

 **‘A’ level Biology**

**Y11 into Y12 Gap task**

Name: …………………………………………………………

The gap task is split into 5 sections, firstly, to enable you to better understand the demands of the ‘A’ level Biology course and secondly, to allow your teachers to better understand your needs. The 5 sections are as follows:

1. Independent study – retrieval practice
2. Literacy
3. Numeracy
4. Practical skills
5. Wider reading

Each section will be based on a topic that you will be studying in the first few weeks of the ‘A’ level Biology course and will begin to build on the knowledge you have acquired from your GCSE studies.

**You should complete all tasks during the summer break and bring your completed paper to your first biology lesson in September.**

**Independent study – retrieval practice**

Past students have cited the increased expectation of independent study as one of the biggest demands of studying A level Biology. Roughly speaking, each hour of lesson should be supported by another hour of independent study. This means over a 2-week timetable, you should be doing 12 hours of independent study **on top of** any homework you are set per subject!

It can be difficult to know what exactly to do for independent study. Simply reading or copying your notes / textbook will not improve how well you can retrieve key information. Instead, make your study strategies generative i.e. retrieving the information from memory with **no cues**. You can then check what you have retrieved using your notes / textbook and make corrections. This is known as retrieval practice. Doing this regularly (30 minutes a day) is hugely powerful in developing strong memory of the key information needed for the subject.

Retrieval practice can take many forms but here I would like you to try out 2 examples:

**Task 1**

Below (and on the next page) are labelled diagrams of animal, plant and bacterial cells and the structure of DNA. There is also a table showing the functions of the cell organelles.

Practice “self-quizzing” of the labels / functions of the cells and DNA by redrawing from memory (it doesn’t need to be a work of art!) and checking your drawing against the diagrams. Repeat this every week until you make no mistakes.

**Structure of DNA**



**Cells & organelles**





|  |  |
| --- | --- |
| Nucleus | Contains the genetic information (genome) for the cell. |
| Mitochondria | Site of aerobic respiration where energy in the form of ATP is released, |
| Cytoplasm | Site of chemical reactions and contains a protein network to allow the movement of substances within the cell. |
| Cell membrane | Regulates the transport of substances into and out of the cell. |
| Ribosome | Site of protein synthesis (translation). |
| Cell wall | Strengthens the cell, preventing it from bursting and maintaining its shape. |
| Chloroplast | Contains chlorophyll to absorb light energy and site of photosynthesis producing glucose. |
| Large vacuole | Contains water and dissolved substances and maintains the cell’s shape. |
| Capsule | Protects the cell. |
| Flagellum | Allows movement. |
| Nucleoid | Loop of bacterial DNA not contained within a nucleus. |

**Literacy**

The ‘A’ level Biology course requires you to write extended responses to exam questions. Not only do these responses need to have a good level of spelling, punctuation and grammar, they also need to utilise specialist scientific vocabulary. Additionally, the exam questions will often use an unfamiliar context that might have new vocabulary for you to decode.

A good technique to use is to use the etymology or morphology of a word to help you understand what it means e.g.

biology

bios -logia

Greek meaning life Latin meaning study

From this we deduce that the word “biology” means “the study of life”. But we can also now deduce the meaning of other words containing “bios” and “logia”.

**Task 2**

Research and write down the etymology of the following terms you will have learnt at GCSE (a simple Google search works well):

1. membrane
2. chloroplast
3. glucose
4. enzyme
5. mitochondria
6. chromosome
7. mitosis
8. lipid
9. carbohydrate
10. organelle

**Numeracy**

10% of the written exam questions will require you to use level 2 mathematical skills. These include selecting and using appropriate statistical tests, rearranging equations and converting units. Getting your own scientific calculator is a must as you will need to know how to perform various calculations on it and each model is slightly different.

**Task 3**

Answer the following questions (**with appropriate units**).

1. Convert the following:
	1. 42 kg to grams

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* 1. 5 m3 to cubic centimetres

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* 1. 2000 cm2 to square metres

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1. An adult human’s kidneys process approximately 1200 cm3 of blood every minute
	1. What is the volume in cubic decimetres?

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* 1. How much blood is processed by the kidneys every second? Give your answer in mm3.

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1. Round the following numbers:
	1. 0.0719 gs-1 to 3 decimal places

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* 1. 8.045 dm3 to 2 significant figures

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1. Complete the following table:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Ordinary number** | 84100 |  |  | 0.000022 |
| **Standard form** |  | 5.412 x 104 | 7.46 x 109 |  |

1. Convert the following units to metres and write them in standard form:
	1. 1 mm

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* 1. 1 nm (nanometre)

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* 1. 1 µm (micrometre)

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* 1. 1 cm

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* 1. 27 mm

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* 1. 5647 mm

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* 1. 399 cm

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* 1. 29000000 µm

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1. Calculate the surface area **and** volume of the following shapes. Show your working:
	1. A cube with side length of 5 mm

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* 1. A cuboid with height of 4 mm, width of 3 mm and depth of 1.5 mm

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* 1. A cylinder with a diameter of 2 cm and length of 12 cm

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1. The body temperatures of 6 people are shown below:

36.7 ⁰C, 37.2 ⁰C, 36.5 ⁰C, 36.2 ⁰C, 36.9 ⁰C and 36.5 ⁰C

* 1. What is the range of temperatures?

