# 2018 Gene Expression, Organisation and Control MCQ

# 2018 / H2 / ACJC PRELIM / P1 Q10

1 Which statement(s) about DNA polymerases and RNA polymerases is/ are correct?

- 1 They read the DNA template in the 3' to 5' direction.
- 2 They unwind and unzip double-stranded DNA.
- 3 They read the terminator sequence and stop adding nucleotides to nucleic acid chains.
- 4 They bind to the same specific sequences to start their processes.

Α	1 and 3	В	2 and 3	С	1 only	D	4 only
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## 2018 / H2 / ACJC PRELIM / P1 Q11

- 2 The following steps describe a method to study the structure and localisation of protein kinase c in yeast cells.
  - tRNAs with anticodon AAG were isolated and chemically modified to carry their specific fluorescent amino acids.
  - During translation, chemically modified amino-acyl tRNAs bind to the large ribosomal subunit.
  - Fluorescent amino acids are incorporated into the elongating polypeptide chain.
  - After translation, the polypeptide chain folds into its native conformation and the positions of the fluorescent amino acids can be detected and studied.

Which of the following describes a condition which will allow the above method to be carried out?

- A Peptidyl transferase is specific to the fluorescent amino acid and the elongating polypeptide chain in order to catalyse the formation of a peptide bond.
- **B** Synthetic amino-acyl tRNA synthetase is specific to the fluorescent amino acid and chemically modified tRNA in order to form modified amino-acyl tRNA.
- **C** The ribosome is specific to the mRNA sequence in order to synthesise protein kinase c.
- **D** Chemically modified amino-acyl tRNA is specific to the P site of a large ribosomal subunit in order to add the fluorescent amino acid to the elongating polypeptide chain.

## 2018 / H2 / ACJC PRELIM / P1 Q14

**3** The table shows the genome size, number of genes and chromosome number of the following organisms:

Organism	Genome size (bp)	Number of genes	Chromosome number
<i>E.coli</i> bacterium	4 369 000	4289	n = 1
Baker's yeast	12 069 000	6200	2n = 32
Amoeba	290 000 000 000	Data not available	500 – 1000 (possibly
			polyploidy)
Rodent	3 399 900 000	Data not available	2n = 64
Humans	3 200 000 000	30 000	2n = 46

From the data provided, it is possible to conclude that

- 1 The less complex the organism, the smaller the genome size.
- 2 Amoeba has more non-coding DNA than humans.
- 3 The larger the genome size, the higher the number of chromosomes.
- 4 The number of housekeeping genes is the same for all organisms.
- **A** 1 and 2 **B** 2 and 4 **C** 3 only **D** 4 only

#### 2018 / H2 / ACJC PRELIM / P1 Q13

In mammalian tissues, iron enter cells via transferrin receptors (TfR) and are stored when they are bound by ferritin proteins. The synthesis of TfR and ferritin is regulated through translational controls by regulatory proteins IRP1 and IRP2, which bind to iron-responsive elements (IREs) found on mRNAs.

IREs are loops found at the 5' UTR of ferritin mRNA and 3' UTR of TfR mRNA respectively. The effects of different iron levels on IRP1 and IRP2 are shown in the figure.



Which row correctly describes the translational control of ferritin mRNA and TfR mRNA?

	Cellular iron (Fe) levels	Ferritin levels	TfR levels
Α	High	High	High
В	Low	Low	Low
С	High	High	Low
D	Low	High	Low

# 2018 / H2 / AJC PRELIM / P1 Q9

5 The coding strand of part of a DNA molecule has the sequence 5' GAATTA 3'.

Which row is correct for this part of the corresponding template, mRNA and tRNA?

	the sequence of the template (non-coding DNA sequence)	the sequence of the mRNA molecule	the anticodons of tRNA used in translation
A	5' TAATTC 3'	5' CUUAUU 3'	5' CUU 3' and 5' AAU 3'
В	5' TAATTC 3'	5' GAAUUA 3'	5' UAA 3' and 5' UUC 3'

С	5' CTTAAT 3'	5' CUUAUU 3'	5' CUU 3' and 5' AAU 3'
D	5' CTTAAT 3'	5' GAAUUA 3'	5' UAA 3' and 5' UUC 3'

#### 2018 / H2 / AJC PRELIM / P1 Q13

- **6** Which statement best explains how related genes involved in the same metabolic pathway are expressed together in eukaryotic cells?
  - A Related genes are usually located on the same chromosome so that they can be controlled by the same set of control elements.
  - **B** The same set of transcription factors may be capable of recognising the same promoter site of related genes.
  - **C** The same sets of control elements are associated with related genes so that they can be recognised by the same sets of transcription factors.
  - **D** Within the control element of related genes, the specific numbers of transcription factors binding to the control element will enable related genes to be expressed.

