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VCE Biology ¾

Nucleic Acids & The Structure of Genes [0.2]

Workshop

Section A: Multiple Choice Questions (15 Marks)

Question 1 (1 mark)

Which of the following is unique to RNA but not DNA?

A. Contains thymine as a nitrogenous base.

B. Is double-stranded.

C. Contains ribose sugar instead of deoxyribose.

D. Functions exclusively in the nucleus.

Question 2 (1 mark)

Which type of nucleic acid is most likely to contain uracil?

A. DNA

B. mRNA

C. tRNA

D. Both b and c.

Question 3 (1 mark)

Which one of the following correctly matches the nucleic acid molecule with its role?

	Molecule	Role
A.	DNA	Carries genetic information to ribosomes.
B.	tRNA	Carries amino acids to ribosomes.
C.	mRNA	Structural component of ribosomes.
D.	rRNA	Contains genetic information that is transcribed.

Question 4 (1 mark)

Which of the following statements concerning DNA and RNA is incorrect?

A. DNA is double-stranded; RNA is single-stranded.

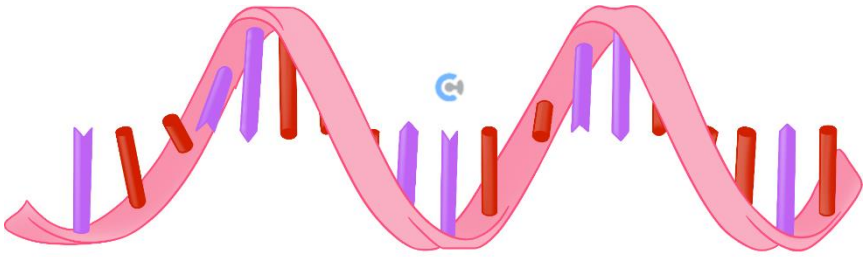
B. DNA contains adenine, thymine, cytosine and guanine bases; RNA contains adenine, uracil, cytosine and guanine bases.

C. In eukaryotic cells, DNA is found in the nucleus; RNA is also found in the nucleus.

D. DNA contains ribose sugar; RNA contains deoxyribose sugar.

Question 5 (1 mark)

The molecule shown below is extracted from the cytosol of a cell.



Source: http://userscontent2.emaze.com

If a chemical analysis was done on this molecule, you would expect to see:

A. Phosphate groups and thymine.

B. Phospholipid groups and guanine.

C. Phosphate groups and uracil.

D. Phospholipid groups and adenine.

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Question 6 (1 mark)

The nucleotide sequence A G U G A C A A could represent:

A. Part of the DNA template of a particular gene.

B. The amino acid chain of a polypeptide.

C. A sequence of mRNA.

D. A section of double helix.

Question 7 (1 mark)

Unlike RNA, DNA has:

A. A uracil base.

B. A sugar called ribose.

C. Two strands of nucleotides.

D. A phosphate group in its nucleotides.

Question 8 (1 mark)

Redundancy in the DNA code means that:

A. The amino acid valine has four possible codons.

B. The amino acids methionine and isoleucine are both coded for by AUG.

C. Uracil replaces thymine in the translated nucleic acid.

D. Each tRNA molecule can carry any amino acid.

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Question 9 (1 mark)

A canola crop had a gene coding for an omega-3 fatty acid, derived from bacteria, inserted into its genome. Individuals who ate the canola gained the benefit of increased omega-3 fatty acids, such as healthier membranes. The characteristic of DNA that allowed this to occur is that the DNA code is:

A. Universal

B. Redundant

C. Degenerate

D. Transferable

Question 10 (1 mark)

A student observed a diagram of single-stranded nucleic acid and determined that it was DNA. A piece of evidence that would support this is the presence of:

A. Uracil.

B. A deoxyribose sugar.

C. A methyl cap and a poly A tail.

D. Anticodons.

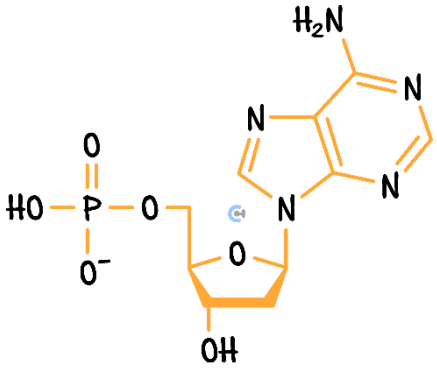
Question 11 (1 mark)

Which one of the following correctly compares DNA and RNA?

