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Monday 4 June 2018 – Afternoon

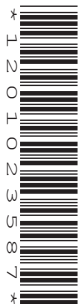
AS GCE HUMAN BIOLOGY

F222/01/ADVANCE NOTICE Growth, Development and Disease

For issue on or after:

13 MARCH 2018

Duration: 1 hour 45 minutes



NOTES FOR GUIDANCE (CANDIDATES)

- 1 This document contains two case studies, which are needed in preparation for questions 1 and 2 in the externally assessed examination **F222/01**.
- 2 You will need to read the case studies carefully and also have covered the learning outcomes for Unit F222/01 (Growth, Development and Disease). The examination paper will contain questions on the two case studies. You will be expected to apply your knowledge and understanding of the work covered in F222/01 to answer these questions. There are 100 marks available on the paper.
- 3 You can seek advice from your teacher about the content of the case studies and you can discuss them with others in your class. You may also investigate the topics yourself using any resources available to you.
- 4 You will **not** be able to take your copy of the case studies, or other materials, into the examination. The examination paper will contain fresh copies of the two case studies as an insert.
- 5 You will not have time to read the case studies for the first time in the examination if you are to complete the examination paper within the specified time. However, you should refer to the case studies when answering the questions.

This document consists of **4** pages. Any blank pages are indicated.

Case Study 1

A CELL CYCLE TOUR

All organisms consist of cells that multiply through cell division. Prokaryotes reproduce using a form of cell division known as binary fission. Eukaryotes undergo two types of division: mitosis, which allows an organism to grow and which replaces cells, and meiosis, which creates haploid gametes.

Before cells can divide by mitosis they must grow in size, replicate their DNA and synthesise new organelles. These processes occur in a series of precisely coordinated phases – one phase must be completed before the next can begin. These phases are known as the cell cycle.

Before 1970, little was known about how the eukaryotic cell cycle is regulated.

In 1970, Leland Hartwell was studying budding in the yeast *Saccharomyces cerevisiae*. Yeasts are single-celled eukaryotes. He noticed that, at high temperature, some yeast cells stopped growing buds at exactly the same point during cell division. Hartwell realised that studying different temperature-sensitive yeast mutants would be a great way to identify the genes controlling the cell cycle.

Hartwell's work inspired Paul Nurse. His model organism was a different type of yeast, *Schizosaccharomyces pombe* – a distant relative of *Saccharomyces cerevisiae*.

Remarkably, Hartwell and Nurse discovered the same gene, coding for a protein with the same function in the cell cycle, in the two species of yeast. Even more remarkably, Nurse later found the same gene in humans. Organisms separated by billions of years of evolution had the same cell cycle control. The gene was named CDK1 (cyclin dependent kinase 1). We now know of several CDK genes, each coding for a protein controlling a different phase of the cell cycle.

Timothy Hunt provided the final piece of the puzzle. Studying cell division in sea urchin eggs, he observed a protein that appeared and then vanished with each round of cell division. Hunt named the protein 'cyclin' and concluded that it was controlling the cycle. We now know that a range of cyclin proteins regulate the activity of the CDK proteins to move the cell cycle from one phase to the next.

In 2001, Hartwell, Nurse and Hunt were awarded the Nobel Prize in Physiology or Medicine. Scientists are often cautious in applying findings from model organisms to humans. However, research on diverse species has revealed that the mechanism for cell cycle control is fundamentally the same in all eukaryotic organisms, and the molecules involved have been conserved through evolution from yeast to humans.

References:

1. <http://jnci.oxfordjournals.org/content/93/23/1766>.
2. http://www.nobelprize.org/nobel_prizes/medicine/laureates/2001/press.html#

All web references correct at the time of production.

Other references should be researched.

Case Study 2

FLOUR POWER

In 1968, Professor Richard Smithells, a British paediatrician, first suggested that vitamins may prevent a range of neural tube defects (NTDs) arising during fetal development. His team conducted a non-randomised controlled trial on the effects of vitamins on NTDs. Their findings raised the possibility that cases of NTDs could be prevented by:

- taking folic acid supplements
- taking other vitamins
- a balanced diet.

In 1983, the Medical Research Council (MRC) conducted a trial to find out whether a vitamin supplement containing either folic acid or a mixture of seven other vitamins (A, D, B₁, B₄, B₆, C and nicotinamide), taken around the time of conception, could prevent NTDs. The MRC study was a randomised double-blind trial. This trial recruited women who were at high risk of having an NTD-affected pregnancy. The results, published in *The Lancet* in 1991, showed that folic acid had a 72 per cent protective effect on women who had previously had an NTD-affected pregnancy. The results also showed that the other vitamins had no significant effect on the occurrence of NTDs. The authors of the report strongly advised that the diet of all women of child-bearing age should contain adequate amounts of folic acid. This recommendation is especially true for women who have previously had an NTD-affected pregnancy. This advice was in addition to the general guidance on the dietary reference values (DRVs) issued in the UK.

Rather than expecting women to follow advice in taking daily folic acid supplements, it is argued that the most effective public health strategy is to add sufficient folic acid to widely eaten foods, such as those containing flour.

Some countries have introduced mandatory fortification of flour with folic acid. In the USA, Canada, Chile and Costa Rica, which all fortified flour between 1998 and 2000, the drop in NTD rates among live new-born babies was between 23 and 78 per cent. All countries that have introduced mandatory fortification of flour with folic acid have consistently reported similar significant decreases in NTD-affected live births.

Folic acid has other benefits. It has been shown to decrease blood levels of the amino acid homocysteine. Too much homocysteine in the blood is associated with a higher risk of coronary heart disease, stroke and peripheral vascular disease. High levels of homocysteine may also increase the development of atherosclerosis.

The mandatory fortification of food with folic acid is controversial and ethical concerns have been raised. Despite this, in 2007, the UK Food Standards Agency, having reviewed the scientific evidence, recommended that folic acid be added to flour and bread in the UK. However, at the time of writing, no European country, including the UK, has implemented mandatory fortification.

References:

1. <https://medlineplus.gov/neuraltubedefects.html>
2. <http://www.nhs.uk/conditions/pregnancy-and-baby/pages/vitamins-minerals-supplements-pregnant.aspx>

All web references correct at the time of production.

Other references should be researched.



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