# 2018 / H2 / DHS PRELIM / P1 Q14

7 Transfer RNA combined with an amino acid is called amino-acyl tRNA. It is possible to chemically convert the amino acid cysteine into the amino acid alanine whilst it is still attached to its tRNA.

The altered amino-acyl tRNA still binds to UGU triplets on messenger RNA (mRNA), but now incorporates alanine into the resulting polypeptide instead of cysteine.



Which statement is correct?

- A codon on the amino-acyl tRNA determines its specificity.
- **B** Both the amino acid and the anticodon of an amino-acyl tRNA affect where it binds to mRNA.
- **c** The amino acid of an amino-acyl tRNA does not influence its binding to mRNA.

**D** The codon-anticodon interaction is influenced by the amino acid on an amino-acyl tRNA.

# 2018 / H2 / DHS PRELIM / P1 Q16

8 The diagram represents some biochemical reactions involved in protein synthesis.



Which of the following is correct?

	The molecule coded directly from DNA is represented by	The bond labelled 5 is known as	The enzyme involved in catalysing bond 5 is
Α	1 and 2	peptide	peptidyl transferase
В	1 and 2	peptide	aminoacyl tRNA synthethase
С	1, 2 and 3	peptide	peptidyl transferase
D	1, 2 and 4	carboxyl	aminoacyl tRNA synthethase

# 2018 / H2 / DHS PRELIM / P1 Q17

9 The following statements illustrate the processes that occur during translation.

- 1 The large subunit of the ribosome binds and forms the translation initiation complex.
- 2 The second amino acyl-tRNA complex now binds to mRNA at the "A" site of the ribosome.
- 3 The small ribosomal subunit, with initiator tRNA bound, binds to the 5' cap of the mRNA and scans for the first start codon.
- 4 Soluble protein called release factor recognises the stop codon and binds at the "A" site.
- 5 Formation of a peptide bond between the first and the second amino acids by peptidyl transferase.
- 6 The second amino acyl-tRNA complex moves from the "A" site to the "P" site.

Which of the following shows the correct order?

- $\textbf{A} \quad 3 \rightarrow 1 \rightarrow 2 \rightarrow 5 \rightarrow 6 \rightarrow 4$
- $\textbf{B} \quad 1 \rightarrow 5 \rightarrow 2 \rightarrow 3 \rightarrow 6 \rightarrow 4$
- $\textbf{C} \quad 3 \rightarrow 5 \rightarrow 2 \rightarrow 1 \rightarrow 4 \rightarrow 6$
- ${\bm D} ~~1 \rightarrow 5 \rightarrow 2 \rightarrow 3 \rightarrow 4 \rightarrow 6$

#### 2018 / H2 / DHS PRELIM / P1 Q23

1 Which best describes the correct order (from earliest to latest) in the control of gene0 expression in protein synthesis?

- A Polyribosome, promoter, spliceosome, histone, primary transcript
- **B** Spliceosome, histone, promoter, primary transcript, polyribosome
- C Histone, promoter, primary transcript, spliceosome, polyribosome
- D Primary transcript, histone, spliceosome, promoter, polyribosome

# 2018 / H2 / EJC PRELIM / P1 Q8

**11** The electron micrograph shows part of a bacterial cell. The DNA molecule has been identified.

Identify structures  $\mathbf{P}$  and  $\mathbf{R}$  as well as the process(es) that is/are occurring below.



	Structure P	Structure <b>R</b>	Process(es)
Α	DNA polymerase	Daughter DNA	DNA replication
в	String of nucleosomes	mRNA	Transcription
С	Polyribosomes	Polypeptides	Translation
D	Polyribosomes	mRNA	Transcription and translation

# 2018 / H2 / EJC PRELIM / P1 Q9

**12** The following diagram shows the expression of a particular gene to its protein product in a eukaryotic cell.

Which combination correctly describes steps 1 - 4?



