Qualification Accredited

OCR
Oxford Cambridge and RSA

AS and A LEVEL
Delivery Guide

BIOLOGY B

H022/H422
For first teaching in 2015

Cells and Chemicals for Life

Version 2

www.ocr.org.uk/biology

Introduction

AS AND A LEVEL
BIOLOGY B (CELLS AND CHEMICALS)

Delivery guides are designed to represent a body of knowledge about teaching a particular topic and contain:

- Content: A clear outline of the content covered by the delivery guide;
- Thinking Conceptually: Expert guidance on the key concepts involved, common difficulties students may have, approaches to teaching that can help students understand these concepts and how this topic links conceptually to other areas of the subject;
- Thinking Contextually: A range of suggested teaching activities using a variety of themes so that different activities can be selected which best suit particular classes, learning styles or teaching approaches.

If you have any feedback on this Delivery Guide or suggestions for other resources you would like OCR to develop, please email resources.feedback@ocr.org.uk.

Would you prefer a Word version?

Did you know that you can save this pdf as a Word file using Acrobat Professional?

Simply click on **File** > **Export to** and select **Microsoft Word**

(If you have opened this PDF in your browser you will need to save it first. Simply right click anywhere on the page and select ***Save as . . .*** to save the PDF. Then open the PDF in Acrobat Professional.)

If you do not have access to Acrobat Professional there are a number of **free** applications available that will also convert PDF to Word (search for *pdf to word* converter).

Curriculum content

This section focuses on the unifying concept of biology, the cell theory.

"The living cell is to biology what the electron and the proton are to physics. Apart from cells and from aggregates of cells there are no biological phenomenon" 'Science and the Modern World' by Alfred North Whitehead, published by Macmillan Company, 1925.

Learners will develop an understanding of the complexity of the cell and the advances that occurred to enable exploration of cells. It should be appreciated that the history of cell biology parallels the invention of and improvements in microscopes.

– The importance of microscopy, to include the use of the light microscope, transmission and scanning electron microscope and ……the confocal scanning microscope.

The requirements of microscopic analysis are highlighted using blood smears and include the use of differential staining and haemotocytometers for cell density. Magnification calculations are included and extended to include the practical use of a graticule for measuring cellular dimensions.
The similarities and differences in cellular structure is covered for eukaryotic animal and plant cells and contrasted with prokaryotic cell structure.

– The differences between the structure of eukaryotic plant and animal cells and between eukaryotic and prokaryotic cells.

The plasma membrane takes a central role in the relationship between organelle structure and cellular function. Active and passive cellular transport processes are covered with practical investigations covering the rate of diffusion across dialysis tubing or phenolphthalein agar, representing a model cell.

– Practical investigations into factors affecting diffusion rates in model cells.

Additional cellular organelles are discussed with reference to their role in protein synthesis. Learners must apply knowledge of the organelles structure and function to their sequential role in the synthesis and secretion of proteins.

Thinking conceptually

This unit is the basis of all biological phenomena covered in the specification and a firm understanding and linking of structure to function is vital for easy progression as the course unfolds. It can be taught through observation, which will introduce students to one of the fundamental aspects of scientific thinking. It also allows integration of technology with biological structure and it should be emphasised how inventions and consequent biological analysis of cellular structure steered each to where we are today with digital microscopy.

The common theme of blood cells that connect many of the learning outcomes can be used as a practical tool to enable students to link them and makes an obvious connection with mammalian transport later in the course. Students often fail to relate a computer-generated image of a cell with the practical limitations of each type of microscope. Practical tasks involving students staining their own material and visualising the results with the light microscope, helps to obviate this difficulty. This may help to eliminate the common error of drawing more in a light microscope image of a cell than is actually visible.

The topic requires a clear comparison of cellular visualisation techniques with the inclusion of flow cytometry and fluorescent markers. This will allow a deeper evaluation of these techniques with regard to medical research, clinical diagnosis and forensic implementation. It could connect well with later sections on disease and immunology.

The plasma membrane should be introduced with emphasis on its polar/non polar nature for students to relate structure to function for all membrane components. They will be able to apply that knowledge later in the course when membrane proteins are a central theme (photosynthesis and cellular respiration) and with the polar nature of water in the next unit. Students find it hard to understand the concept of polar and non polar interactions. It is commonly analogised with positive and negative charges attracting. Simple experiments with adding coloured oils to water or vice versa can help to cement what appears to be a contradiction and if necessary, a follow through with an oil spill analogy.

