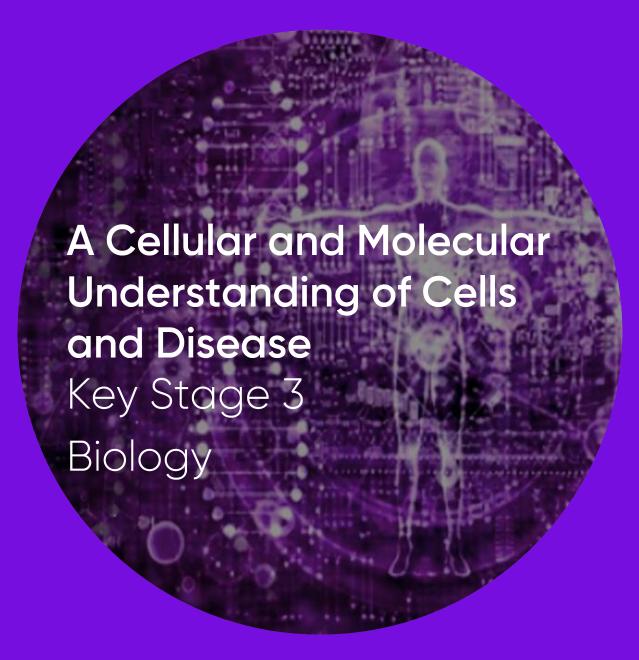
Research Based Curricula





For Teachers RBC Guide



Learner aims

The Research-Based Curriculum aims to support student attainment and progression by providing classroom resources about cutting-edge research at local universities. The resources are designed to:

- ✓ promote intellectual curiosity in all KS3 students
- ✓ stretch and challenge students to think about content that
 may be beyond the confines of the curriculum
- ✓ develop core academic skills, including critical thinking, metacognition, and written and verbal communication
- ✓ Encourage students to view these subjects as engaging, worthwhile and inspiring for continued and further study

Content

The programme represents a unique collaboration between universities and schools. Trained by AccessEd, PhD Researchers use their subject expertise to create rich resources that help bring new discoveries and debates to students.

The Research-Based Curriculum packs offer four units suitable for KS3 students. The lessons (units) span a range of exciting and interdisciplinary topics related to English, Maths and Science. Each pack includes four hours of teaching and practical, student-led activity content, supported by a student pack and teacher notes. All packs are available online and free of charge for teachers at select schools.

Each Subject Pack contains:

- 1. Four chapters that function as subject 'lessons'
- 2. Questions and practical activities to check and reinforce understanding
- 3. Challenge activities and extra reading
- 4. Study skills, tips and guidance at the back
- 5. Model answers pack (this document)

For Teachers Using the RBC packs



Suggested school use

These resources are designed to be used flexibly by teachers. They can be completed by students individually or in groups, inside or outside the classroom. In order to achieve the best possible outcomes for students, it is recommended that these packs are delivered with teacher support.

Delivery options

Classroom discussion and curriculum support

These curriculum-linked packs and their activities, as well as the Final Reflection, can be great structures for in-class discussion or debates, if a final written Reflection isn't possible. They are also ideal as an alternative for a written assignment. These packs supplement curriculum learning with additional case studies and extra-curricula working examples.

Homework activities and parent/carer-led time

Questions can be set as homework activity for students, either following an RBC chapter delivered during a lesson, or as an independent reading and study task. Questions can also be set for parents and carers to lead with their children.

Lunch Club

The resources can be completed in small groups across a series of weekly lunch clubs or after-school clubs online or in person. Groups can reflect on their learning by presenting a talk or poster on the subject matter at the end of the course.

Research challenge

The resources can be used to ignite curiosity in new topics and encourage independent work. Schools could hold a research challenge across a class or year group. Pupils could choose their own difficulty level and final presentation format – essay, presentation, video, etc., and submit individually or in small groups, with a final celebration event.

Transition project

Resource packs can function as 'transition' projects over the summer, serving as an introduction to the next level of study between KS3 and KS4. Students could present their reflections on the experience in a journal.

