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TUITION

Phone: +442081445350

www.chemistryonlinetuition.com

Email:asherrana@chemistryonlinetuition.com

BIOLOGY

THE CONTROL OF GENE EXPRESSION

Level & Board	AQA (A-LEVEL)
TOPIC:	EPIGENETICS AND RNA INTERFERENCE
PAPER TYPE:	QUESTION PAPER - 1
TOTAL QUESTIONS	6
TOTAL MARKS	31

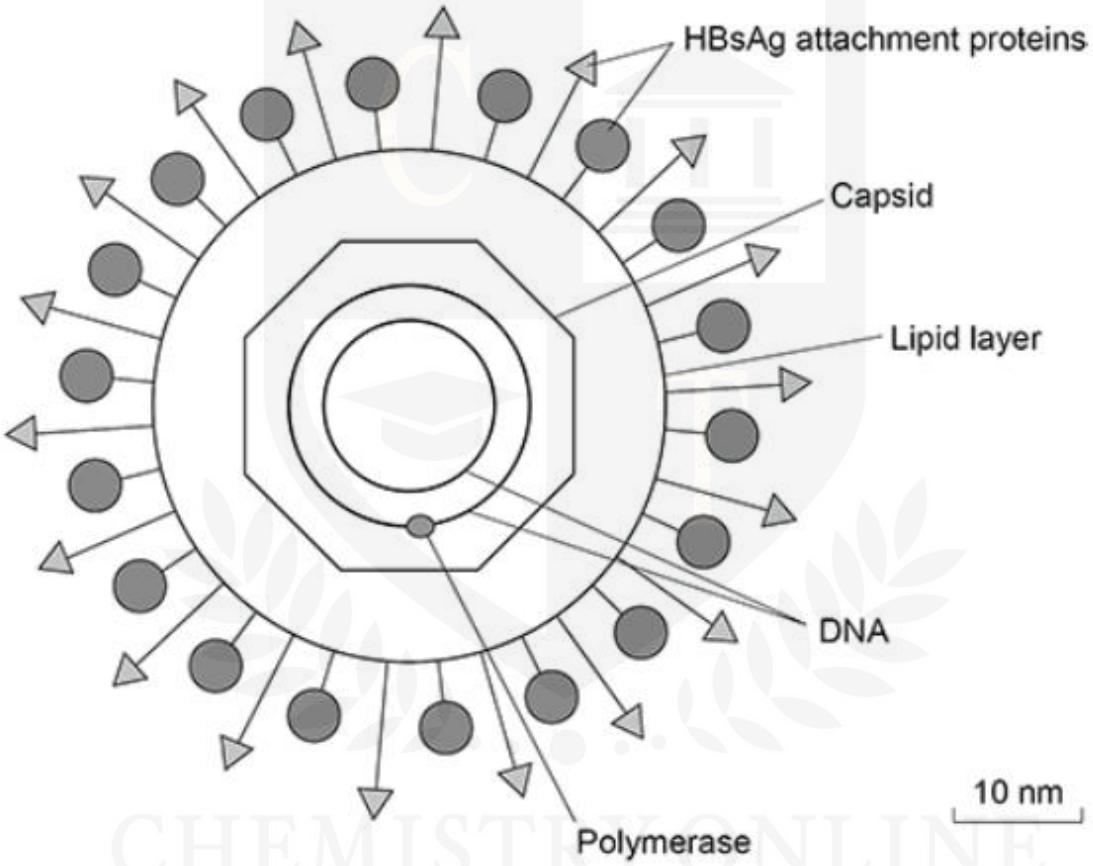
Epigenetics and RNA interference - 1

1.

The hepatitis B virus is the cause of hepatitis B, a potentially fatal liver infection (HBV).

Figure 1 depicts the HBV structure.

Figure 1



(a) A liver cell is infected by HBV. The diameter of the liver cell is 25 μm.

