

## AS Biology Syllabus 9700

### Unit 2: Molecules and Membranes

#### Recommended Prior Knowledge

Students will need some background knowledge in chemistry before embarking on this Unit. They should understand the terms *atom*, *molecule* *electron* and *ion*. They should also have a basic understanding of covalent and ionic bonding, and of molecular and structural formulae. They should be able to write and understand simple chemical equations. Some knowledge of energy changes (potential energy and bond energy) would be helpful. They should understand the kinetic theory, and be able to use it to explain diffusion in solutions. **Advanced Biology**, Jones and Jones, CUP, has an Appendix covering the basic chemistry required for this Unit.

<http://www.rsc.org/education/teachers/learnnet/cfb/contents.htm>

<http://www.biology.arizona.edu/biochemistry/tutorials/chemistry/page1.html>

} are excellent sites covering basic chemistry for biologists

#### Context

This Unit could be studied either before or after Unit 1. It provides essential reference material for students when studying all future Units in their AS/A2 course. An understanding of the structure, roles and behaviour of biological molecules is fundamental to an understanding of physiology, genetics and some aspects of ecology.

#### Outline

The Unit begins with the properties and roles of water in relation to living organisms. It introduces the concepts of hydrogen bonding and solubility, which lead to an understanding of the properties of biological molecules. Three of the main groups of biological molecules, carbohydrates, fats and proteins, are studied. There is an emphasis on relating their molecular structures to their properties and functions in living organisms. This leads on to an understanding of the structure and functions of biological membranes.

#### B Biological molecules

- Structure of carbohydrates, lipids and proteins and their roles in living organisms
- Water and living organisms

#### D Cell membranes and transport

- Fluid mosaic model of membrane structure
- Movement of substances into and out of cells

There are many good opportunities within this Unit for students to develop their practical skills relating to Assessment Objectives in Group C (Experimental skills and investigations), particularly in the handling and manipulation of a range of equipment, apparatus and chemicals and including the design and evaluation of their own investigations (assessed in Paper 5). Each student should be given some opportunity to work alone and under time pressure in preparation for the practical exam(s). This Unit lends itself to reinforcement of learning by taking frequent short-answer tests, so that students gain the confidence to answer questions that require them to apply their basic knowledge and understanding to new situations or to solve related problems (the final learning outcome in each section).

**AO Learning outcomes**

B (i) describe and explain the roles of water in living organisms and as an environment for organisms;

**Suggested Teaching activities**

The way in which this topic is handled should be tailored to the students. Those with a strong chemistry background are likely to have little trouble with understanding the concepts involved, while others may find this difficult and will need a slow, steady approach that keeps things as simple as possible. A question and answer session / whole class discussion will help gauge student knowledge. It is a good idea to make cross-references to other areas of biology, such as cell biology, during this section so that students gain a wide perspective on the roles of the biochemicals they study in this Section/Unit.

Aim to give students a sound but simple description of hydrogen bonding, and use this to explain why water has a relatively high boiling point, high specific heat capacity, high surface tension and high latent heat of vaporisation. Its solvent properties should also be discussed - this will help to explain the solubility or otherwise of the biological molecules to be dealt with later in this Unit. Each of these properties can be related to the roles of water within living organisms and as an (external) environment for them. Emphasise the role of water as an important solvent in biological systems - introduce concept of *polar* and *non-polar* here.

If students carry out their own research, they may come across reference to the importance of hydrogen bonding in protein structure (this Unit) and DNA (Unit 3) and there is the option to discuss this briefly with the class.

**Class activities**

1. Looking up key terms in the index of a variety of Biology books. Brief written and diagrammatic explanation of polar/non-polar and hydrogen bonding and its importance.

