

Excretion and Osmoregulation

(An overview)

Excretion.

Animals must **get rid of two types of wastes** —

1. Wastes from the digestive system (feces) and
2. wastes from metabolic activities (CO₂, water & urine).

Excretion is the elimination of metabolic wastes from the body (Removing digestive wastes (pooping) is called egestion).

Major Metabolic Wastes

The end products of metabolism fall under two major categories: carbon dioxide and nitrogen containing compounds. Besides these products, water also requires to be eliminated if found in excess. Here we shall give our attention mainly to the production of nitrogenous wastes and their elimination.

Nitrogenous Wastes

The catabolism of amino acids and nucleic acids produces nitrogen-containing by-products called nitrogenous waste that must be eliminated from the body.

Ammonia

Ammonia is formed as a result of deamination of amino acids. It is poisonous, so it presents only in low concentration in the blood of many animals. Animals that excrete ammonia — aquatic invertebrates, most bony fishes, tadpoles, and salamanders — live in habitats with abundant water that carries the waste away. In these animals, ammonia simply diffuses into the water from blood that flows through the gills.

Urea

It is the major nitrogenous waste product derived from amino acid metabolism. It is also excreted by some animal as an end product of purine bases metabolism. Urea is less toxic and more soluble in water than ammonia. In livers of mammals, urea is synthesized from ammonia through a series of reactions known as urea cycle. In elasmobranchs, adult amphibians, and mammals, the nitrogenous wastes are eliminated in the form of urea.

Uric acid

It is excreted by the animals which conserve water, at least during parts of their life cycle, such as birds, terrestrial reptiles, insects, and some snails. In this case ammonia is converted into uric acid. It is less toxic than ammonia and only slightly soluble in water. As a result of its low solubility, uric acid precipitates and thus can be excreted using very little water.

Classification of animals on basis of types of nitrogenous compounds excreted

Ammonotelic

The animals of this group excrete nitrogenous wastes mainly in the form of ammonia. This is predominantly among aquatic animals, e.g. certain unicellular animals, most bony fishes, tadpoles etc.

Ureotelic

In these animals, nitrogen is excreted predominantly in the form of urea, e.g. mammals, amphibians, and elasmobranchs. Among fishes, both ammonotelic and ureotelic metabolism are present.

Uricotelic

Animals are described as being uricotelic when nitrogen is excreted predominantly in the form of uric acid, e.g. birds, insects, lizards, snakes, and some gastropods.




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|---|---|---|---|
| Animal group | Most aquatic animals | Mammals, most amphibians, some marine fishes, some reptiles, and some terrestrial invertebrates | Birds, insects, and most reptiles |
| Major form of nitrogenous waste | Ammonia (NH ₃) and ammonium ions (NH ₄ ⁺) | Urea <chem>NC(=O)N</chem> | Uric acid <chem>C1=NC2=C(N1)C(=O)N(C2=O)N</chem> |
| Energy required for production | None | Moderate | High |
| Amount of water required for excretion | High | Moderate | Low |
| Toxicity of waste | High | Low | Low |

Figure. Nitrogenous wastes produced by different animal groups. The three forms of nitrogenous wastes, which are derived from the breakdown of proteins or nucleic acids, have different properties.

Osmoregulation

Osmoregulation is the control of ion concentrations in body fluids. Depending on its habitat, an animal may need to conserve or eliminate water and ions.

In other words osmoregulation is the process by which organisms control the concentration of water and solutes in their bodies.

What is osmosis?

The movement of water down its gradient across a semipermeable membrane is called **osmosis**.

What is osmolrity?

The concentration of solutes in a solution is called the solution's osmolarity. It is measured in osmoles per liter. If the solutes are separated by a selectively permeable membrane and cannot cross that membrane, water moves from the side of lower osmolarity—that is, lower solute concentration and higher water concentration—to the side of higher osmolarity—higher solute concentration and lower water concentration.

What is osmotic Stress?

Osmotic stress occurs when the concentration of dissolved substances in a cell or tissue is abnormal. It means that water and solute concentrations are different from their set points.

Many organisms respond to osmotic stress by osmoregulating, just as they respond to heat or cold stress by thermoregulating.

Osmorugulators and Osmoconformers

Osmoregulators

Animals that maintain an internal osmolarity different from the medium in which they are immersed have been termed osmoregulators. i.e. osmoregulators maintain very stable internal ion concentrations and osmolarities, even when living in water whose osmolarity is very different from that of their body fluids or on land.

Such animals drink or excrete water and ions as necessary to maintain an internal osmolarity that is generally about 300 mOsm/L, or about one-third that of seawater and at least 10 times that of fresh water.

Osmoregulators maintain stable cellular levels of ions and water, but this requires considerable expenditure of energy, primarily to pump ions into and out of epithelial cells.

Most vertebrates, with the notable exception of elasmobranchs and hagfish, are strict osmoregulators, maintaining the composition of the body fluids within a small osmotic range.

OSMOCONFORMERS

An animal that does not actively control the osmotic condition of its body fluids and instead conforms to the osmolarity of the ambient medium is termed an osmoconformer. In this case, the osmolarity of extracellular and intracellular fluids is matched with seawater. The osmolarity of blood and other fluids of marine osmoconformers is like that of seawater, around 1,000 mOsm/L.