Determine the number of times this cell's diameter is more than HBV using Figure 1. The lipid layer should be used to gauge HBV diameter. **(2)**

2.

Researchers looked into how well two different kinds of RNA interference (RNAi) molecules worked to stop HBV replication. These were the following molecules: long hairpin RNA (lhRNA) and short hairpin RNA (shRNA).

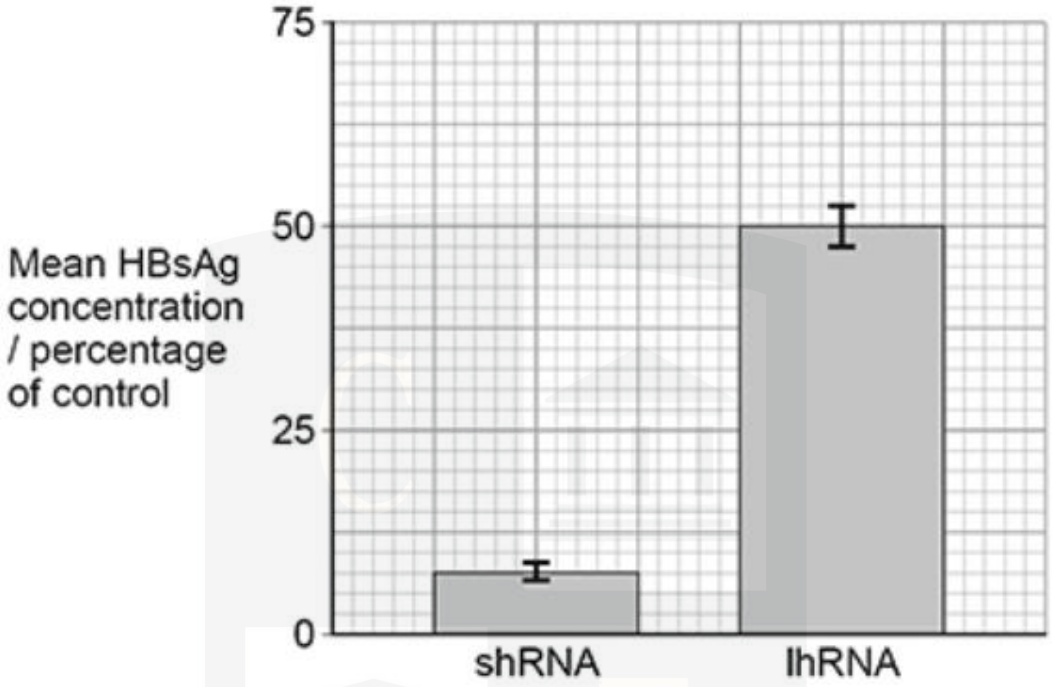
The researchers introduced either shRNA or lhRNA into mouse liver cells that had been infected with HBV. The amount of the attachment proteins, HBsAg, in these cells was then measured.

HBV replication is gauged by the amount of HBsAg present.

The scientists' findings are displayed in Figure 2.

Over 95% of the data is represented by the error bars, which show ±2 standard deviations from the mean.

Figure 2



(a) Combining RNAi molecules with a lipid is one way to introduce these molecules into cells. Explain why this might lead to an increase in RNAi molecules' absorption by cells. **(2)**

(b) Analyze the two types of RNAi's potential applications in the treatment of hepatitis B in humans using all the material supplied.

In your response, do not discuss how RNA interference inhibits HBV replication**. (5)**

3.

A steroid hormone, testosterone is a member of the androgen family of male sex hormones.

(a) Hydrophobic steroid hormones.

Justify the quick entry of steroid hormones via the cell-surface membrane of a cell. **(2)**

(b) Testosterone binds to a particular androgen receptor (AR) in the cytoplasm.

A protein is an AR.

Explain or propose a reason for testosterone's binding to a particular AR. **(2)**

(c) The shape of an AR is altered when testosterone binds to it. At this point, the AR molecule reaches the nucleus and increases the expression of genes.

