Homeostasis in mammals

Question Paper 1

Level	International A Level
Subject	Biology
Exam Board	CIE
Topic	Homeostasis
Sub Topic	Homeostasis in mammals
Booklet	Theory
Paper Type	Question Paper 1

Time Allowed : **72 minutes**

Score : **/ 60**

Percentage : **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 When preparing infertile women for in-vitro fertilisation (IVF), it is necessary to stimulate the growth and maturation of several ovarian follicles. This is done by giving daily injections of the glycoprotein hormone, follicle stimulating hormone (FSH).

Each molecule of FSH has quaternary structure and consists of two different polypeptide chains, α and β.

(a) Explain what is meant by *quaternary structure*.

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(b) Human FSH can be extracted from women's urine (u-hFSH). A procedure involving the use of monoclonal antibodies is used to produce purified u-hFSH.

Suggest how monoclonal antibodies can be used to obtain purified u-hFSH from urine.

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(c) Recombinant human FSH (r-hFSH) can be produced by adding the genes coding for the α and β polypeptide chains of FSH to mammalian ovary cells.

Suggest why mammalian cells are needed to produce r-hFSH, rather than bacterial cells.

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(d) In IVF treatment, a second hormone, human chorionic gonadotrophin (hCG) is injected when mature ovarian follicles (Graafian follicles) have developed.

Draw a **labelled** diagram to show the structure of a mature ovarian follicle.

[3]

(e) The effectiveness of r-hFSH was compared with that of u-hFSH. Women starting IVF treatment were randomly divided into two groups and given **either** r-hFSH **or** u-hFSH.

The differences between the two groups of women after FSH treatment are shown in Table 2.1.

Table 2.1

	women receiving r-hFSH	women receiving u-hFSH
number of women	119	102
mean number of mature follicles per woman	13	8
concentration of oestrogen in the blood / nmol dm^{-3}	6.55	3.95

(i) With reference to Table 2.1, compare the effects of treatment with r-hFSH and u-hFSH **and** suggest explanations for the differences.

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(ii) The probability of the results for the mean number of mature follicles per woman occurring by chance is < 0.002.

Explain what is meant by this probability.

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[Total: 14]

2 The Indian cobra (*Naja naja*) is a species of venomous snake found in South Asia.

Fig. 6.1 shows an Indian cobra.

Fig. 6.1

(a) The Indian cobra's venom contains a toxin which causes muscle paralysis in mammals bitten by the snake. The toxin acts at cholinergic synapses.

Suggest ways by which the toxin in cobra venom may cause muscle paralysis.

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(b) Describe the role played by calcium ions in synaptic transmission.

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(c) Synapses slow down the rate of transmission of nerve impulses but have an important role in the nervous system.

Outline **two** of the roles of synapses in the nervous system.

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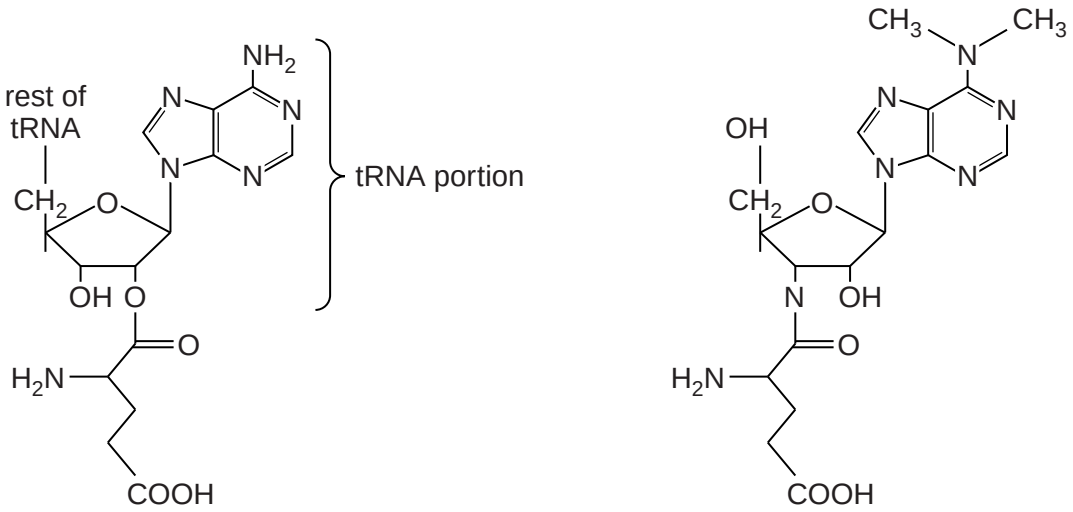
[Total: 8]

3 The enzyme glutamyl-tRNA reductase (GluTR) is present in many bacteria to make a product which is essential to their survival.

GluTR acts on the substrate glutamyl-tRNA, which is composed of the amino acid glutamic acid attached to a tRNA.

Fig. 3.1 shows the structure of glutamyl-tRNA and another compound called glutamycin.



glutamyl-tRNA **glutamycin**

Fig. 3.1

(a) Explain how glutamycin can act as an inhibitor for the enzyme GluTR.

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(b) The bacteria take in glutamic acid by active transport.

Describe the process of active transport.