Unit One Model Answers



- DNA is transcribed in the nucleus of cells and translated in the cytoplasm to produce molecules made of individual amino acids, which are the breakdown product of ingested proteins absorbed in the small intestine during digestion. Amino acid chains are the Primary structure of proteins which twist and fold to produce the final functioning forms. Proteins have several functions including signalling roles, structural roles and enzyme roles.
- 2. Amino acid: Small molecules which are the building blocks of proteins. They are recycled from the breakdown of protein in food and are used to form new proteins during translation.
 - **Primary structure:** A chain of amino acids, produced from translation. It has no 3D structure.
 - Transcription: The process by which DNA code is read in the nucleus.
 - Translation: The process of creating a protein primary structure/a chain of amino acids. It occurs in the cytoplasm.
- 3. Models should be a chain structure which is twisted and then folded. Students could take a photo of their creations.

Unit One Model Answers



- 4. If a person did not consume enough protein in their diet there would be insufficient amino acids taken up by the small intestine, leading to decreased protein synthesis. If proteins cannot be made efficiently, this could lead to defects in or deficient cell growth/division and cell repair. Depleted enzyme levels and signalling proteins would affect many cellular processes in the body. Students could give a specific example of gastrin or other proteins, e.g. less gastrin leads to decreased stomach acid release and insufficient digestion.
- 5. Varies per individual. As a rule, 11-14 year olds require half a gram per pound of body weight daily. Around 50-70 grams per day is average, ideally with even spread throughout the day.
- 6. Open question. An example would be: 'Per chocolate digestive biscuit, there are 1.1 grams of protein. This is surprisingly high compared to Jaffa cakes which only have 0.6 grams of protein per cake.'
- 7. The goal is to get students thinking about making smarter choices with protein intake and be aware of what they are eating.

Unit One Model Answers



Answers Challenge activity

Students should mention:

- mRNA is complementary to DNA / DNA is the template for mRNA.
- mRNA is single strand of nucleotides unlike DNA which is double stranded.
- mRNA is made in the nucleus but is transported to the cytoplasm (ribosomes in the cytoplasm)
- The mRNA transports the message/code from the DNA to the cytoplasm where amino acids bind to it in a specific sequence.

Advanced:

- Amino acids are assembled by ribosomes and transfer RNAs.
- Mention of codons (three bases of DNA code for one specific amino acid.
- Differences between mRNA and DNA structurally.

Unit Two Model Answers



Answers 1.

Ingested food enters the stomach	3
Undigested food form faeces	9
Food travels down the oesophagus	2
Small and broken down molecules are absorbed	6
Digested food enters the small intestine	5
Amylase begins to digest food	1
Digested food enters the large intestine	7
Hydrochloric acid begins to break food down	4
Water is absorbed	8

- 2. Digestive system: The system of organs which is responsible for moving food throughout the body and breaking reusable foods down into molecules to allow the body to function.
- **Gastrin:** A protein secreted by G cells in response to food, responsible for the release of gastric acid into the stomach.
- **Metabolism:** the sum of all reactions taking place in an individuals body to break down food into energy or reusable molecules in order to survive.
- Bile: A greenish-brown alkaline fluid which aids digestion and is secreted by the liver and stored in the gallbladder.
- 3. Individual answer
- 4. Model answer: Proteins in food are ingested at the mouth and travels down the oesophagus after chewing. They lands in the stomach where hydrochloric acid and stomach churning break down large proteins into smaller pieces and amino acids. Enzymes also break proteins down into smaller molecules. Small and broken down molecules are absorbed into the bloodstream in the small intestine. Amino acids can then be recycled and used for protein synthesis.

Unit Two Model Answers



- 5.
 - a) Hydrochloric acid
 - b) Liver
 - c) Hormone
 - d) Amylase
 - e) Gastrin
 - 6. Impaired gastrin production may lead to decreased stomach acid production, which further leads to reduced or inefficient digestion.
 - Increased gastrin production may lead to an excess of hydrochloric acid in the stomach and could lead to acid reflux, or damage the stomach lining.

Unit Two Model Answers



Answers Challenge activity

Students should discuss proteins, carbohydrates and fats as a minimum but could list others such as vitamins.

Example answer:

Proteins from food such as meat and eggs are broken down by enzymes (proteases) into chains of amino acids and individual amino acids. Some amino acids are recycled for protein synthesis in lysosomes. Some amino acids are broken down and used to generate energy.