	1	2	3	4
Α	DNA is demethylated	Alternative splicing occurs	Activators bind to enhancers	Ribosome binds to 5' UTR
в	DNA is demethylated	5' capping occurs	RNase does not degrade 5' capped mRNA	Initiation factors bind to ribosome
с	DNA is methylated	Poly(A) tail is added to 3' end	poly-A tail is extended	Phosphorylation of protein
D	DNA is methylated	5' capping occurs	Removal of 5' cap	Activators bind to enhancers

#### 2018 / H2 / JJC PRELIM / P1 Q10

13 Which statements concerning DNA and RNA are correct?

- 1 Adenine and guanine are bases that have a double ring structure; cytosine, thymine and uracil are bases with a single ring structure.
- 2 An adenine nucleotide from DNA is the same as an adenine nucleotide from RNA; DNA adenine pairs with thymine and RNA adenine pairs with uracil.
- 3 The base pairing that occurs in a double DNA helix and when RNA is synthesised during transcription is always according to the rule that a purine pairs with a pyrimidine.
- 4 The two polynucleotides on a DNA molecule run in opposite directions so that the double helix formed has two strands that are parallel to each other.
- **A** 1, 2 and 3
- **B** 1, 2 and 4
- **C** 1, 3 and 4
- **D** 2, 3 and 4

#### 2018 / H2 / JJC PRELIM / P1 Q11

**14** The table compares the structure and function of some elements involved in transcription.

	made of protein	interacts with protein	codes for protein
RNA polymerase	1	2	3
promoter	4	5	6
terminator	7	8	9
gene	10	11	12

Which combination of numbers link the four elements listed to their structures and functions?

- **A** 1, 5, 6, 9 and 12
- **B** 1, 5, 8, 11 and 12
- **C** 2, 6, 7, 8 and 11
- **D** 3, 4, 8, 10 and 12

## 2018 / H2 / JJC PRELIM / P1 Q13

15 In which process do nucleosomes play a role in eukaryotes?

- 1 tRNA activation
- 2 transcription regulation
- 3 DNA supercoiling
- **A** 1, 2 and 3
- B 2 and 3 only
- C 2 only
- **D** 3 only

#### 2018 / H2 / MJC PRELIM / P1 Q14

#### **QUESTION 16**

Exceptions to the universal genetic code are found in mammalian mitochondria, as shown in the table.

mRNA codon	in mammalian cytoplasm, codes for	in mammalian mitochondria, codes for	
AGA	arginine	stop	
AGG	arginine	stop	
AUA	isoleucine	methionine	
UGA	stop	tryptophan	

A short length of DNA triplet code with the following base sequence was transcribed.

## TATTCTTCCACT

How many peptide bonds would be formed by ribosomes during translation in mammalian cell cytoplasm and in mammalian mitochondria?

	mammalian cell cytoplasm	mammalian mitochondria
Α	2	1
В	2	0
С	3	0
D	3	1

# 2018 / H2 / MJC PRELIM / P1 Q17

#### **QUESTION 17**

CDC2 protein kinase is essential for mitosis to take place.

Which processes will help to maintain the presence of this protein?

- 1 methylation of guanine on the 5' end of mRNA
- 2 addition of adenine polynucleotides to the 3' end of mRNA
- 3 inhibition of cytoplasmic protease enzymes
- 4 inhibition of spliceosome involved in the removal of pre-mRNA introns
- **A** 1, 2 and 3 only **B** 2, 3 and 4 only **C** 1 and 3 only **D** 2 and 4 only

#### 2018 / H2 / NJC PRELIM / P1 Q5

**18** A peptide consists of ten amino acids of four different kinds.

What is the number of tRNA molecules required to translate the mRNA for this peptide?

- **A** 4
- **B** 10
- **C** 12
- **D** 30

#### 2018 / H2 / NJC PRELIM / P1 Q7

**19** The packing of DNA in the nucleus is necessary to compact the DNA to fit within the nucleus.

The following statements describe this process.

- 1 Looped domains are formed with the aid of chromosome scaffold.
- 2 Further coiling results in formation of condensed chromatin as seen in metaphase.
- 3 DNA winds twice around a histone octamer to form nucleosome.
- 4 Subsequent coiling results in the formation of a solenoid fibre.

Which combination correctly describes the sequence of DNA packing?

- **A** 1, 3, 4, 2
- **B** 1, 4, 3, 2
- **C** 3, 1, 4, 2
- **D** 3, 4, 1, 2

#### 2018 / H2 / NJC PRELIM / P1 Q10

**20** Drug R is a DNA methyltransferase inhibitor and drug Q is a histone deacetylase inhibitor. An experiment was carried out to investigate the effects of drug R and Q on the expression of a gene.