Diffusion rates, visualised with, for example, agar blocks help students to develop a deeper understanding of diffusion rates in gas exchange, osmosis and the principle that a small organism with a large surface area to volume ratio has a fast rate of diffusion, which is required later in the specification.

Organelle function is orientated to the role of relevant organelles in one particular function. This links organelle function in a clear and chronological manner and will eliminate the usual student mistake of omitting the relevance of the cytoskeleton in the movement of vesicles within the cell.

Thinking contextually

This topic is amenable to a plethora of visual techniques with many practical activities. One practical activity (Learner Activity 2) can span a few sessions and will link many outcomes. It will allow students to visualise their output and thus consider the limitations and requirements for sample preparation.

If it is not possible for students to make their own blood smear slides then these can be purchased, for example from [1].

There are a number of online resources that can be used when teaching about microscopes [2] and [3].

There are also online resources to assist with teaching magnification and how to use eyepiece graticules [4] and [5].

Different staining techniques can give depth to this topic and pictures showing these cell stains can be easily found[6].

There are many mini activities (starters/plenaries) that will help to introduce or reinforce these learning outcomes (Learning Activity 1 & 4). This can involve use of SOLO hexagons for linking eg different microscopes and their requirements[7]. Dominoes can also be used for matching organelle structure/function/picture (Learning Resource 1).

The overarching theme of the first part of this unit could be its application in clinical diagnosis (Learner Activity 5) which links well with later units on non communicable diseases. Rates of diffusion can be easily demonstrated using phenolphthalein and agar blocks. This can be expanded with students 'designing' their own agar model cell shape and see what affect it has on the rate of diffusion. An alternative experiment is outlined in Learner Activity 3.

[1] Blood smear slides, Phillip Harris
www.philipharris.co.uk/search?phrase=blood+smear+slides
This is a selection of blood smear slides that are available.

[2] Light Microscopy video (Wellcome Trust)
www.youtube.com/watch?v=Xo7mr90GYLA&list=PL343000004E5AA238&index=14&t=0s&app=desktop
This video showing the use of the light microscope is 7 minutes long.

[3] Scanning Electron Microscopy Video (Wellcome Trust)
www.youtube.com/watch?v=pT-tnPiDjoo
This video showing the use of the electron microscope is 3 minutes long.

[4] Magnification Java Tutorial (Olympus America Inc.)
www.olympus-lifescience.com/en/microscope-resource/primer/java/lenses/simplemagnification/
Interactive programme for investigating and performing calculations relating to the magnification of samples.

[5] Calibration of eye piece graticule with stage micrometer video
www.youtube.com/watch?timecontinue=309&v=9haN53mojnI
This video explains how to calibrate an eyepiece graticule with a stage micrometer and how this can be used to calculate the actual size of a specimen.

[6] Microscopy staining - Microbial life educational resources
serc.carleton.edu/microbelife/research_methods/microscopy/index.html
Excellent overview of why we use stains in microscopy and how different common stains are used.

[7] SOLO taxonomy hexagon template, Hooked-PamHook
pamhook.com/solo-apps/hexagon-generator/
Template for hexagons that can be used for starters/plenaries within this topic. Good for differentiation.

Activities

Learner Activity 1
The relative size of organisms and their cellular content

One activity for relative cell size can be combined with the interests of the students, eg Harry Styles height (m) through to Harry Styles red blood cell diameter (micrometres) and Harry Styles haemoglobin molecule in that red blood cell (nanometres) or Ronaldo's height…..with visuals!

Or it could link to other subjects eg nanotechnology as well as areas within the specification, including bacteria in pathogenic microorganisms and human ovum in reproduction.

1. In pairs, students have to find out 6/8 (differentiation can be applied here) organisms/ objects that vary in size from metres to nanometres.
2. Students should be guided that at least 1 of their objects must be a type of cell.
3. They then present their list to the rest of the class and it can be discussed or even judged as to which is the most interesting, funny etc.

Learner Activity 2
Preparing and visualising a blood smear

The activity can be done in pairs or small groups depending on numbers and available resources.