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(c) In leguminous plants, glutamic acid is also essential for the formation of root nodules containing the bacterium *Rhizobium.*

(i) Name the stage in the nitrogen cycle carried out by *Rhizobium.*

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(ii) Suggest advantages of *Rhizobium* living in root nodules of leguminous plants.

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(iii) Explain the role of *Rhizobium* in the growth of leguminous plants.

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[Total: 12]

4 **(a)** In mammals, the water potential of the blood is constantly monitored by osmoreceptor cells in the hypothalamus of the brain. When the water potential of the blood decreases, ADH (antidiuretic hormone) is produced by cells in the hypothalamus and released into the blood via an endocrine gland.

(i) Explain what is meant by the term *water potential*.

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(ii) Describe the effect on water potential of adding solute to a solution.

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(iii) State precisely where ADH is released into the blood.

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(iv) The decrease in the water potential of the blood is sometimes due to the loss of water from the body of a mammal.

List **two** ways by which water may be lost from the body.

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(b) Describe the action of ADH on the kidney.

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(c) Diabetes insipidus is a condition caused by an inability to produce ADH or by the kidneys being unable to respond to ADH.

Suggest symptoms that may be experienced by a person who has diabetes insipidus.

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[Total: 11]

5 **(a)** Fig. 6.1 outlines how a cholinergic synapse works.

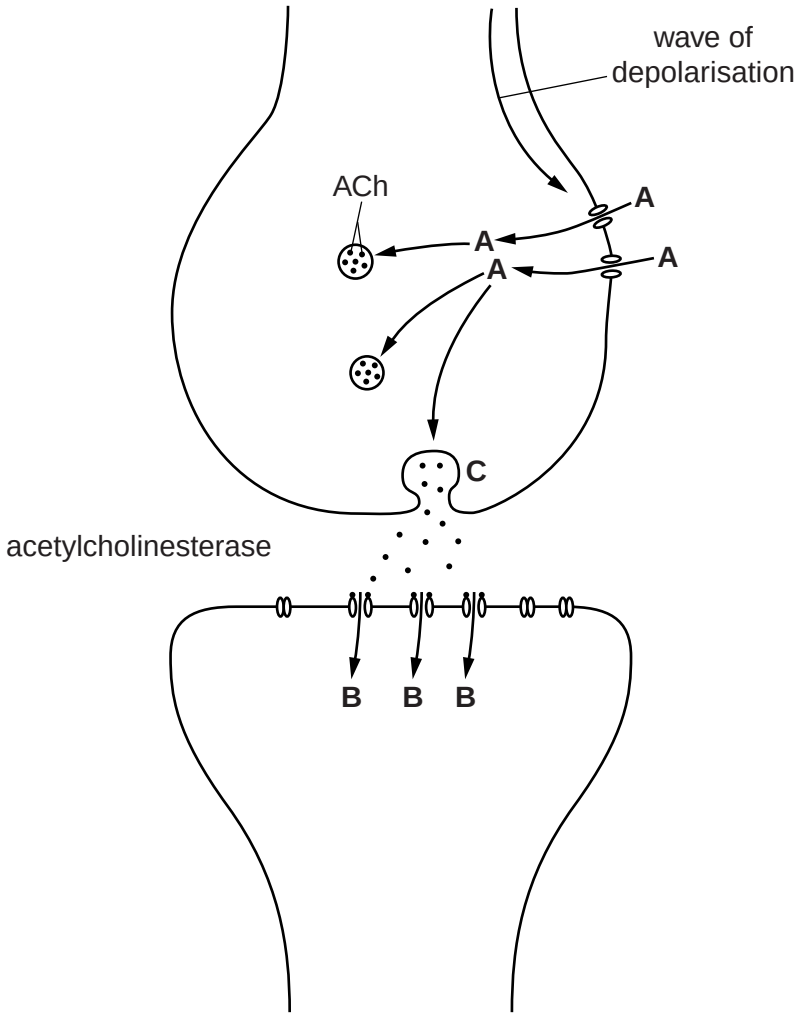

Fig. 6.1

With reference to Fig. 6.1:

(i) name **A** and **B**

A .....

B ..... [2]

(ii) name the process occurring at **C**

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(iii) state the effect of **B** entering the post-synaptic neurone

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(iv) explain the role of acetylcholinesterase in the synapse.

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(b) Some synapses in the brain use the neurotransmitter dopamine. After the postsynaptic membrane has been depolarised, dopamine leaves the receptor proteins and moves back into the presynaptic neurone through specific transporter proteins.

Schizophrenia is a condition in which there is a higher than usual concentration of dopamine in certain areas of the brain. The drug phenothiazine has a similar shape to dopamine and is used to treat schizophrenia.

Suggest and explain what occurs at the synapse when phenothiazine is used in the treatment of schizophrenia.

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(c) DRD4 is a dopamine receptor in humans. The gene coding for the DRD4 receptor has a large number of alleles, of which an individual can have only two.

Three alleles of the DRD4 receptor gene have the following mutations:

- a single base substitution
- a 21 base-pair deletion
- a 13 base-pair deletion.

The 13 base-pair deletion has the most serious consequences for the structure of the DRD4 receptor protein. Suggest why this is so.

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(d) One allele of the DRD4 gene has been found more frequently amongst individuals whose personality is described as 'impulsive and exploratory'.

Describe the mechanism whereby an allele such as this could have become common in the human population.

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[Total: 15]