**Learning resources**

[http://faculty.fmcc.edu/mcdarby/majors101book/chapter\\_03-chemistry/03-Water\\_Properties.htm](http://faculty.fmcc.edu/mcdarby/majors101book/chapter_03-chemistry/03-Water_Properties.htm)

has information for biologists about the chemistry and properties of water

**AS and A Level Biology** gives a briefer treatment of this topic (Chapter 2, pp.37 & 38).

The properties of water are fully described and explained in **Biological Science 1 and 2 (3<sup>rd</sup> edition)**, Taylor, Green, Stout & Soper, pub. CUP, and in **Advanced Biology**, Jones and Jones, pub. CUP.

**Bio Factsheet 30:** *The biological importance of water*

**Bio Factsheet 78:** *Chemical bonding in biological molecules*

**AO Learning outcomes**

- B (b) describe the ring forms of  $\alpha$ -glucose and  $\beta$ -glucose;
- (c) describe the formation and breakage of a glycosidic bond with reference both to polysaccharides and to disaccharides including sucrose;

**Suggested Teaching activities**

All students will be familiar with the term *carbohydrate*, but are likely to know little about their molecular structure. Explain that glucose is used here as an example of a monosaccharide; an understanding of its  $\alpha$  and  $\beta$  forms will be needed in order to understand polysaccharide properties later. Using the term *hexose* sugar is useful here as an introduction for pentose sugars (Unit 3) and respiration and photosynthesis (A2).

An explanation of how a glycosidic bond forms, and how the bond can be broken, introduces the terms *condensation* and *hydrolysis*. It should also lead to an understanding of *monosaccharide* and *disaccharide*. Using knowledge of the structure of  $\alpha$  glucose, students should be able to describe the formation of maltose. They are not required to describe the structure of fructose, but should know that sucrose is a disaccharide formed from  $\alpha$  glucose and fructose. Students should be shown molecular diagrams of sucrose formation. Note also that the terms *monomer* and *polymer* are not required by the syllabus, but may be useful to candidates in their understanding of macromolecules such as polysaccharides, polypeptides and polynucleotides.

**Class activities**

1. Making molecular models of  $\alpha$  and  $\beta$  forms of glucose. Using the  $\alpha$  glucose models to demonstrate the formation of maltose (group work). If there are enough, class construction of a polysaccharide. There are some inexpensive drinking straw based models as well as plastic sphere / bond models.
2. Numbering the atoms on existing drawings of glucose molecules, and completing incomplete diagrams by adding OH and H groups.
3. Practising drawing  $\alpha$  and  $\beta$  glucose with all the atoms, and omitting the carbon atoms, as well as diagrams summarising glycosidic bond formation (e.g. to form maltose).

**Learning resources**

<http://www.pdb.org/pdb/home/home.do>  
the Protein Data Bank

It is possible to view models of molecules on line at Botany on-line:  
<http://www.biologie.uni-hamburg.de/b-online/e17/17.htm>

Molecular models are available from suppliers, such as Philip Harris.

**AS and A Level Biology** (Chapter 2, pp.23 & 24), like other texts, uses diagrams to illustrate these structures and processes. Note that maltose is made in nature from degradation reactions, as in the breakdown of starch, so the 'formation' of maltose shown illustrates the principle of glycosidic bond formation by a condensation reaction.

## AO Learning outcomes

- B (a) carry out tests for reducing and non-reducing sugars (including using colour standards as a semi-quantitative use of the Benedict's test);

## Suggested Teaching activities

Although foods are commonly tested, explain to students that these types of tests are useful to identify biochemicals (in this case reducing and non-reducing sugars) in a range of plant and animal material. Hence they can be referred to as *biochemical tests*.

Students could first carry out the Benedict's test for reducing sugars on a range of (liquefied) food containing sugar(s) or on solutions of different sugars; this will be revision for most of them. Include at least one food substance or sugar solution that does not contain reducing sugar and gives them a negative result. Explain to them that this test does not give a positive result for sucrose (the only non-reducing sugar they will come across). Ask them to suggest how they might be able to adapt the test to identify a non-reducing sugar (encourage them to draw on their knowledge of glycosidic bonds) before carrying out this test on a fresh sample of their 'negative result'. AR sucrose, not LR or cane sugar, is preferred.