1. A drop of blood is placed at one end of a glass slide (frosted end so students can pencil their initials on the slide).
2. Another slide (45° angle) drags the blood spot to the end of the slide. If the blood spot is concentrated, it can be diluted with phosphate buffer. This could be linked to counting the cells using a haemocytometer.
3. The slide is dried in methanol, ideally in a Coplin jar as slides can be placed in back to back and at least 10 slides can be processed at a time.
4. When air dried, slides are added to a volume of Leishman stain (or similar, which can be diluted in phosphate buffer) that is adequate to cover the smears.
5. After 30 minutes (approx.), the smears are washed in buffer and air dried.
6. They can now be observed directly under a x400 magnification (or higher if oil immersion lens is available).

Learner Activity 3
Rate of diffusion using dialysis tubing

This introduces students to dialysis tubing, which will help with their understanding of osmosis in the next unit. It can also be used to explore limitations, fair tests and precision aspects of qualitative/quantitative analysis.

1. Place a suspension of starch in dialysis tubing.
2. Place the dialysis tubing in various concentrations of iodine solution (CLEAPSS guidelines followed).
3. The time taken for the dialysis tubing to turn blue/black is recorded.

Learner Activity 4
Role of organelles in protein production and secretion

Do not poison me!

Key organelles:

Nucleus

Rough Endoplasmic Reticulum

Cytoskeleton

Vesicles

Golgi Apparatus

In groups, students can play a scientific version of the 'hot air balloon' game.

Each student is assigned an organelle linked to protein synthesis.

They have to justify why they should not be stopped from functioning.

For example; *"I am a vesicle that transports the protein from the rough endoplasmic reticulum to the Golgi Apparatus for processing, without me the protein cannot be modified and so cannot function"*.

Students could decide who should go but it can be used as a good extension and deep exploration of the topic by introducing what poisons could prevent functioning of certain organelles in this process and the subsequent effects (Cytochalasin B on cytoskeleton).

Activities

Learner Activity 5
Leukaemia Diagnosis

There are picture cards and character cards for this activity (Learner Resource 2). Each set is arbitrarily labelled so students have to match them (or similar activity).

So this activity can be carried out in a number of ways; as a matching pairs activity for a plenary (cards could all be face down and memory matched, character with picture) or a more extended activity where students can each take a character and develop it further with their own research. Indeed, other characters can be added to link with other areas of the syllabus, eg

I am a clinical immunologist and I will measure blood antibody levels.

Even if used as a simple plenary, it emphasises the relevance and combinatorial nature of these learning outcomes.

It begins with:

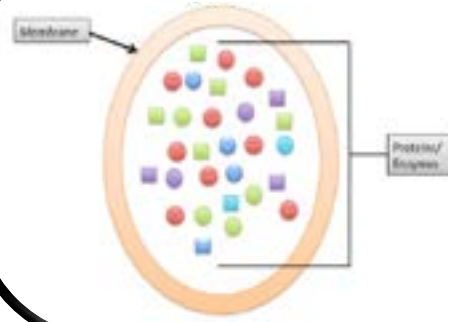
You are a doctor trying to ascertain whether your patient has leukaemia and if so, what type of leukaemia.

Learner Resource 1

Golgi Body

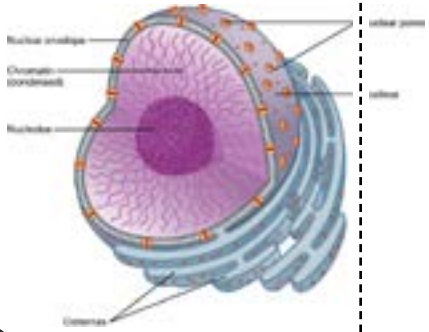
I am used to modify and package proteins and/or lipids ready for secretion

Lysosome



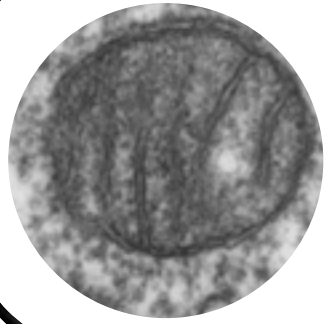
I am a vacuole that contains hydrolytic enzymes

