

Nelson Biology VCE Units 3 & 4

Answers to Chapter Questions

Chapter 1

Review questions

- 1 Both non-living and living things are composed of matter. Matter is made up of atoms.
- 2 Living things are capable of reproduction, growth and movement.
- 3 6 electrons
- 4 The proton defines the element.
- 5 The atomic number would be 15 and the mass number would be 32. The symbol for phosphorus is P. The standard notation is $^{32}_{15}\text{P}$.
- 6 The number of neutrons may vary in all the isotopes of a particular element. Hence, an element may have different mass numbers.
- 7 The four major elements found in living things are oxygen, carbon, hydrogen and nitrogen.
- 8 Radioactive isotopes are used as a source of radiation in therapy and as tracers to tag particular compounds.
- 9 A compound is a pure substance made up of more than one type of atom held together by chemical bonds.
- 10 Ionic compounds are composed of cations and anions, which form ionic bonds. Molecular compounds result from atoms sharing their electrons to form covalent bonds. Molecular compounds vary in their solubility in water depending upon their polar nature. Ionic compounds are generally more soluble in water than molecular compounds.
- 11 Molecular compounds result from the sharing of electrons between non-metal elements, whereas ionic compounds are composed of ions and result from the transfer of electrons between metallic and non-metallic elements. As a result of the charges carried, ionic compounds tend to be more readily dissolved in water compared to molecular compounds.
- 12 A chemical bond is the force of attraction holding atoms together in chemical molecules.
- 13 Molecules that have permanent regions of opposite charge are termed 'polar'. Non-polar molecules have no permanent regions of opposite charge.
- 14 Water molecules are highly polar and attract one another, forming hydrogen bonds. Hydrogen bonding determines many of the unique properties of water.
- 15 Hydrophilic molecules, such as alcohol, have regions of opposite charge that readily form hydrogen bonds with water molecules and hence dissolve.

- 16 a** Water has a high latent heat. Dogs pant on a hot day to increase loss of heat by evaporation.
- b** Water is adhesive. Water molecules form hydrogen bonds with other polar molecules in the walls of a glass tube and hence adhere to and creep up the walls of the tube.
- 17** pH is a measure of how acid a solution is owing to the concentration of hydrogen ions. Buffers maintain a specific pH level by releasing or accepting hydrogen ions as required.
- 18** Water molecules form the solid ice. In the solid state the hydrogen bonds between water molecules spread the molecules apart. This results in the density of ice being lower than that of liquid water. Hence, ice floats, allowing aquatic organisms to survive below the ice.
- 19** The four main types of macromolecules are nucleic acids, proteins, complex carbohydrates and lipids.
- 20** Nucleic acids, proteins and complex carbohydrates are all polymers.
- 21** The key feature in a chosen example is to show the elimination of a water molecule when two monomers are linked together. It can be said that a water molecule ‘condenses out’ and students could liken this to a drop of water forming in their diagram.
- 22** Autotrophs use simple inorganic molecules to synthesis their macromolecules, whereas heterotrophs use organic compounds that first need to be broken down and then the products are used to synthesise macromolecules.
- 23** A carbohydrate molecule is made up of carbon, hydrogen and oxygen atoms.
- 24** Carbohydrates can be classified by the number of monomeric units that make up the carbohydrate: monosaccharides (one monomer), disaccharides (two monomers) and polysaccharides (more than two monomers). Increasing numbers of monomers and the complexity of the linkages determine their structural and storage functions.
- 25 a** Glycogen is a storage polysaccharide found in animals.
- b** Starch is a storage polysaccharide found in plants.
- 26** Lettuce is high in fibre owing to the cellulose it contains. However, humans lack the enzyme required to break down cellulose into the glucose monomers that could provide us with a source of energy.
- 27** Students should show that cellulose, in plant cell walls, is made up of polymers in straight chains lying close to one another and kept in place by hydrogen bonding. In the case of the cell walls of fungi, students should indicate that chitin may have a similar arrangement but that the polymer chains have N-containing groups attached.
- 28** Lipids are large molecules that are largely insoluble in water. Their hydrophobic nature and high energy content allows them to function as an energy store, as an important component of the cell membrane and in providing a protective and waterproof layer.
- 29** A simple diagram should show that, in the case of saturated fats, there are only single bonds between the carbon atoms, whereas in the case of unsaturated fats a double bond between two carbon atoms should be clearly present. Saturated fats should be fairly straight and unsaturated fats more kinked.