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* 1. What is the mode?

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* 1. What is the median?

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* 1. What is the mean?

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1. Complete the following table by calculating the percentage increase in plant height.

|  |  |  |  |
| --- | --- | --- | --- |
| **Plant** | **Height at week 2 (cm)** | **Height at week 5 (cm)** | **Percentage increase (%)** |
| **1** | 7.6 | 11.4 |  |
| **2** | 6.7 | 10.7 |  |
| **3** | 8.5 | 11.9 |  |

**Practical skills**

As part of your A level Biology studies, you will complete several practical investigations. These are not formally assessed but do combine to form a portfolio known as the Practical Endorsement. At the end of your course you will receive a pass or a fail in this which will go alongside your grade from the exams.

**Task 4**

Read the method for a practical investigation into enzyme activity. Answer the How Science Works questions about the investigation.

Method

|  |  |
| --- | --- |
| 1. Clamp the gas syringe securely, angled slightly downward.
2. Add 10 ml of 5 % hydrogen peroxide to a conical flask.
3. Put the bung securely in the flask and connect to the gas syringe.
4. Draw 2 ml of 5% yeast solution and 3 ml of air into a 10ml syringe.
5. Connect the 10ml syringe to the flask using the second bung hole.
6. Dispense the yeast solution into the conical flask and start timing.
7. Record the volume of gas in the gas syringe every 10s, record in the results table.
8. Repeat twice more for this concentration using the same conical flask.
9. Repeat steps 2 to 8 with 10, 15 and 20 % hydrogen peroxide.
 | A screenshot of a video game  Description automatically generated |

1. What is the independent variable in this investigation?

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1. What is the dependent variable?

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1. Suggest a variable that would need to be controlled.

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1. One student suggested that a set of 3 repeats should be completed with 10 ml of water instead of hydrogen peroxide. Why is this a good suggestion?

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1. Identify a limitation with the experiment and suggest an alteration that would improve it.

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**Wider reading**

You are now studying only 3 subjects and (hopefully!) this is because you really enjoy them! Biology is a wide reaching subject and you will find that your teachers have passions for particular aspects of it. These passions start by discovering information away from the course itself through wider reading.

**Task 5**

Read the attached article on the role of cell membranes in the ageing process (‘Pill of super-protective ‘heavy’ fat may be key to eternal youth’) and complete the following tasks:

1. Summarise the article in your own words (no more than half an A4 page).
2. Produce a glossary of any biological / scientific terms used (don’t forget to include some etymology – see task 3).

**Task 6**

Familiarise yourself with the recommended reading and watching lists below.

Reading around your ‘A’ level subjects will help you develop a more comprehensive understanding of particular topics and their real-life contexts. Try to develop a habit of reading books, articles, or news articles, and listening to podcasts or watching TV programmes related to biology. If you discover other interesting sources of information, please share them with the rest of us!

**Websites**

<https://phys.org/biology-news/>

<https://www.quantamagazine.org/biology/>

<https://www.newscientist.com/>

<http://www.bbc.co.uk/news/science_and_environment>

**Books**

The Serengeti Rules by Sean B. Carroll

What is Life? By Paul Nurse

A Short History of Nearly Everything by Bill Bryson

The Body by Bill Bryson

Mutants: On the Form, Varieties and Errors of the Human Body by Armand Marie Leroi

The Ancestor’s Tale by Richard Dawkins

Genome: The Autobiography of a Species in 23 Chapters by Matt Ridley

Power, Sex and Suicide: Mitochondria and the Meaning of Life by Nick Lane

Epigenetics: The Ultimate Mystery of Inheritance by Richard C Francis

The Symbiotic Planet by Lynn Margulis

Microbes and Man by John Postgate

**Podcasts / Radio**

Ingenious - <https://www.bbc.co.uk/programmes/m000h0fy>

A 5 part series with each 15 minute episode exploring a single gene, including the ginger gene and the breast cancer gene.

BBC Inside Science - <https://www.bbc.co.uk/programmes/b036f7w2>

A weekly show exploring whatever science is in the news.

Big Biology - <https://www.bigbiology.org/>

Big Biology is a podcast that tells the stories of scientists tackling some of the biggest unanswered questions in biology.

**Films**

Contagion

“Healthcare professionals, government officials and everyday people find themselves in the midst of a pandemic as the CDC works to find a cure.”