Nucleus



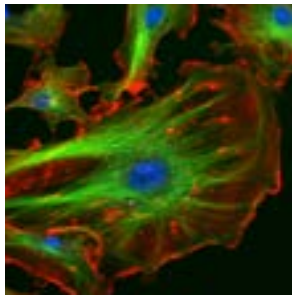
I contain chromosomes

Mitochondria



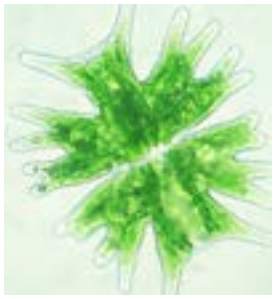
I am the 'battery' of the cell as I am the site of most of the ATP production

Cytoskeleton



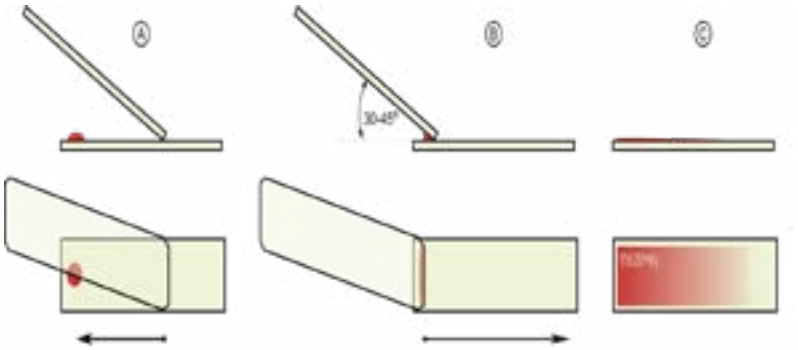
I am a series of proteins responsible for cell structure and movement of vesicles within the cell

Chloroplast

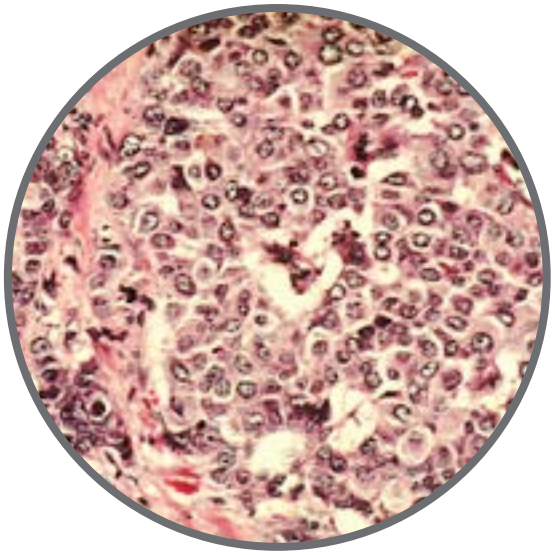


I am the site of photosynthesis in an autotrophic cell

I am a phlebotomist and I take peripheral blood samples from patients



I am a histologist in a clinical laboratory and I will take a smear of the patient's blood and stain the cells so they can be identified



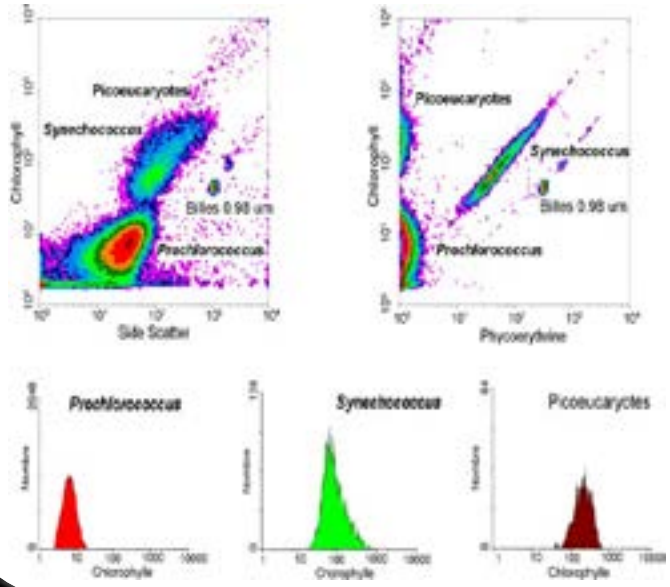
I am a pathologist and I will look through a light microscope to see what cells are present in the blood smear and if they look abnormal