Ingested fats such as from meats and cheese are broken down by enzymes (lipases) during digestion into fatty acids and glycerol. Fatty acids and glycerol are stored primarily in adipocytes (Fat cells) until needed as energy for movement and bodily processes.

Ingested carbohydrates such as from potato and sweets are broken down by enzymes (amylase and carbohydrase) into sugars. There are several sugar types such as fructose and sucrose, however glucose is the most common. Sugars are then stored, mostly as glycogen bundles.

Glucose is stored as glycogen. Glycogen is mostly stored in the liver and muscles until needed for energy such as during exercise, when glycogen is broken down into glucose again.

Unit Three Model Answers



Answers

Disease X is recessive, therefore two copies of the diseased gene are needed for the disease to occur.
 Jenny has a 50% chance of giving her child the diseased gene and Mohammed has a 100% chance of passing on the diseased gene.
 Combined, Jenny and Mohammed's offspring have a 50% chance of inheriting Disease X and a 50% chance of not inheriting the disease. However the offspring will certainly

carry at least one copy of the diseased gene.

- 2. Brown eyes are dominant
- 3. Gametes
- DNA: The self-replicating material found in nearly all living organisms as the main component of chromosomes.
 It is the carrier of genetic information and is a polymer made up of nucleotides.
 - **Gene:** A distinct section of DNA sequence on a chromosome which encodes for a specific characteristic or molecule. It is a unit of heredity which is transferred from a parent to offspring contributes to characteristic of the offspring.
 - Environmental variation: The changing of a phenotype in response to environmental conditions or stimuli. This is often due to environmental factors which damage DNA/genes, leading to new allele variants.
 - Genetic variation: The differences in gene frequencies or alterations between gene sequences among individuals of the same species. Individuals have unique genes inherited from both parents and arisen from many gene mutations, producing genetic variation among populations.

Unit Three Model Answers



Answers

- 5. TT can roll their tongue
 Tt can roll their tongue
 tt cannot roll their tongue
- 6. This will differ by class but approximately 70% of the population can roll their tongue.
- 7. This will differ between pairs. An example is as follows:

Student 1 choices: Student 2 choices:

Purple spots Orange wings Black centre



Yellow spots White wings Black centre



Purple/yellow Orange/white Black/Black

Offspring genotype: Offspring phenotype:

Purple spots
Orange&White wings
Black centre

Purple spots are dominant and will be expressed rather than the recessive yellow allele.

Orange wings are recessive and White wings are recessive, resulting in a hybrid of orange and white wings (maybe a peach colour or maybe patches of both colours).

Black centres are dominant and the offspring has two alleles and therefore will have a black centre.

Unit Three Model Answers



Answers Challenge activity

Human cells can be found in hair, saliva or blood traces found at crime scenes.

Forensic scientists extract DNA from these cells.

Genetic profiling/DNA fingerprinting is done.

Enzymes digest the DNA into fragments and each individual will have different fragments. Fragments can be separated by size using gel electrophoresis/an electric current. This produces unique profiles.

Sample profiles can be compared to a database of known profiles to identify matches.

Everyone has different, unique profiles (except identical twins).

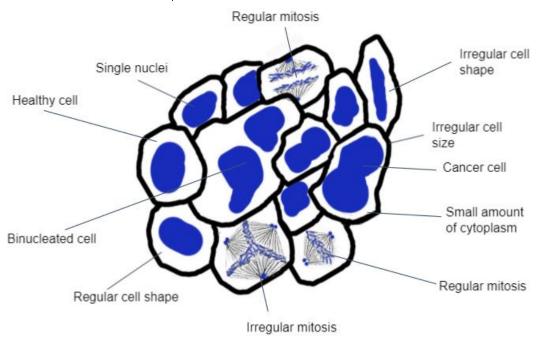
If a match is found on the database, it can be used as evidence to support the arrest of a suspect.