**Class activities** (remind students to control all variables)

1. Use Benedict's test on water, pure glucose, fructose, maltose, lactose, sucrose, protein solutions, starch suspension, vegetable oil and also on a range of natural biological materials (e.g. fruits, tubers). Describe the tests made and the results obtained.
2. Use Benedict's test on water, and on solutions containing sucrose, before and after hydrolysis in hot acid and neutralisation. Describe the tests made and the results obtained.
3. Carry out the Benedict's test on a range of glucose solutions of known concentration to obtain colour standards. Then carry out a semi-quantitative analysis to determine the approximate concentration of an unknown, by comparing the colour (and depth of colour) obtained to the colour standards.
4. Carry out tests to identify which unmarked solution is glucose solution only, which is sucrose solution only and which is a mixture of both glucose and sucrose solutions.

## Learning resources

<http://jchemed.chem.wisc.edu/JCESoft/CCA/CA5/MAIN/1ORGANIC/ORG18/TRAM18/B/MENU.HTM>

has illustrations of simple Benedict's test, including negative test for sucrose before hydrolysis. However, the use of a water bath, rather than direct heating, is recommended

<http://www.mrothery.co.uk/module1/Mod%201%20techniques.htm>

and

[http://www.mrothery.co.uk/bio\\_web\\_prac/practicals/2Food%20Tests.doc](http://www.mrothery.co.uk/bio_web_prac/practicals/2Food%20Tests.doc)

clear protocols and a straightforward description of Benedict's test for reducing and non-reducing sugars

<http://www.biopics.co.uk/as/cho.html>

protocol including tests for reducing and non-reducing sugars, and some points to consider

**AS and A Level Biology** describes suitable ways of carrying out these tests (Chapter 2, p.25). Additional publications for these tests: **Practical Advanced Biology Comprehensive Practical Biology for A Level** (includes a protocol that describes a semi-quantitative test)

**Biological Science 1 and 2 (3<sup>rd</sup> edition)**, Taylor, Green, Stout & Soper, pub CUP  
**Advanced Biology: Principles and Applications: Study Guide**, Clegg and Mackean, pub. John Murray (out of print, but 'used' copies available)

## AO Learning outcomes

B (d) describe the molecular structure of polysaccharides including starch (amylose and amylopectin), glycogen and cellulose and relate these structures to their functions in living organisms;

(a) carry out the iodine in potassium iodide solution test for starch;

## Suggested Teaching activities

Build on the students' understanding of glycosidic bond formation and the numbering of carbon atoms to enable them to see the difference between the structure of amylose and amylopectin. Students should be able to link the coiling effect of amylose and branching of amylopectin to the idea of more compact structures for storage. Explain the advantage of branching of amylopectin and glycogen in providing large number of 'ends' to attach and detach glucose units.

Show students how forming polysaccharides with alternate  $\beta$  glucose residues rotating by  $180^\circ$  provides a straight chain, useful for structural purposes (cellulose). Build on their understanding of hydrogen bonding, covered in B(i), to discuss how parallel cellulose molecules can form fibrils (and then fibres – refer back to Unit 1 and the cellulose cell wall).

### Class activities

1. Get students to handle strings of beads on wire or to join hands and pretend to be 'long, strong chains of  $\beta$  glucose residues' (cellulose), 'compact, energetic spirals of  $\alpha$  glucose residues' (amylose), and 'compact, branched, amorphous, energetic shapes of  $\alpha$  glucose residues' (amylopectin and glycogen) – the concrete experiences help to learn a difficult abstract idea.
2. Make brief written and diagrammatic explanations of the relationship between structure and function.
3. Carry out the iodine in potassium iodide solution test on a range of different types of starch (suspensions) to see the range of blue-black colours obtained.
4. Test different food substances to identify those containing starch.