Red blood cell count normal (women)
4.5 million

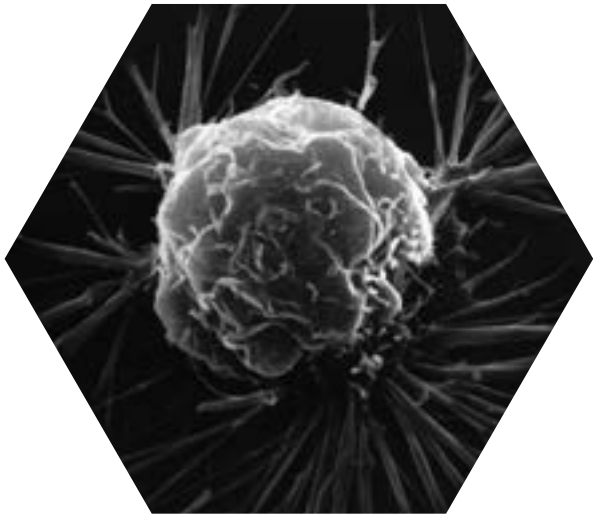
Red blood cell count cancer (some)
3.0 million

I am a clinical biochemist and I will count the number of red and white blood cells in the blood sample

Learner Resource 2



I am a clinical immunologist and I take some of the blood sample and 'label' it with fluorescent markers that will be present on cancer cells only. I then analyse the labelled cells using a flow cytometer which will tell me if any cancer cells are present.



I am an electron microscopist and I will take the blood sample to look in more detail for rare cancer cells that would not be present in large enough numbers for a light microscope and who's appearance is very characteristic.

2.1.2 Water in Plants and Animals

The first part of this section focuses on the medium of life: water. Most of the chemistry of life occurs in water and this is emphasised with requirements for relating waters properties to function and how its role as a solvent is utilised in biochemical analysis.

- *Analysis of secondary data on the composition of mammalian body fluids to illustrate the role of water as a solvent.*

The detection of proteins, starch and sugars is covered including the use of biosensors. The qualitative indications of their presence will be compared to a more quantitative analysis using colorimetry.

- *The methodology and interpretation of the results of the biuret test, benedicts test and colorimetry.*

Polymers are discussed and their chemical formation and breakdown is detailed, with particular reference to glycogen and starch. Their monomer's structure is examined and the formation of the disaccharide lactose.

Finally osmosis is discussed in terms of its function in mammals. Factors affecting the rate of osmosis is illustrated with practical investigations in both animal and plant cells.

Thinking conceptually

This unit allows water to take a more central role in linking biological processes and biomolecules. The structure of water and its functional relevance is extended to include analysis of solutions relevant to eg clinical analysis.

This should be taught as visually as possible with models and even role-play to illustrate hydrogen bonds. When told these are weak bonds, many students envisage this as relatively ineffectual so the 'power' behind these bonds should be emphasised. The importance of ions in solution should be covered with reference to physiological conditions so it does not become too chemical and abstract. Fluid analysis, either real or fabricated, could be illustrated for a particular condition that could have an element of humour (Learner Activity 2). This can easily be linked with future topics including heart function and kidney function. It will also focus students on the different units applicable to serum analysis as students usually miss the different units when comparing data.

It may be more relevant to cover osmosis at this juncture in the teaching as it flows well with the previous learning outcomes. As usual, there are a plethora of practical activities to illustrate the effect of various factors on the rate of osmosis, which could be investigated here as part of PAG 8. There are many interactive animations on line to follow on or introduce the practical activities[1].

Although water potential calculations are not required it is useful to constantly discuss water movement in terms of water potential so students avoid the mistake of explaining water movement in terms of water concentrations.

Detection of various biomolecules can be easily performed for various foodstuffs and differing concentrations of pure solutions. Colorimeter readings should be given to students to compare with their qualitative observations, especially if they have not had a chance to use a colorimeter. Biosensors can be discussed from a practical perspective by purchasing ovulation sticks and used with yellow dyed water if urine is not appropriate! Glucose tests could be analysed in a comparative fashion, which will help students appreciate that positive Benedicts tests involve coloured precipitates and not coloured solutions, as commonly stated.