	DNA	RNA
A.	Contains deoxyribose.	Contains ribose.
B.	Is a shorter molecule.	Is a longer molecule.
C.	Found only in the nucleus in eukaryotes.	Found in the nucleus and a variety of cytoplasmic locations in eukaryotes.
D.	Contains four different monomers.	Contains five different monomers.

Question 12 (1 mark)

The diagram below shows the structure of a nucleotide, which is the sub-unit of a nucleic acid.



Which one of the following statements is correct?

A. All nucleotides are chemically identical.

B. This nucleotide could contain the amino acid thymine.

C. The nucleotide shown in the diagram can only be found in DNA.

D. Adjacent nucleotides are joined together as a result of a condensation reaction.

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Question 13 (1 mark)

In the United States of America (USA), genetic screening of newborn babies is conducted for around 60 conditions. In the United Kingdom (UK), nine conditions are screened for and in the state of Victoria in Australia, 25 conditions are screened for. The table below provides data on the most frequent genetic conditions identified from screening newborn babies in the USA, the UK and Victoria, Australia.

Genetic Condition	Incidence (No. of babies born with a condition: Total no. of babies born)		
	USA	**UK**	**Victoria, Australia**
Phenylketonuria (PKU)	1: 10000 - 15000	1: 10000	1: 12000
Galactosaemia	1: 30000 - 60000	Not screened	Not screened
Primary congenital hypothyroidism (CH)	1: 2000 - 4000	1: 3000	1: 2200
Sickle-cell disease (SCD)	1: 500 African Americans	1: 2000	Not screened
Congenital adrenal hyperplasia (CAH)	1: 15000	Not screened	Not screened
Cystic fibrosis (CFTR)	1: 2500 - 3500 Caucasians	1: 2500	1: 3300

Data: Genetics Home Reference, <https://ghr.nlm.nih.gov>; National Health Service, <www.nhs.uk/pages/home.aspx>; Victorian Clinical Genetics Services, <www.vcgs.org.au>

From this information, it can be concluded that:

A. CAH is not present in Australian newborn babies.

B. The frequency of PKU and CFTR has risen in all countries of the world.

C. The most frequent genetic condition that affects Victorian newborn babies is CH.

D. Cystic fibrosis in newborn babies is more prevalent in Victoria than in the UK.

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Question 14 (1 mark)

A portion of a DNA molecule has the following base sequence:

−ATCTTAGGCCAT−

Which one of the following would be the complementary mRNA strand?

A. UAGAATCCGGUA

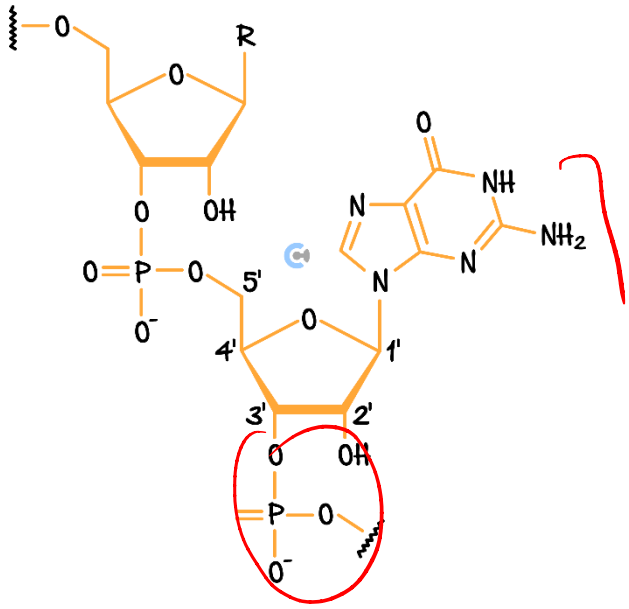
B. TAGAATCCGGTA

C. UAGAAUCCGGUA

D. UACAUUCCGGUA

Question 15 (1 mark)

The diagram below shows a small segment of the structure of an organic macromolecule.



Which of the following statements correctly identifies what occurs when this segment is joined to other similar structures?