- Cell growth: The process by which a cell grows and divides to produce two identical daughter cells by completing the cell cycle.
 - **Cell cycle:** The series of events and phases which takes place as a cell grows and divides into two daughter cells.
 - **Mitosis:** A type of cell division resulting in two daughter cells being produced. It is a part of the cell cycle in which replicated chromosomes are separated into two nuclei to maintain the normal number of chromosomes.
 - Tumour: An abnormal mass of cells that forms when cells lose their ability to regulate cell division and therefore replicate continuously and rapidly, often acquiring mutations. Tumours may be benign or malignant.
 - **Genetic mutation:** An alteration in the nucleotide sequence of DNA within the genome of an organism.



Answers 2. An example:



Note: Regular mitosis separates chromosomes into two distinct sets which then form two identical daughter cells. In the labelled irregular mitosis cell, the chromatids are being pulled in three directions, which will produce three daughter cells. Students should recognise that two sets of chromatids will be formed in healthy cells.

- 3. Before daughter cells are formed, the 92 chromosomes are separated into two sets of 46 chromosomes (during mitosis). The cell then divides into two identical daughter cells, each containing 23 pairs of chromosomes.
- 4. Flip books/videos should start with healthy regular/uniform cells with single nuclei. One cancer cell should emerge with irregular shape/size/nuclei, this should divide exponentially with cancer cells becoming increasingly irregular and cancer cells may spread to surrounding tissues.



- 5. Interphase is part of the cell cycle in which cells replicate their chromosomes (producing 46 pairs in humans) and replenish their energy and resources.

 The copying of chromosomes is essential to ensure that mitosis results in the production of two daughter cells with the desired number of chromosomes (23 pairs each). The replenishment of energy and resources is important to enable mitosis to occur.
- 6. One mutation alone does not cause cancer, it takes time to acquire several mutations which lead to cancer development. Over time, individuals may also be exposed to more carcinogens or risk factors which increase the likelihood of mutations occurring that could lead to cancer formation.



Answers

Challenge Activity

Model answer: students should discuss some of the following events /steps

Inte	erph	nase



Prophase



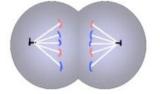
Prometaphase



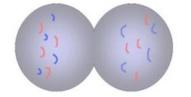
Metaphase



Anaphase



Telophase



Cytokinesis





Interphase	46 chromosomes in the nucleus are doubled.
Prophase	Chromosomes condense and become visible.
Prometaphase (advanced)	Nuclear membrane dissolves and microtubules/spindle fibres/proteins attach to centromeres (the centre of duplicated chromosomes)
Metaphase	Chromosomes align at the centre of the cell
Anaphase	Separated chromosomes pulled apart
Telophase	Microtubules/fibres disappear and cell division begins as nuclear membrane forms around each set of separated chromosomes.
Cytokinesis	The cytoplasm and cell membrane divide to form two identical daughter cells, each with 46 chromosomes

Final Reflection Activity Further Guidance



- Students should discuss the process of gastrin production from DNA to protein (transcription and translation) to folding.
- Gastrin production occurs in G cells, in response to food intake.
- Gastrin is a hormone and therefore it is secreted into the blood stream and travels to other cells.
- Gastrin is primarily known for its role in gastric acid secretion (hydrochloric acid).
- Students should discuss how gastrin binds to CCKBR (receptor) to initiate a response, which have a variety of effects in cells (acid secretion, increasing cell growth, inhibiting cell death and increasing cell migration).
- Students should discuss the Zollinger-Ellison Syndrome and other side effects of increased or decreased gastrin production. They may mention that random mutations could occur to the gastrin gene in response to carcinogens, etc.
- Students should discuss the gastrin's role in furthering cancer development (increasing cell growth, inhibiting cell death and increasing cell migration) too much gastrin production can lead to tumours/cancer.
- Students could hypothesise that low gastrin production, or impaired gastrin due to mutations could lead to reduced stomach acid and poor digestion.

In partnership with





The Higher Progression Partnership South Yorkshire (HeppSY) is part of a national programme to help school and college students aged 13–19 across South Yorkshire. We support those at most risk of missing out on Higher Education by providing impartial outreach work including information to help students make well informed decisions about their future and routes into university, higher and degree apprenticeships or other providers. HeppSY works in partnership with Sheffield Hallam, The University of Sheffield and schools and colleges across our region. You can visit us at www.heppsy.org, follow us on Twitter @HeppSYPlus or find us on Youtube where there are many resources.





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