Polymerisation is covered in the context of glucose so the structure of glucose must be mastered. This is best illustrated with molecular models like Molymods® but can be engineered with plasticine and matchsticks or straws. The link between branching and solubility is illustrated well by discussing glycogen storage disease type IV where lack of branching leads to deposits in the liver[2]. This can be discussed again when homeostatic mechanisms are covered later in the course.

[1] pbslm-contrib.s3.amazonaws.com/WGBH/arct15/SimBucket/Simulations/osmosis/content/index.html
Simulation demonstrating osmosis.

www.youtube.com/watch?v=BOcwXZ6sTeU
A walkthrough video of investigating osmosis using potato cylinders.

amrita.olabs.edu.in/?sub=79&brch=17&sim=182&cnt=1
Outline, procedure, animation, simulation and video on using a potato as an osmometer.

[2] www.ncbi.nlm.nih.gov/books/NBK115333/

Thinking contextually

The relevance of water to all biological systems can be demonstrated in many fun, interactive ways[3] (Learner Activity 1) and plenaries can involve mix and match cards of properties versus pictures of relevance to living processes. Throughout these illustrations, the importance of the hydrogen bond should be emphasised.

For a more clinical perspective on water as a solvent, biochemical analysis can be given to students, even forming a mini role play of a patient if this suits your students (Learner Activity 2).

The practical detection of proteins and sugars should be used in a comparative manner so test strips and colorimeter analysis can be compared with Benedicts test. This could be completed in the context of a market place (Learner Activity 3).

Condensation of glucose monomers and subsequent hydrolysis reactions should be taught with models but this can be simplified with plasticine models for students who can only learn structures pictorially and not from a chemical point of view.

Osmosis is a practical based activity with eg potato cubes and celery strips although the relevance of water potential of body fluids can be illustrated by looking at various situations where the electrolyte balance is disturbed eg too much alcohol, very salty burger. This could be tied in to Learner Activity 2.

Reference: experiment to see how many water drops fit on a penny

[3] www.stevespanglerscience.com/lab/experiments/penny-drops

Activities

Learner Activity 1 The sinking bug

This illustrates the surface tension of water. Students are provided with a large piece of foil, some plasticine, a beaker of water and a weighing balance. Students must design an organism that can float on water and add pieces of plasticine to its legs or part of its body if it does not have legs! This must be evenly distributed but that could be left for students to work out.

Students weigh the plasticine and have to keep adding it, a certain weight at a time, until the organism sinks. Pictures of pond skaters could be shown prior to or following the activity and the winning group could be the one with the most unusual design or the one that could hold the most plasticine without sinking.

Learner Activity 2 Patient problems

Students work in small groups. The patient's symptoms and biochemical analysis (Learner Resource 1) are handed to the students and they must match the correct symptoms with the analysis. The normal values must be given to each group for comparison. This can include role play within the group, where each member could randomly pick a patient and then have to act out the patient entering the hospital, a form of charades.

This can be extended to include descriptions of the data and what drugs or strategies should be used to treat the patients.

It must be emphasised to the students that the analysis is a simplified version of real life scenarios as they are appropriate to
A Level understanding.

Learner Activity 3
Patient problems

Students are split into market stall holders and consumers. The number for each will depend on your class and the level of differentiation you may wish to include although there should be a minimum of 3 students per market stall. Each market stall holder is given a test for glucose:

- Benedicts
- Benedicts with colorimeter (readings)
- different testing strips available from various outlets
- Benedicts with a standard curve and
- glucose reaction with potassium permanganate[4].

Consumers make their way around the market stalls (spaced out around the class) and the market stall must demonstrate their kit and try to 'sell' it to the consumer. At the end the consumer must decide which test would be the best for a number of criteria including;

- ease of use
- ease of interpretation
- qualitative possibilities
- reliability.

Experiment of glucose with potassium permanganate.