The graph shows the experimental results.



Which statements are possible explanations for the results shown?

- 1 Drug R increases gene expression by preventing methylation at CpG islands at the promoter.
- 2 Inhibiting DNA methylation is more effective in increasing gene expression than inhibiting histone deacetylation.
- 3 Drug Q results in weaker binding of histones to DNA.
- 4 Drug Q increases gene expression by increasing the accessibility of RNA polymerase to the promoter.
- A 2 and 4 only
- B 3 and 4 only
- **C** 1, 3 and 4
- **D** 1, 2, 3 and 4

#### 2018 / H2 / NJC PRELIM / P1 Q11

**21** The globin gene family in humans consists of  $\alpha$ ,  $\beta$  and  $\gamma$  genes. These genes code for the globin chains that make up haemoglobin and are expressed at different levels during different developmental stages.

The graph shows the expression of the various globin chains during the prenatal (fetal) and postnatal (after birth) periods.



- **A** A growth factor triggers the expression of a transcription factor that increases the rate of  $\beta$ -globin gene expression during the postnatal period.
- **B** Alternative splicing results in the differences in the levels of expression of globin chains during the prenatal period.
- **C** Methyl groups are added to regulatory sequences of  $\gamma$ -globin genes during the postnatal period, allowing for some proteins to bind.

**D** The shortening of poly(A) tail in the mRNA of  $\gamma$ -globin genes reduces its stability, resulting in a decrease in the rate of expression of  $\gamma$ -globin chains during the postnatal period.

#### 2018 / H2 / NYJC PRELIM / P1 Q22

**22** Which statement defines all control elements?

- **A** A segment of DNA to which RNA polymerase binds preferentially.
- **B** A short region of DNA that can bind with proteins to enhance transcription levels.
- **c** DNA sequences that interact with proteins to determine the rate and timing of gene expression.
- **D** Proteins found only in eukaryotes that bind to DNA sequences to control transcription.

#### 2018 / H2 / PJC PRELIM / P1 Q11

- 23 Some of the processes of protein synthesis are listed.
  - 1 condensation of amino acids
  - 2 positioning of adjacent amino acids
  - 3 termination of polypeptide chains
  - 4 activation of amino acids
  - 5 binding of amino acids to tRNA

Which processes only occur in ribosomes?

- **A** 1, 2 and 3
- **B** 1, 2 and 5
- **C** 2, 3 and 4
- **D** 3, 4 and 5

#### 2018 / H2 / PJC PRELIM / P1 Q14

**24** Different tissues in a plant were supplied with a radioactively labelled substance to identify which tissues were actively synthesising mRNA.

A polypeptide has the amino acid sequence glycine - arginine - lysine - serine. The table shows the possible tRNA anticodons for each amino acid.

amino acid	tRNA anticodons
arginine	UCC GCG
glycine	CCA CCU
lysine	υυς υυυ
serine	AGG UCG

Which sequence of bases on the DNA would code for the polypeptide?

- A CCA CGC AAG AGC
- **B** CCT TCC TTC TCG
- **C** GGA AGG AAA AGC
- **D** GGT TGG TTG TGC

#### 2018 / H2 / RI PRELIM / P1 Q9

**25** The active messenger RNAs (active mRNAs) in tissue cells can be isolated by passing the homogenised cell contents through a fractionating column. The column has short lengths of uracil nucleotides attached to a solid supporting material. Molecules of mRNA that can pass through the column are quickly broken up into small pieces and cannot be translated.

The active mRNAs that attach to the column can be collected subsequently by an appropriate treatment.

Which statements correctly describe active mRNA?

- 1 Active mRNAs are held to the fractionating column by bonds between adenine and uracil bases.
- 2 Active mRNAs can be released from the fractionating column by breaking hydrogen bonds.
- 3 Only mRNAs with polyadenine tailing can be translated.
- 4 Polyadenine tailing stabilises mRNA and prevents it from being broken up.
- **A** 1 and 2
- **B** 1, 2 and 3
- **C** 3 and 4

## D 1, 2, 3 and 4 2018 / H2 / RI PRELIM / P1 Q14

**26.** Recombinant DNA techniques can be used to alter the locations of control elements within DNA sequences, so as to study the effects of these changes on the levels of transcription. The diagram shows the various structures of transcription units and the corresponding relative levels of transcription. The promoter, enhancer and coding sequences are represented by letters P, E and G respectively. The number of symbol '+' indicates the relative frequency of transcription.