Gattaca

“A genetically inferior man assumes the identity of a superior one in order to pursue his lifelong dream of space travel.”

This film explores the issues around genetic engineering and genetic selection.

Creation

“Torn between faith and science, and suffering hallucinations, English naturalist Charles Darwin struggles to complete 'On the Origin of Species' and maintain his relationship with his wife.”

The Immortal Life of Henrietta Lacks

“An African-American woman becomes an unwitting pioneer for medical breakthroughs when her cells are used to create the first immortal human cell line in the early 1950s.”

**TV**

There are many David Attenborough documentaries on BBC iPlayer that are fantastic, here is a selection of the most recent:

Planet Earth II - <https://www.bbc.co.uk/programmes/p02544td>

Blue Planet II - <https://www.bbc.co.uk/programmes/p04tjbtx>

Dynasties - <https://www.bbc.co.uk/programmes/p06mvmmr>

Aside from Attenborough, there are some other great shows with biology at their heart:

Secret Universe: The Hidden Life of The Cell - <https://www.dailymotion.com/video/xzh0kb>

Inside Nature’s Giants – search YouTube



**Pill of super-protective ‘heavy’ fat may be key to eternal youth**

Bolstering cells with a dose of heavy fat may be the key to curing degenerative diseases. And it may help you hold back the years

By **Jessica Hamzelou**

Holding back the years

COULD a shiny orange capsule of modified fat help to keep you young? For the first time next month, fats designed to reinforce our cells against age-related damage will be given to people in a clinical trial. The participants have a rare genetic disorder, but if the treatment works for them, it could eventually help us all live longer, more youthful lives, says the scientist behind the work.

Mikhail Shchepinov, director of [Retrotope](http://www.retrotope.com/), a biotech company based in Los Altos, California, wants eventually to slow down the ageing process. But he is starting with a related problem – treating the inherited movement disorder Friedreich’s ataxia, with which ageing shares a mechanism. They are both caused, in part, by a molecular attack on our cells. Shchepinov’s idea is to counteract this assault by reinforcing our cells’ defences, slowing the progression of this incurable disease. If it works, it should demonstrate that the approach is also suitable for tackling ageing.

The damage he wants to address is caused by molecules called oxygen free radicals, made when our cells metabolise. Free radicals have unpaired electrons that desperately try to find a partner by tearing electrons off other molecules. This triggers a chain reaction as the denuded atom then does the same to its neighbour.

This chain reaction is particularly dangerous for the fatty acids that form our cell membranes. “They burn like gunpowder until hundreds of thousands are damaged,” says Shchepinov. Proteins and DNA also come off badly. Blocking the reaction should prevent the damage, but Shchepinov has a different idea.

He reckons we can protect our cells from free radicals simply by strengthening the bonds between molecules that make up our cell membranes. This can be done by swapping the hydrogen in the fatty acids for a different form known as deuterium. Because deuterium has an extra neutron, it is heavier than hydrogen and forms stronger bonds (see “[The skinny on heavy fat](https://www.newscientist.com/article/mg22630214-900-pill-of-super-protective-heavy-fat-may-be-key-to-eternal-youth/#bx302149B2)“).

**“Swapping some of the fat we eat with stronger fats should allow us to build more robust cells”**

Enter the modified fat pill. The idea is that substituting some of the fats we normally eat with modified, stronger fats in pill-form should allow us to build stronger cells. To test the idea, Shchepinov and his colleagues developed heavy versions of an omega-6, polyunsaturated fatty acid. “It’s not a nutrient – it’s a new chemical that is different from the fats you get in your diet,” says Retrotope co-founder Robert Molinari, the biochemist who is leading the clinical trial.

The approach works in yeast – [samples that metabolised heavy fats appear to be up to 150 times as resistant to the oxidative stress](https://www.newscientist.com/article/mg20827844-000-heavy-hydrogen-keeps-yeast-looking-good) caused by free radicals as those given regular fatty acids.

The next step is to see whether heavy fat can slow the progression of Friedreich’s ataxia. This is caused by free radical damage to the nerves responsible for movement and usually means people are wheelchair-bound within 10 to 20 years of symptoms appearing. The idea makes sense, says [Corinne Spickett](http://www.aston.ac.uk/lhs/staff/az-index/dr-corinne-spickett/) at Aston University in Birmingham, UK. “The underlying chemistry is quite correct – the fats are theoretically less susceptible to attack by free radicals,” she says.

The trial launching in June is a safety study. The team will be checking that the doses of heavy fat are well tolerated by 18 people with Friedreich’s ataxia. They don’t expect problems – even if every cell membrane were made from their modified fatty acids, the total amount of deuterium in the body would still be around four times lower than a dangerous dose.