A. The reaction is catabolic.

B. A net output of energy occurs.

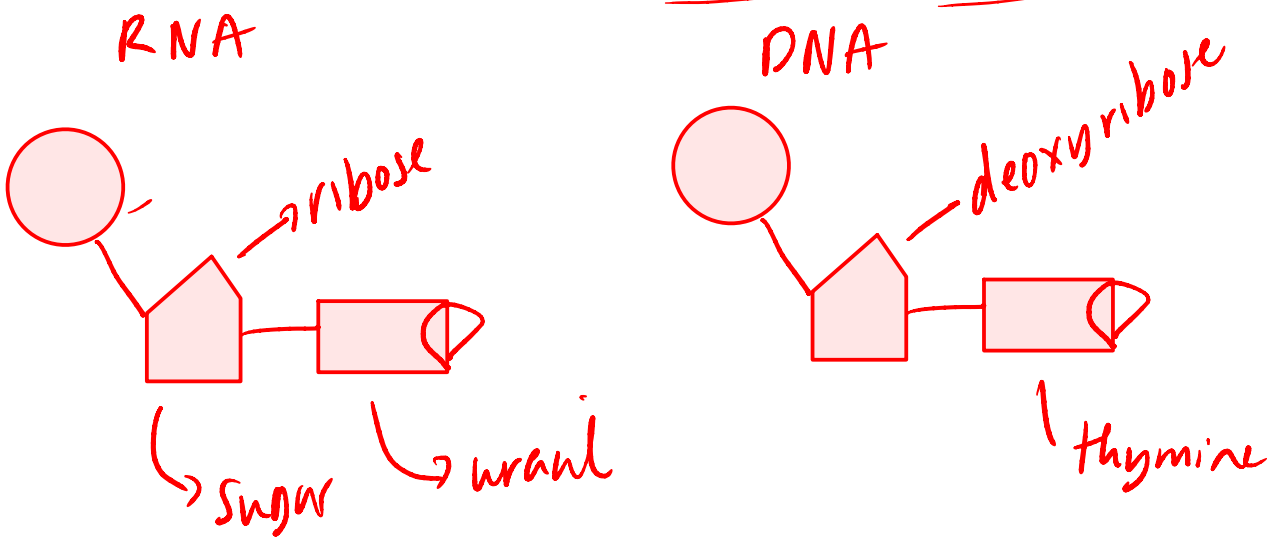
C. A condensation reaction would occur.

D. An input of water is required for this reaction to occur.

Section B: Warm Up Questions (20 Marks)

Question 16 (4 marks)

a. In the space below, draw and label the structure of both an RNA nucleotide and a DNA nucleotide. (2 marks)



b. Name two different types of nucleic acids and describe two differences between them. (2 marks)

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Question 17 (3 marks) /2

Describe what is meant by "degenerate" in reference to the genetic code, and explain its significance.

↳ multiple codons coding for a single amino acid

↳ silent mutations — where mutations occur but amino acid stays same

Question 18 (2 marks)

Explain what feature of the genetic code makes it possible for viruses to infect cells.

Universality → viruses infect DNA which can be read + produced by any host cell

Question 19 (2 marks)

Describe the difference in the function of mRNA and rRNA.

↳ makes up the ribosome
↳ does protein synthesis

↳ copy of genetic instructions

Question 20 (2 marks)

Scientists often want to visualise organic molecules under microscopes and in cultures, by adding a fluorescent dye which binds to specific features of a molecule.

Explain how a scientist could make a dye tag to DNA only and not RNA.

↳ another way of asking differences between the two

→ deoxyribose

→ ~~ur~~uracil / thymine

AUA → 1 amino acid

Question 21 (2 marks)

Explain why the genetic code could not be a 'doublet' code.

↳ coon 2 bases code for an amino acid

↳ 16 combinations

This results in only 16 combinations of bases, which is less than the 20-21 amino acids used for protein production

This will mean that either some amino acids won't be produced OR multiple amino acids will be made from a codon, which makes the code AMBIGUOUS

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Question 22 (5 marks)

→ EUKARYOTIC

Describe the structure of genes, referencing the key binding sites and regions in your answer and explain their relevance.

PROMOTER → start → RNA polymerase starts transcription

EXONS → CODING

INTRONS → NON CODING

TERMINATOR → STOP → where transcription ceases

OPERATOR → regulatory sequence where transcription factors will bind → proteins which control gene expression