[4] www.saps.org.uk/attachments/article/103/SAPS%20-%20Estimating%20glucose%20concentration%20in%20solution%20-%20Scottish%20Highers.pdf

Learner Resource 1

Normal levels in blood

Protein concentration: 6.0-8.3 gdm^{-3} in blood,

Glucose concentration (before a meal): 4-5.9$mmoldm^{-3}$

pH:7.0-7.5

hydrogencarbonate ions: 22 to 26 $mmol/dm^{-3}$

haemoglobin: 115-165 g/dm^{-3}

sodium ions: 135 - 145 $mmol/dm^{-3}$

potassium ions: 3.5 - 5.0 $mmol/dm^{-3}$

chloride ions: 98 - 108 $mmol/dm^{-3}$

Normal levels in urine

Urine output: 1-2 litres / 24 hours per normal adult.

pH: 4.6 – 8

protein: $0mgdm^{-3}$

95% water, approx. 5% other solutes

Symptoms		
Patient **Hetty Donut** was admitted to hospital with dizziness and headaches. She has a history of diabetes. Her blood was analysed showed the following results:	Patient **Stanley Stomachache** has been admitted to hospital complaining of stomach pains. He has had diarrhoea for the last 24 hours. His blood was analysed and showed the following results:	Patient **Ruby Renal** has been admitted to hospital with pains in her back and difficulty passing urine. Her urine was tested:
Data		
Glucose concentration (before a meal): 7.2 $mmoldm^{-3}$ pH: 7.0 hydrogencarbonate ions: 23 $mmol/dm^{-3}$ haemoglobin: $125g/dm^{-3}$ sodium ions: 135 $mmol/dm^{-3}$ potassium ions: 3.8 $mmol/dm^{-3}$ chloride ions: 99 $mmol/dm^{-3}$	Glucose concentration (before a meal): 4.5 $mmoldm^{-3}$ pH: 7.2 hydrogencarbonate ions: 23 $mmol/dm^{-3}$ haemoglobin: $125g/dm^{-3}$ sodium ions: 180 $mmol/dm^{-3}$ potassium ions: 3.8 $mmol/dm^{-3}$ chloride ions: 140 $mmol/dm^{-3}$	Urine output: 0.8 litres / 24 hours per normal adult. pH: 4.6 protein: $25mgdm^{-3}$ 95% water, approx. 5% other solutes

Symptoms		
Professor Puffalot has been admitted to hospital with difficulty breathing. His blood was analysed:	**Ronald Runaround** has been admitted to hospital after running the marathon. His clothes are damp with sweat. His blood was analysed:	**Sylvia Slipover** has been admitted to hospital after cutting her leg with a chainsaw. Her blood was analysed:
Data		
Protein concentration: 6.0gdm^{-3} in blood, Glucose concentration (before a meal): 4.2 $mmoldm^{-3}$ pH:6.3 hydrogencarbonate ions: 30 $mmol/dm^{-3}$ haemoglobin: $120g/dm^{-3}$ sodium ions: 135 $mmol/dm^{-3}$ potassium ions: 3.9 $mmol/dm^{-3}$ chloride ions: 99 $mmol/dm^{-3}$	Protein concentration: 6.2 gdm^{-3} in blood, Glucose concentration (before a meal): 4.2 $mmoldm^{-3}$ pH:7.2 hydrogencarbonate ions: 23 $mmol/dm^{-3}$ haemoglobin: $125\ g/dm^{-3}$ sodium ions: 136 $mmol/dm^{-3}$ potassium ions: 2.4 $mmol/dm^{-3}$ chloride ions: 99 $mmol/dm^{-3}$	Protein concentration: 6.2 gdm^{-3} in blood, Glucose concentration (before a meal): 4.5 $mmoldm^{-3}$ pH: 7.0 hydrogencarbonate ions: 23 $mmol/dm^{-3}$ haemoglobin: $99\ g/dm^{-3}$ sodium ions: 136 $mmol/dm^{-3}$ potassium ions: 3.5 $mmol/dm^{-3}$ chloride ions: 99 $mmol/dm^{-3}$

Need to get in touch?

If you ever have ave any questions about OCR qualifications or services (including administration, logistics and teaching) please feel free to get in touch with our Customer Support Centre.

General qualifications
01223 553998
general.qualifications@ocr.org.uk

Vocational qualifications
02476 851509
vocational.qualifications@ocr.org.uk

For more information visit
ocr.org.uk/i-want-to/find-resources/
ocr.org.uk
/ocrexams
/twitter.com/ocrexams
/company/ocr
/ocrexams

We really value your feedback

Click to send us an auto generated email about this resource. Add comments if you want to. Let us know how we can improve this resource or what else you need. Your email address will not be used or shared for any marketing purposes.

I like this **I dislike this**