skin, lungs, sweat, CO_2.

For *each* group, *how* these structures perform their particular function needs to be *explained*, e.g. the following.

- Diffusion and concentration gradients, filtration pressures, active transport, energy requirements, SA.
- Osmoregulation, homeostasis.
- Excretion of CO_2.

For *each* group, reasons for *differences* between the groups need to be *explained*, e.g. the following.

- Why insects excrete uric acid, but mammals excrete urine; the need for a storage organ (bladder) in mammals.
- The complexity of mammals' kidneys compared with the simplicity of the nephridia and Malpighian tubules.

- Differences related to the presence of an open blood system compared with a closed system.
- These differences need to be related to differences in habitat (e.g. aquatic or terrestrial), activity of the animals (very active or less active), size and complexity of the animals (large or small), and ecological niches (specific adaptations to their habitat and lifestyle).

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