trp operon

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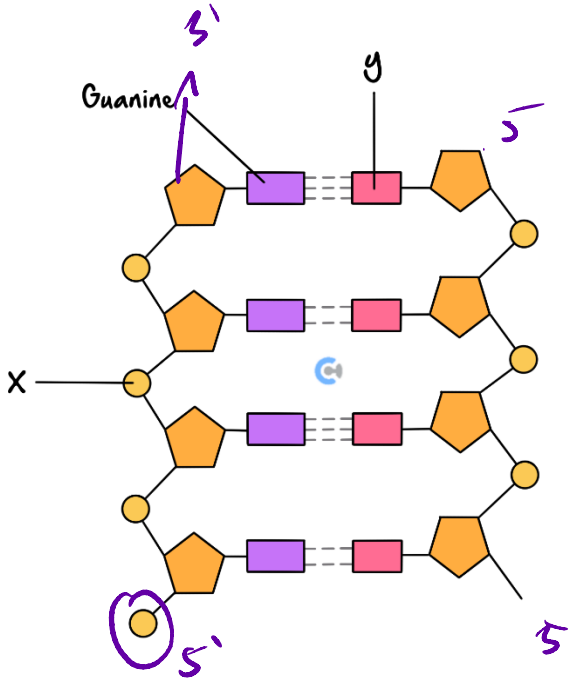
Section C: Exam Style Questions (30 Marks)

Question 23 (8 marks)



a. List the full name of the molecule in the diagram above. (1 mark)

DNA

b. Identify the labels *X* and *Y*. (2 marks)

Phosphate

Cytosine

c. In reference to this molecule, explain the meaning of the term 'anti-parallel'. (2 marks)

Each DNA strand runs in an opposite direction
5' to 3', the other 3' to 5'
↳ phosphate
sugar ↳ beneficial for orientation

d. Identify three places in a plant cell where this molecule can be located. (3 marks)

NUCLEUS

CHLOROPLAST

MITOCHONDRIA

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Question 24 (4 marks)

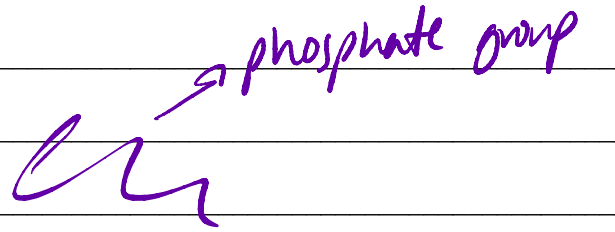
The table below represents a small section of a DNA template sequence that is about to be transcribed.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
A	**G**	**T**	**C**	**C**	**G**	**T**	**A**	**G**	**C**	**T**	**G**	**A**	**A**	**T**	**C**	**C**	**G**	**G**	**T**	**T**	**G**

Draw a diagram of the DNA molecule that includes the first four nucleotides from the table.

On your diagram, label the:

- Phosphate, nitrogenous base and deoxyribose of the DNA molecule.
- Hydrogen bond(s).



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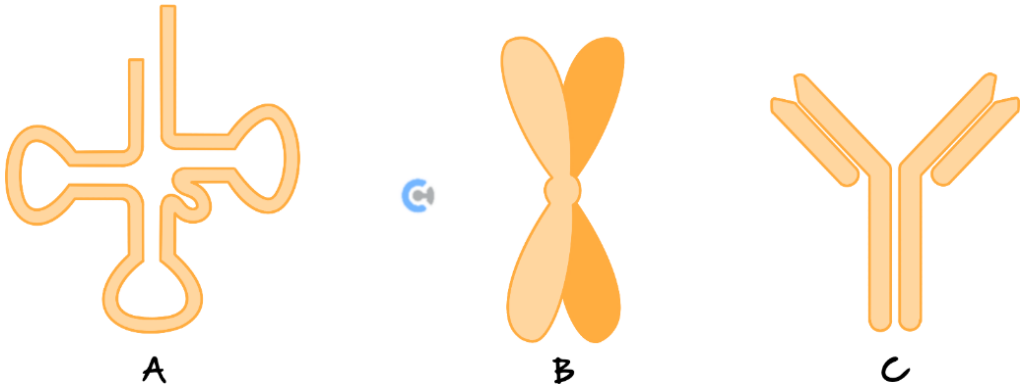
Question 25 (4 marks)

a. Identify which of the following molecules (A, B or C) could represent a molecule of tRNA. (1 mark)



b. Identify the function of the two different forms of RNA below. (2 marks)

rRNA makes up the ribosome for protein synthesis

mRNA copy of genetic instruction taken from nucleus to ribosome

c. Describe what is meant by the term 'universal genetic code'. (1 mark)

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Question 26 (6 marks)

The sequence of the first part of an exon in a piece of pre-mRNA has the following sequence:

AUGCUCAUCGAGCCG

The pre-mRNA molecule will be modified to produce mRNA, which will then be translated to produce a polypeptide known as protein *X*.

a. Explain the difference between an exon and an intron. (1 mark)

coding ↳ non-coding

b. Give one difference between the structures of (i) DNA and mRNA, and (ii) mRNA and tRNA. (2 marks)

shape ↗ closer

linear vs t-shape

c. When the exons are spliced together, adjacent nucleotides need to be joined in the mRNA molecule. Name the type of reaction that joins these adjacent nucleotides. (1 mark)

condensation polymerisation

d. A company wishes to patent the sequence of DNA that codes for the production of protein *X* but they need to change the sequence of the exon to do so.

