Teaching notes: Inorganic ions

These teaching notes relate to section 3.1.8 of our AS and A-level Biology specifications. This resource describes key teaching points in the accompanying PowerPoint presentation.

Key points

- Ions are charged particles that result when an atom gains or loses one or more electrons.
- Because they are charged, ions move in an electric field. Negatively charged anions move to the positively charged electrode (the anode) and positively charged ions move to the negatively charged electrode (the cathode). This is the basis of electrophoresis, which A-level students will learn about in section 3.8.4.3.
- Ions that students will learn about in the co-teachable first year A-level/AS include:
    - hydrogen ions (H^+), eg pH = $-\log_{10}[H^+]$
    - sodium ions (Na^+), eg in sodium co-transport with glucose and amino acids (section 3.3.3)
    - phosphate ions (PO_4^{3-}), eg in DNA (section 3.1.5), in ATP (section 3.1.6) and in phospholipids (sections 3.1.3 and 3.2.3).
- Rather than dwell on different ions here, it is suggested that specific ions are dealt with in the biological context in which they occur.
- This topic can also be used to illustrate:
    - ionic bonds
    - 'heavy' and 'light' isotopes (different number of neutrons in nucleus), eg, the use of ^{14}C in tracer experiments (section 3.3.4.2)
    - atomic mass.

PowerPoint presentation

Atoms (slide 2)

This slide introduces the concept of atoms.

Each atom has a nucleus containing protons and neutrons around which orbit electrons. Since the number of positively charged protons is the same as the number of negatively charged electrons, the atom has no overall charge.

Other concepts that could be introduced here are:

- all the atoms in one element have the same number of protons, eg carbon atoms always have 6 protons
- atoms of a single element might have different numbers of neutrons, eg most carbon atoms have 6 protons and 6 neutrons (atomic mass 12) but some have 6 protons but 8 neutrons (atomic number 14). These two forms are called **isotopes** and are represented as carbon 12 (^{12}C) and carbon 14 (^{14}C), respectively.

A sodium atom (slide 3)

This slide shows a single atom of sodium (Na atom).

The nucleus has 11 protons and 11 neutrons. The 11 electrons are found in 3 orbitals. The inner is full (2 electrons), the middle is full (8 electrons) but the outer contains only a single electron.

Stability of atoms (slide 4)

Atoms are stable when their outer orbital is full.

Losing or gaining one or more electrons helps to stabilise the atomic structure.

A sodium ion is formed when a sodium atom loses the electron from its outer orbital (slide 5)

A sodium ion is formed when a sodium ion becomes more stable by losing the lone electron in its outer orbital.

Click on the slide and the electron is 'lost', forming a sodium ion.

Ions are formed when an atom gains, or loses, electrons (slide 6)

This slide provides a summary of what has gone so far.

It also introduces the terms **anion** and **cation**.

Representing ions (slide 7)

This slide introduces the way in which we represent ions.

It is worth stressing here that examiners expect students to use appropriate terminology in written examinations. For example:

- in Year 1/AS, they should write that glucose is absorbed in the small intestine by co-transport with sodium ions (allow Na^+ or Na ions, but **not** sodium or Na)
- in Year 2, they should write that nerve impulse transmission involves sodium ions (allow Na ions or Na^+ but **not** sodium or Na) and potassium ions (allow K^+ or K ions but **not** potassium or K).

Some ions are complex (slide 8)

This slide introduces compound ions, such as phosphate, which will appear when learning about phospholipids (sections 3.1.3 and 3.2.3), DNA structure (section 3.1.5) and ATP (section 3.1.6).

A cation and anion can share electrons (slide 9)

This slide introduces the concept of ionic bonds, showing how a sodium atom becomes stable by losing the sole electron from its outer orbital and a chlorine atom becomes more stable by gaining an eighth electron to fill its outer orbital.

In doing so, both atoms are ionised and an ionic bond is formed.

Questions for students

No questions for students are supplied to accompany this topic, reflecting the fact that it contains background knowledge about basic chemistry.