Explain how the AR might encourage the expression of a gene**. (2)**

Number of CAG repeats in the *AR* gene	**Probability (P) value**
⩽ 16	0.02
⩽ 17	0.30
⩽ 18	0.07
⩽ 19	0.09
⩾ 20	0.06

(d) From the information in the above table, what conclusions can you draw?

(2)

4.

For development and storage, plants move sucrose from their leaves to other tissues.

Protein SUT1 is a co-transporter of sucrose.

Researchers looked into whether tobacco plant leaf cells transported sucrose to other tissues via SUT1.

(a) Researchers downregulated the SUT1 gene's expression to investigate the function of SUT1 in tobacco plants.

The SUT1 mRNA generated during transcription of the SUT1 gene is referred to as "sense" SUT1 mRNA. Through the insertion of an additional gene, the scientists genetically altered plants to enable the synthesis of "antisense" SUT1 mRNA.

The tobacco plants the scientists had were of two kinds:

• Type A plants: those that underwent genetic modification

• Plants classified as type B are unmodified genetic material.

Explain how the expression of the SUT1 gene would be decreased in type A plants if 'antisense' SUT1 mRNA were produced. **(5)**

5.

The myelin coating of neurones is harmed by the immune system in the uncommon illness known as Guillain-Barré syndrome. Damage to the myelin sheath can result in a variety of symptoms, including numbness, muscle weakness, and paralysis. Periodic disruptions to autonomic nervous system neurones might lead to irregular heart rates.

A protein known as huntingtin causes brain damage, which results in Huntington's disease. The production of huntingtin is caused by a dominant mutant allele.

There were forty-six participants in the first medication experiment that effectively lowered huntingtin levels in the human brain. For four and a half months, the patients were on the medication. All of the patients had lower huntingtin concentrations.

The medication was injected into the cerebrospinal fluid, which surrounds the brain and spinal cord, at the base of the spine. There are single-stranded DNA molecules in the medication. These single-stranded molecules block the messenger RNA (mRNA) responsible for making huntingtin.

Although they can appear at any age, Huntington's disease symptoms often appear between the ages of 30 and 50. The quantity of CAG base sequence

repeats in the Huntington's disease gene is associated with both the likelihood and the age at which symptoms first appear. Epigenetics, however, may also have an impact on the age at which symptoms initially appear, according to current research.

(c) Single-stranded DNA molecules were employed in the first medication experiment that was successful in lowering huntingtin levels in the brain (lines 13–14).

Provide a hypothesis and an explanation for how this medication might lower the amount of the protein huntingtin. **(3)**

I am Sorry !!!!!

(d) Scientists from the first successful drug trial to reduce concentrations of

huntingtin (lines 9–11) reported that the drug is not a cure for Huntington's disease.

Suggest two reasons why the drug should not be considered a cure.

Do not include repeats of the drug trial in your answer**. (2)**

6.

(a) Give two explanations for why the medication was injected into the CSF fluid rather than being taken as a tablet (lines 12–13). **(2)**

(b) Provide an example of how epigenetics might impact the age at which Huntington's disease symptoms first appear. **(2)**

DR. ASHAR RANA

CHEMISTRY ONLINE
TUITION

Phone: +442081445350
www.chemistryonlinetuition.com
Email: asherrana@chemistryonlinetuition.com

- Founder & CEO of Chemistry Online Tuition Ltd.
- Tutoring students in UK and worldwide since 2008
- CIE & EDEXCEL Examiner since 2015
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CONTACT INFORMATION FOR **CHEMISTRY ONLINE TUITION**

- UK Contact: 02081445350
- International Phone/WhatsApp: 00442081445350
- Website: www.chemistryonlinetuition.com
- Email: asherrana@chemistryonlinetuition.com
- Address: 210-Old Brompton Road, London SW5 OBS, UK