## Learning resources

<http://www.rpi.edu/dept/bcbp/molbiochem/Meb/mb1/part2/sugar.htm> has a comprehensive review of carbohydrate structure including examples of polysaccharides

<http://www.calfnotes.com/pdffiles/CN102.pdf> material on the structure and function of these polysaccharides in the context of calf nutrition

Most AS and A level textbooks cover this material thoroughly.

**AS and A Level Biology** (Chapter 2, pp.26-28), like other texts, uses diagrams to relate these structures to their functions.

[http://www.mrothery.co.uk/bio\\_web\\_prac/practicals/2Food%20Tests.doc](http://www.mrothery.co.uk/bio_web_prac/practicals/2Food%20Tests.doc) has clear protocols, including this one

**Practical Advanced Biology** and **Comprehensive Practical Biology for A Level** include suitable tests.

**Bio Factsheet 39: Carbohydrates: revision summary**

**Bio Factsheet 174: The structure and function of polysaccharides**

**AO Learning outcomes**

B (e) describe the molecular structure of a triglyceride and a phospholipid and relate these structures to their functions in living organisms;

**Suggested Teaching activities**

The insolubility of triglycerides, and the behaviour of phospholipids when in contact with watery liquids, should be related to the absence or presence of polar groups; once again, refer back to the earlier work on water to help to explain this. Saturated and unsaturated fatty acids should be mentioned but do not go into detail at this stage. The formation of bilayers by phospholipids may be described at this stage, or dealt with later, in topic D(a). Students should be able to describe a range of functions of lipids in organisms, relating each of these functions to their molecular structure.

**Class activities**

1. Make very simple paper cut out models of triglycerides to illustrate the non-polar exposed fatty acids, and phospholipids to show the very different ends of the molecule.
2. Lay out side-by-side the cut out phospholipids to form a bilayer (keep the paper models for use in D(a))
3. Examine diagrams of triglycerides, describing evidence that makes them good energy stores (lots of carbon-carbon bonds, highly reduced so energy can be released by oxidation, insoluble in water so can be localised in the organism).

(a) carry out the emulsion test for lipids

- Students may already know the (ethanol) emulsion test for lipids from earlier work.
4. Use the (ethanol) emulsion test with vegetable oil and yellow-dyed water.
  5. Use the emulsion test with crushed fruits and seeds.

**Learning resources**

<http://www.biotopics.co.uk/as/lipidcondensation.html>  
formation of a triglyceride, information and animation

**AS and A Level Biology** (Chapter 2, pp.29 & 30), like other texts, uses diagrams to relate these structures to their functions.

**Bio Factsheet 42:** *The structure and function of lipids*

**Bio Factsheet 74:** *The structure and biological functions of lipids*

**Bio Factsheet 152:** *Phospholipids*

[http://www.mrothery.co.uk/bio\\_web\\_prac/practicals/2Food%20Tests.doc](http://www.mrothery.co.uk/bio_web_prac/practicals/2Food%20Tests.doc)  
has clear protocols including this one

**AS and A Level Biology, Practical Advanced Biology and Comprehensive Practical Biology for A Level** all include suitable tests.

## AO Learning outcomes

B (f) describe the structure of an amino acid and the formation and breakage of a peptide bond;

(g) explain the meaning of the terms *primary structure*, *secondary structure*, *tertiary structure* and *quaternary structure* of proteins and describe the types of bonding (hydrogen, ionic, disulfide and hydrophobic interactions) that hold the molecule in shape;

(h) describe the molecular structure of haemoglobin as an example of a globular protein, and of collagen as an example of a fibrous protein and relate these structures to their functions (the importance of iron in the haemoglobin molecule should be emphasised);

## Suggested Teaching activities

Students do not need to know the structures of different amino acids, but they do need to understand that the R (residual) group can take many different forms and for learning outcome (g) they will need to understand that interactions between R groups allow the different types of bonding found in protein tertiary structure. There is no need to go into any detail at all about how individual amino acids behave in solution; the behaviour of terminal amine and carboxyl groups in a protein molecule is of little importance compared with the behaviour of the R groups. Students should understand that a series of condensation reactions leads to the formation of a polypeptide. This will lead to the introduction of levels of organisation of protein structure and a question and answer session/whole group discussion. This should be followed by written and diagrammatic explanation of protein structure and the role of bonding in determining shape and stability.

