Analyse all the data provided to discuss how several species of cichlid fish have evolved over a short period of time.

(9) Q07b

~~Genes~~ Fish that have a higher rate of gene duplication generally have a higher number of to mutations on the transcription factor binding site. this will result in them of showing different phenotypes and if favourable, pass on to offspring. ~~Because the~~ The mutations on the transcription factor binding site is responsible for the evolution of many of the cichlid fish. However, the O nil niloticus, being the most ~~one~~ related to the common ancestor, has had no mutations in the transcription factor binding site, and even though the high rate of gene duplication of 45. Gene duplication will ~~occ~~ occasionally make mistakes and this results in mutations in the ~~transp~~ ~~trans~~ transcription factor binding site. This means that the higher the rate of gene duplication, the increased change of a mutation. Given this, the O. niloticus experiences O mutations. This is because it has a rate of ^ 0.022 ~~mutat~~ mutations changing an amino acid. with This change in a amino acid will result in a ~~tran~~ mutation in the transcription factor binding site. There are few changes in the amino acid because DNA is degenerate.

(Total for Question 7 = 14 marks) 3

8 The scientific article you have studied is adapted from *The Biologist*.

Use the information from the scientific article and your own knowledge to answer the following questions.

(a) State the meaning of the term stem cell (paragraph 1).

(2) 1 Q08a

A stem cell is an undifferentiated cell that can differentiate and become any type of tissue or organ cell, given the right signal.

(b) Describe how a 'single fertilised egg' can produce many different cell types (paragraph 2).

(3) 0 Q08b

The embryonic stem cells that are made from the egg fertilised egg can differentiate into all types of cells in the body due to the node releasing specific signalling chemicals which all the stem cell to grow into a specific cell type.

(c) Name the property shown by 'spontaneously beating regions' in cardiac muscle (paragraph 15).

(1) 0 Q08c

Can release and electrical current much like the SAN.

(d) Mice used in research have a number of limitations (paragraph 6). Mice that are homozygous for a recessive trait are rare in the population, but can be produced in genetic crosses.

Explain how genetic crosses could be used to generate a mouse line expressing a recessive trait.

(3) 2 Q08d

If you make two heterozygous mice, 25% of the offspring will show the recessive trait. If you do this with another two mice ~~and~~ that are heterozygous, 25% of those mice will also show the recessive trait. If you then mate the two recessive mice, then 100% of the offspring will show to recessive trait because they are all homozygous recessive.

(e) Retinoic acid affects the expression of genes in embryonic stem cells (ESCs) leading to the development of neural tissues (paragraph 11).

Explain how chemicals such as retinoic acid could affect gene expression.

(3) 2 Q08e

These chemicals are specific to what type of cell will be made. With the addition of retinoic acid, for example, it binds to repressor molecules on the DNA and this falls off the promoter site. This then allows RNA polymerase to bind to the operator site and make proteins for that cells specific function.

(f) The Zika virus can cause microcephaly. This condition is a result of brain tissue not developing in the foetus (paragraphs 20 and 21).

Explain how the Zika virus can cause microcephaly.

(3) 0 Q08f

When a woman is pregnant, the Zika virus can bypass the placenta and infect the foetus. It stops the development of the brains of foetus's and this results in microcephaly of the newly born child.

(g) Tissue rejection can occur in organs transplanted from other individuals (paragraph 22).

Explain how the immune system is involved in tissue rejection.

(4) 1 Q08g

In the bilayer of all cells, glycolipids are present of the cell surface membrane that are specific to that ~~egg~~ organism. If ~~the~~ a tissue is transplanted, the glycolipids on that tissue will be different to the ones on the body. This will be seen by the body as foreign and start to destroy it (aka tissue rejection) ~~The~~ ~~active~~ The immune system will treat it as a disease and therefore will be a large ~~immun~~ immune response

(h) **Human cells can be grown in monolayers using tissue culture (Figure 1).**

Devise a procedure to investigate the effect of temperature on the growth rate of a monolayer of human cells.

Skh

(5) 2 Q08h

take 5 samples of human tissue from the same person. Place in a petri-dish with ~~a~~ ~~plenty~~ ~~of~~ ~~the~~ saline solution of glucose, oxygen and other important vitamins & minerals to ensure that the cells are getting enough nutrients. Place each ~~stele~~ sample in different temperatures from 10°C to 50°C. Leave for one week and look at the growth. Measure the area that the tissue has grown. Repeat 10 more times with samples from a different person each time. Keep the petri dish's sealed and ~~away~~ away from direct sunlight at all times.

(i) Describe how a gastruloid differs from an organoid (paragraphs 21, 26 and 28).

(2) 1 Q08i

An organoid is essentially a small organ that has been grown from stem cells. A gastruloid is a three-dimensional aggregated of cells made from human-induced pluripotent embryonic stem cells.

(j) Describe two ethical issues concerning the use of human embryonic stem cells in research (paragraph 32).

(2) 1 Q08j

An embryo must be first made by the fertilisation of an egg. This means that a ~~baby~~ potential baby may die. After 14 days, the baby may start to make nerve cells and therefore feel pain. This is unnecessary suffering.

(k) Explain the advantages of using iPSCs compared to ESCs for the production of transplant material (paragraphs 33 and 34).

(3) 2 Q08k

Embryonic stem cells are taken from embryos whilst iPSCs are taken from a skin sample and the induced into being stem cells. This means that potential babies do no have to be killed, therefore avoiding an ethical issue. iPSCs can be made from the tissue that the patient who needs the organ will get. This means that the tissue grown is technically his tissue and will mean that the immune system will not reject the tissue and the patient will not have to be on immunosupressant drugs for the rest of their lifetime.

(Total for Question 8 = 31 marks) 12

TOTAL FOR PAPER = 100 MARKS

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