At first, each volunteer will be given two 1 gram tablets of heavy fat per day. “It looks like a fish oil pill,” says Molinari. After a break, the dose will be ramped up, with people taking five tablets, twice a day. Because the heavy fats need to overwhelm the fats we usually get in our food, the volunteers will be placed on a special diet. “They can have olive oil and saturated fats but not polyunsaturated fatty acids,” says Shchepinov.

**Reverse the damage**

Molinari hopes that the treatment will not only halt the progression of the disease, but also improve people’s symptoms. By replacing cellular fatty acids with stronger ones, there is a chance of rescuing nerves that are sick, but not dead. “A degree of reversal of damage is possible,” he says. “We see improvements in cell experiments – we won’t know about the effects in people until we do the trial.” Although a larger trial will be needed to determine any effect on symptoms, the team is hoping to see some hints during the safety study.

“The principle is sound, and some beneficial effects of heavy fats have been seen in cells and rodents,” says Spickett. “But will this translate to humans? We’ll have to see.”

Theoretically, heavy fats could also prove useful in other diseases in which free radicals are implicated, such as Parkinson’s. A few years ago, Shchepinov and colleagues at the University of Arkansas and the Scripps Research Institute in California, found that [a diet rich in heavy fats protected mice](http://www.sciencedirect.com/science/article/pii/S0378427411014500) against the worst ravages of the mouse equivalent of Parkinson’s disease.

And then there’s the question of whether a heavy fat pill can slow ageing. “If you can fix oxidative damage then lifespan will be extended,” says Shchepinov. “It’s the same mechanism.”

To get a better idea of its potential, the team plans to run a trial in rodents, lasting around three years. A human trial would be more complicated as it would be incredibly difficult to tease apart the many factors known to play a role in ageing (see “[Ageing explained](https://www.newscientist.com/article/mg22630214-900-pill-of-super-protective-heavy-fat-may-be-key-to-eternal-youth/#bx302149B1)“). “The jury is still out on the free radical theory of ageing,” says [Mark Cooper](https://iris.ucl.ac.uk/iris/browse/profile?upi=JMCOO56) at University College London. “Free radicals do contribute to ageing, but there is a massive amount going on – it might not just be down to one thing.”

**“Free radicals contribute to ageing, but there is so much going on, it might not just be down to this”**

But Shchepinov is sanguine. To him, ageing is just a collection of diseases. If the fatty acids benefit people with these diseases, they will automatically extend lifespan, he says. “Maybe people will live until they are 180 and start dying of something else,” he says. “It’s a complex approach, but I hope our fatty acids will play a role.”

**Ageing explained**

You’re born, you age, you die. But no one is exactly sure what’s going on under the hood. Here are some ideas about why we age:

**Blame the free radicals**

[When cells metabolise they produce reactive molecules called free radicals](https://www.newscientist.com/article/dn25040-lifespan-predicted-from-flashes-in-worm-cells) that attack other molecules, harming cells in the process. The damage is known as oxidative stress and as it accumulates over time, it is thought to [cause the general wear and tear of the body as we age](https://www.newscientist.com/article/mg18624994-900-the-radical-route-to-a-longer-life).

**Chromosomes worn away**

The ends of our chromosomes are capped with bundles of protective DNA called telomeres. These shrink every time a cell divides, until eventually, the telomeres are too short for this to happen. When cell division stops, [the cells are unable to replenish themselves and maintain the body’s tissues](https://www.newscientist.com/article/dn3337-shorter-telomeres-mean-shorter-life), leading to age-related disease.

**Cells get grumpy in old age**

In the 1960s, scientists discovered that cells can only divide a finite number of times – a number referred to as the Hayflick limit. Once you get to this point, however, a cell doesn’t die. Instead, it senesces – it enters a state in which it stops dividing and starts pumping out chemicals that cause damaging inflammation. Researchers are beginning to link senescence to a range of age-related diseases, [including Alzheimer’s](https://www.newscientist.com/article/mg21528843-200-ageing-cells-offer-new-target-for-alzheimers-therapy).

**The skinny on heavy fat**

**What is heavy fat?**

Fatty acids are made up of carbon, oxygen and hydrogen. To make a fatty acid, or any other hydrogen-containing molecule, “heavy”, hydrogen is swapped for its heavier isotope, deuterium. The result is a molecule that forms stronger bonds, and is more resistant to damage.

**Does heavy fat weigh more than normal fat?**

A little bit. An ice cube made of heavy water will sink in a glass of normal water. A mole – a standard unit used in chemistry – of the fatty linoleic acid weighs 280 grams, while a mole of heavy linoleic acid weighs 282 grams.

**Will eating heavy fat make me fatter?**

Not according to the researchers launching the heavy fat trial (see main story). The fatty acids they want to use as a substitute only make up 1 or 2 per cent of the total energy intake in a normal diet.