The various levels of protein structure could be taught by reference to haemoglobin. Its globular shape and solubility (which can be related to the positions of polar R groups on the outside of the coiled and folded molecule) are typical of metabolically active proteins. The structure and function of collagen can be contrasted with this.

Note: students often think that to have quaternary structure proteins must be composed of four polypeptides.

### Class activities

1. Examine diagrams of typical amino acid and simple amino acids, to identify the R group and the part common to them all, as well as the amine group and carboxylic acid group.
2. Draw simple diagrams of the structure of a typical amino acid, a condensation reaction to show the formation of a dipeptide and a hydrolysis reaction to show the breakage of a peptide bond.
3. Individual students or pairs to make an A4 poster showing the

## Learning resources

<http://www.biotopics.co.uk/as/aa.html>  
interactive amino acid structure, this page leads on to show animations of the formation and breakage of peptide bonds.

**AS and A Level Biology** has detailed information (Chapter 2, pp.30-34).

The molecular structure and functions of haemoglobin and collagen are also thoroughly covered in **AS and A Level Biology** (Chapter 2, pp.34-37).

For an extension activity, the use of paper chromatography to analyse the amino acids in albumen is described in **Practical Advanced Biology** and **Comprehensive Practical Biology for A Level**.

**Advanced Biology: Principles and Applications. Study Guide**, Clegg and Mackean, pub.John Murray ((out of print, but 'used' copies available), also describes a method for analysing amino acids using chromatography.

**Bio Factsheet 80:** Structure and biological functions of proteins

**Bio Factsheet 175:** Haemoglobin: structure & function

(a)  
carry out the biuret test for proteins;

- role of one kind of bonding in one level of protein structure, so that the whole group covers all types of bonding and all levels of structure.
4. Construct a comparison table showing the similarities and differences between haemoglobin and collagen.
  5. Use the biuret test on a solution of egg white, skimmed milk, chicken or tofu and water. Students are likely to have come across this test already, from earlier work. They need this learning reinforced, and they need any confusions corrected.
  6. Carry out a semi-quantitative biuret test. Prepare a set of standard solutions, and then for each add a fixed volume to the same volume of biuret solution in separate test tubes, mixing the contents and leaving for a standard length of time. Use the same volumes and time for unknown solutions and compare the intensity of colour obtained with the standards.

**Advanced Biology: Principles and Applications. Study Guide**, Clegg and Mackean, has a flow chart to show how the different tests, such as the biuret test, can be used to identify unknown substances or substances in a mixture.

**Practical Advanced Biology** and **Comprehensive Practical Biology for A Level** and **AS and A Level Biology** include suitable protocols for this test.

[http://www.mrothery.co.uk/bio\\_web\\_prac/practicals/2Food%20Tests.doc](http://www.mrothery.co.uk/bio_web_prac/practicals/2Food%20Tests.doc)  
has clear protocols including this one

<http://www.biotopics.co.uk/nutrition/footes.html>  
using the standard biochemical (food) tests to investigate the contents of different foods

**Bio Factsheet 173: How to identify foods: Food Tests and Chromatography**  
Note that chromatography is not required learning.