As previously supplied, the sequence of the pre-mRNA is:

AUGCUCAUCGAGCCG 7

Explain the feature of the genetic code that would enable the company to do this. Identify one alteration that could be made to the sequence of the pre-mRNA that would not affect the structure of the protein. Use the codon table below to assist in answering this question. (2 marks)

	U		C		A		G		
U	UUU	Phenylalanine	UCU	Serine	UAU	Tyrosine	UGU	Cysteine	U
	UUC	Phenylalanine	UCC	Serine	UAC	Tyrosine	UGC	Cysteine	C
	UUA	Leucine	UCA	Serine	UAA	Stop	UGA	Stop	A
	UUG	Leucine	UCG	Serine	UAG	Stop	UGG	Tryptophan	G
C	CUU	Leucine	CCU	Proline	CAU	Histidine	CGU	Arginine	U
	CUC	Leucine	CCC	Proline	CAC	Histidine	CGC	Arginine	C
	CUA	Leucine	CCA	Proline	CAA	Glutamine	CGA	Arginine	A
	CUG	Leucine	CCG	Proline	CAG	Glutamine	CGG	Arginine	G
A	AUU	Isoleucine	ACU	Threonine	AAU	Asparagine	AGU	Serine	U
	AUC	Isoleucine	ACC	Threonine	AAC	Asparagine	AGC	Serine	C
	AUA	Isoleucine	ACA	Threonine	AAA	Lysine	AGA	Arginine	A
	AUG	Methionine (Start)	ACG	Threonine	AAG	Lysine	AGG	Arginine	G
G	GUU	Valine	GCU	Alanine	GAU	Aspartic Acid	GGU	Glycine	U
	GUC	Valine	GCC	Alanine	GAC	Aspartic Acid	GGC	Glycine	C
	GUA	Valine	GCA	Alanine	GAA	Glutamic Acid	GGA	Glycine	A
	GUG	Valine	GCG	Alanine	GAG	Glutamic Acid	GGG	Glycine	G

Degeneracy 1

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Question 27 (2 marks)

An organism has a template DNA strand sequence of bases:

TATATACGGGCGATGACTCATAGG

a. Write the complementary mRNA sequence to this strand. (1 mark)

AUAUAUGCCCGCUACUGAGUAUCC

b. How many amino acids does this code for? (1 mark)

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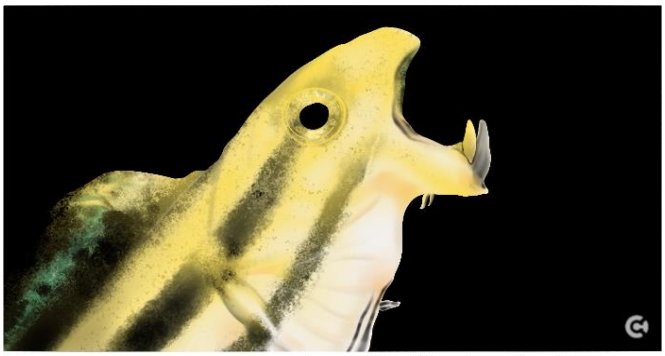
Question 28 (3 marks)

Fang blennies *(Meiacanthus grammistes)* are little fish that have large fangs capable of delivering venom to their victims. The venom is made up of a number of substances, including an opioid peptide. It is thought that when the fang blennies bite the 'would-be' predator the opioid causes a drop in blood pressure. This would then disorientate and slow the predator down, giving the fang blennies a chance to escape. It could also relax the jaws and allow them to escape.



Source: https://s-media-cache-ak0.pinimg.com

Nucleic acids found in the cells of the fang blennies are needed for the synthesis of the opioid proteins found in the cells of the blennies.

Explain how the roles of the three different types of RNA within the cells of the blennies that are needed to produce the venom.

refer back to specific question in answer

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Question 29 (3 marks)

How is DNA oriented? Explain and describe its importance to DNA's function.

→ 5' to 3' strands / antiparallel

→ differentiate each strand of DNA

↓ read + transcribe DNA in correct sequence

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