- 30** Phospholipids are important components of the plasma membrane.
- 31** Cholesterol is a component of membranes and confers a level of rigidity. It is also important as the starting point of various steroid hormones, such as oestrogen, testosterone, bile salts and vitamin D.
- 32** Glycolipids are lipids with a carbohydrate group attached and form receptor sites on the plasma membrane.
- 33** Protein diversity is made possible by arranging the 20 different amino acid monomers in various combinations or sequences that differ in length.
- 34** Proteins may have a structural or physiological function. Structural proteins are fibrous and insoluble, whereas proteins that are physiological are globular and soluble.
- 35** Students should use Table 1.7 to show the diversity of protein function based upon whether a protein is insoluble and has a structural function or whether it is soluble and has a physiological function. Each physiological function should be listed with an example of a protein and its action.
- 36** A hydrophilic amino acid will be on the outside of a protein molecule and attracted to the aqueous environment. Hydrophilic amino acids have regions of charge that can interact with polar water molecules.
- 37** After the formation of the polypeptide, interactions between the atoms on adjacent amino acid residues, such as hydrogen bonding, give rise to secondary structures known as coils (α -1 helices) and folds (β -1 sheets).
- 38** The tertiary level of protein structure produces its functional shape.
- 39**
- a** The structure of a nucleotide consists of three distinct chemical parts: (1) the phosphate group; (2) a five-carbon sugar; and (3) a nitrogen base. See Figure 1.42c.
 - b** Nucleotides vary in the type of nitrogen base present and in the nature of the sugar between DNA (deoxyribose) and RNA (ribose).
- 40** The 'base-pairing' rule means that only certain nitrogen bases will pair with each other. Adenine will only bond with thymine, in the case of DNA, forming a base pair, and guanine will only bond with cytosine to form a base pair.
- 41** In prokaryotic cells, DNA is found in the cytoplasm as a 'single chromosome' and as smaller circular structures called plasmids. In eukaryotic cells, most of the DNA is found on linear chromosomes within the nucleus. Smaller amounts of DNA are also found in the mitochondria and chloroplasts. DNA is an information molecule that stores information, written in a chemical code, for the production of proteins by the cell.
- 42** Both molecules are polymers and use a triplet code. DNA is double stranded, and RNA is usually single stranded. Ribose sugar is present in both but is in a deoxygenated form in DNA. The nitrogen base thymine in DNA is replaced by uracil in RNA.
- 43** The concept map should show the following connections: a gene is a sequence of DNA; the gene is expressed as a protein by the cell; all the genes for the organism are collectively termed the genome.

- 44 RNA exists in various forms with specific functions. mRNA is a transcribed copy of the gene to be expressed within the DNA molecule. mRNA is mobile; it leaves the nucleus and enters the cytoplasm. Transfer molecules of tRNA match amino acids to the specific codon indicated by the mRNA. Ribosomes are the organelles that are the site of the assembly of the polypeptide. Ribosomes contain their own rRNA.

Apply understanding

- 1 Students need to recognise that water, a highly polar molecule, is the universal solvent for life forms and that other polar substances will dissolve in water: hence the expression 'like dissolves like'. Equally, non-polar substances will not dissolve in water. For a cell to exist, the outer boundary should not dissolve in water but other substances (e.g. nutrients, waste products) should.
- 2 For water to reach the leaves of a tall gum tree a continuous column of water has to exist in the xylem vessels. The column of water is maintained by the cohesive and adhesive properties of water that are caused by the polarity of the molecule. Hydrogen bonding between water molecules accounts for the cohesion, and attraction of the polar water molecules to the walls of the xylem vessels accounts for the adhesion.
- 3 Monomers are linked chemically together to form polymers by the action of enzymes and the elimination of a water molecule from the appropriate functional groups. Students need to see that a reverse reaction, under the control of a specific enzyme, in which water is replaced, is possible. Such a reaction is termed 'hydrolysis'.
- 4 Students need to understand that an amino acid is defined by its functional groups – the amino group and the acid group – but that it is the differences in the R groups attached to the central carbon atom that gives rise to the variation between amino acids.
- 5 Proteins are made up of amino acids. Each amino acid contains an amino group that contains a nitrogen atom.
- 6 Students need to show an understanding that the arrangement of polymer chains can explain properties of substances. Polymer chains lying in parallel can form long elastic fibrous proteins such as keratin, but polymer chains that have side branches and/or form cross links with one another may reduce the elasticity but add greater strength to the protein, as in the case of silk.
- 7 Students need to consider the arrangement of the monomer in the polymer chains in cellulose and glycogen to understand that, although both are polysaccharides and insoluble, they both have different functions.
- 8 This tests student understanding of the 'base-pairing' rule and the replacement of thymine by uracil in the case of RNA.
 - a TACGCATGAATTGG
 - b UACGCAUGAAUUGG
- 9 Phospholipids have a hydrophilic head and a hydrophobic tail. Hence, students need to show an understanding that the polar head will be orientated to the water molecules, whereas the non-polar tail will be orientated away from water and towards other hydrophobic regions on adjacent phospholipid molecules.
- 10 Students need to relate the observation of the change in the protein to a denaturing of the tertiary structure caused by the high temperature. Students should note that the change is irreversible.