## AO Learning outcomes

- D (a) describe and explain the fluid mosaic model of membrane structure, including an outline of the roles of phospholipids, cholesterol, glycolipids, proteins and glycoproteins ;

## Suggested Teaching activities

To understand membrane structure, students bring together their knowledge of the molecular structure and behaviour of phospholipids, proteins and carbohydrates. Students will benefit from visual stimuli and should be shown a range of different diagrams of the fluid-mosaic model. Ask for suggestions for the roles of the different membrane components. Build on their knowledge of protein structure related to function to discuss roles of the different types of membrane protein. The role of unsaturated and saturated fatty acids in the fluidity of the membrane can be discussed, which will lead on to how cholesterol acts to regulate fluidity. A basic explanation of how glycoproteins and glycolipids can act as antigens will help student understanding in the Immunity section (Unit 5) later.

### Class activities

1. Add relevant labels to diagrams, then practise drawing a labelled diagram that will ultimately take 2-3 minutes to draw in an exam.
2. Use the phospholipids models from B(e) and protein cut-outs (different types) to build a model membrane.
3. Research and compile a list of the roles of the different membrane components.

## Learning resources

[www.ultranet.com/~jkimball/BiologyPages/CellMembranes.html](http://www.ultranet.com/~jkimball/BiologyPages/CellMembranes.html)  
illustrated explanation at a slightly higher level

<http://www.wisc-online.com/objects/ViewObject.aspx?ID=ap1101>  
an excellent animation building up the structure of the cell membrane

<http://www.stolaf.edu/people/giannini/flashanimat/lipids/membrane%20fluidity.swf>  
very short animation of membrane fluidity

**Bio Factsheet 8:** *The cell surface membrane.*

**AS and A Level Biology** (Chapter 4, pp.50-53), like other texts, uses diagrams and text to explain this model of membrane structure.

AO  
D

### Learning outcomes

(c)  
describe and explain the processes of *diffusion*, *facilitated diffusion*, *osmosis*, *active transport*, *endocytosis* and *exocytosis* (terminology described in the IOB's publication **Biological Nomenclature** should be used; no calculations involving water potential will be set);

### Suggested Teaching activities

Ask students to suggest which substances need to cross the cell surface membrane, entering or leaving cells before introducing the idea of different transport mechanisms.

Deal firstly with thermodynamic (so-called passive) methods of movement across membranes - diffusion, facilitated diffusion and osmosis - and then the active ones. Students should understand that facilitated diffusion is simply diffusion through a protein channel, and that osmosis is simply diffusion of water. Take great care with osmosis terminology. Use the terms:

- **partially permeable**
- **water potential**
- **solute potential**
- **pressure potential.**

**DO NOT** refer to or use the terms osmotic potential, osmotic pressure, wall pressure, hypertonic, hypotonic or isotonic.

Note that no calculations will be set.

Students often make the error of thinking about how a *solution* moves, rather than the individual molecules and ions within it. Ensure that they understand that each particle is moving individually and randomly. It may be helpful to use Visking tubing as an example of a partially permeable membrane, to illustrate osmosis.

Discuss with students why it is necessary to transport substances against the concentration gradient. Providing students with examples of active transport (to set the scene) can help but note that students are not required to give details.

It is useful for students to note that pinocytosis and phagocytosis are both forms of endocytosis. Students will be required to describe phagocytosis in the Immunity section (Unit 5).

### Learning resources

[http://highered.mcgraw-hill.com/sites/0072495855/student\\_view0/chapter2/animation\\_how\\_diffusion\\_works.html](http://highered.mcgraw-hill.com/sites/0072495855/student_view0/chapter2/animation_how_diffusion_works.html)  
animations of different mechanisms of transport across membranes

<http://www.emc.maricopa.edu/faculty/farabee/BIOBK/BioBooktransp.html>

first of a series of pages on transport in and out of cells. Clear diagrams and reasonably brief text

**Biological Nomenclature (4<sup>th</sup> Edition)**, pub. Society of Biology, explains the terminology that should be used when teaching osmosis. Older editions of text books are likely to use obsolete terminology, which should be avoided as it can make the topic confusing for students.

**AS and A Level Biology**, organises this suitably into transport involving natural kinetic energy, and transport involving energy from hydrolysis of ATP (Chapter 4).