With reference to the diagram, which of these statements is a valid conclusion?

- **A** The relative distance between promoter and enhancer has no effect on the frequency of transcription.
- **B** The frequency of transcription is increased when the enhancer is located upstream of the promoter.
- **C** An enhancer is required for transcription.
- **D** Orientation of the enhancer does not affect the frequency of transcription.

#### 2018 / H2 / RVHS PRELIM / P1 Q10

**27** A segment of a polypeptide chain, Arg – Gly – Leu – Phe – Val – Leu – Arg, is encoded by the following segment of DNA:

The genetic code (read from inside out) is given below.



# 2018 / H2 / RVHS PRELIM / P1 Q11

- 28 Which of the following are features of a eukaryotic genome?
  - 1 multiple genes are under the control of the same regulatory sequence
  - 2 many genes are interrupted by non-coding sequences
  - 3 presence of multiple control elements for controlling gene expression
  - 4 supercoiling in most regions to further compact the DNA molecule
  - A 1 and 4
  - **B** 1 and 3
  - C 2 and 3
  - **D** 2 and 4

#### 2018 / H2 / SAJC PRELIM / P1 Q17

- **29** Which of the following statements about the eukaryotic control elements are correct?
  - 1 Attachment of the RNA polymerase II at the TATA box is achieved with the help of a series of specific transcription factors
  - 2 A given gene may have multiple enhancers, each active at a different time or in a different cell type or location in the organism
  - 3 Repressors bind to silencer regions of DNA far upstream of promoters to repress transcription
  - **A** 1 and 3
  - **B** 1 and 2
  - **C** 2 and 3
  - **D** 1, 2 and 3

#### 2018 / H2 / TJC PRELIM / P1 Q11

**30** A peptide consists of ten amino acids of four different kinds.

What is the theoretical minimum number of different kinds of tRNA molecules required to translate the mRNA for this peptide?

- **A** 4
- **B** 10
- **C** 12
- **D** 30

#### 2018 / H2 / NJC PRELIM / P1 Q14

3 Casein is a major protein found in mammalian milk.

<sup>1</sup>When the mammals are producing milk, the pathway for the production of casein can be represented as shown in the diagram below.



When the mammals are not producing milk, the pathway can be represented as shown in the diagram below.



Which one of the following conclusions can be made from the information above?

- A Ribonuclease has the effect of turning on the casein gene.
- **B** Casein is a repressor protein for milk production in mammals.
- **C** The hormone prolactin allows for the expression of the casein gene.
- D Mammals produce milk only in the absence of the hormone prolactin.

#### 2018 / H2 / VJC PRELIM / P1 Q9

**32** The flowchart shows the classification of several regions of non-coding eukaryotic DNA, **X**, **Y** and **Z**.



- **C** 1 and 4 only
- **D** 2 and 3 only

#### 2018 / H2 / VJC PRELIM / P1 Q12

**33** The onset of puberty is triggered when cells in the hypothalamus region of the brain start to produce and secrete gonadotropin-releasing hormone (GnRH), which triggers the production and release of follicle-stimulating hormone and luteinising hormone from the anterior pituitary.

Which of the following statements are true during the onset of puberty?

- 1. DNA in the region containing the GnRH gene is methylated in cells of the hypothalamus.
- 2. DNA in the region containing the GnRH gene is methylated in cells of the anterior pituitary.

- 3. GnRH receptor is only expressed in cells of the anterior pituitary.
- 4. GnRH triggers the activation of activators in cells of the anterior pituitary via signal transduction.
- 5. The transcription initiation complex is formed at the enhancer controlling the GnRH gene in cells of the hypothalamus.
- A 1 and 4
- **B** 2 and 3
- **C** 1, 4 and 5
- **D** 2, 3 and 4

2018 Gene Expression, Organisation and Control MCQ ANS			
Question	Answer	Question	Answer
1	C	21	B
2	B	22	C
3	C	23	Α
4	C	24	В
5	B	25	D
6	C	26	Α
7	C	27	D
8	A	28	С
9	A	29	С
10	C	30	Α
11	D	31	С
12	B	32	В
13	C	33	D
14	B		
15	B		
16	B		
17	A		
18	B		
19	D		
20	D		