**Bio Factsheet 54: Water potential**

**Bio Factsheet 116: Transport Mechanisms in cells.**

### **Class activities**

1. Build understanding of diffusion using students moving around the classroom pretending to be diffusing particles. This model can be extended to facilitated diffusion, osmosis and active transport by introducing a line of chairs / desks across the classroom, with suitable sized gaps, or gaps manned by selective students – use computer based animations and diagrams.
2. Make brief written descriptions and draw annotated diagrams explaining each of these processes.
3. Summarise similarities and differences between the types of transport in tabular form.
4. Carry out investigations using different solutions (e.g. glucose, starch suspension) placed within lengths of Visking tubing (tied at both ends) and placed in water (and vice versa). Note appearance of tubing and perform biochemical tests on the internal/external solution after a set time period (also serves to consolidate B(a)).

**AO Learning outcomes**

D (d) investigate the effects on plant cells of immersion in solutions of different water potential;

**Suggested Teaching activities**

Students may become confused between water potential and solute potential.

Water potential may be measured by immersing pieces of root or stem (e.g. potato tuber tissue) in sucrose solutions of different concentrations. The water potential of the tissue is equivalent to the water potential of the solution in which there is no change in length or mass of the tissue.

Solute potential may be measured by immersing epidermal strips (e.g. onion) in solutions of different concentrations and counting the number of cells showing plasmolysis. Solute potential of the tissue is equivalent to the water potential of the solution in which 50% of the cells are plasmolysed.

**Class activities**

1. Use potato tuber (or similar starchy tissue) to find water potential of tissue.
2. Use onion epidermis (or similar one-cell thick tissue) to find solute potential of tissue.
3. Produce high power drawings of onion cells in different stages of plasmolysis.

**Learning resources**

<http://www.kscience.co.uk/animations/plasmolysis.htm>

very basic introduction to plasmolysis and turgidity

<http://www.biotopics.co.uk/life/osmdia.html>  
illustrations and a gap-fill exercise (but students need to be aware that the descriptions should be in terms of water potential and not the terms used here)

<http://www.biotopics.co.uk/life/carrot.html#top>  
osmosis in carrot tissue – experimental instructions with interactive questions

<http://www-saps.plantsci.cam.ac.uk/osmoweb/wpmenu.htm>  
some interesting extensions of these investigations

**AS and A Level Biology** has diagrams and light micrographs of plasmolysed cells (Chapter 4, pp.57 & 58).

Several investigations are described in **Practical Advanced Biology**, in **Biological Science 1 and 2 (3<sup>rd</sup> edition)**, Taylor, Green, Stout & Soper, pub CUP and in **Comprehensive Practical Biology for A Level**.

**AO Learning outcomes**

D (b) outline the roles of cell surface membranes;

**Suggested Teaching activities**

Students will now understand the role of the cell surface membrane in controlling the passage of substances into and out of the cell. They may now appreciate that membranes have a wide range of other roles, although if they have not yet done unit 1, they will not yet be in a position to understand these in detail.

The cell recognition function of cell surface membranes is covered in the Immunity section in Unit 5 when describing the functions of lymphocytes.

**Class activities**

1. Draw a diagram of a piece of plasma membrane, and annotate the parts responsible for movement of ions (actively and by facilitated diffusion), water, gases, small polar molecules, lipid-soluble molecules through the membrane, cell recognition, responding to levels of extra-cellular hormones like insulin and adrenaline and other functions (from bibliographic and web-based research).

**Learning resources**

<http://www.biologymad.com/cells/cellmembrane.htm>

useful to summarise section D (or as reinforcement after each learning outcome)

In **AS and A Level Biology**, the roles of the cell surface membrane are clearly described (Chapter 4, pp.52 & 53).

Functions of cell membranes are listed in **Advanced Biology**, Jones and Jones, pub. CUP. Note that only the roles of the cell surface membrane are required.