Teaching notes: RNA interference (RNAi)

These teaching notes relate to section 3.8.2.2 of our A-level Biology specification. This resource describes key teaching points in the accompanying PowerPoint presentation.

PowerPoint presentation

Introduction - key points (slide 1)

Students can be given a simple overview of this topic.

- As a result of RNA interference, mRNA molecules produced by transcription of a gene can no longer be translated.
- Even though the gene is 'switched on', the protein it encodes is not produced.
- The gene is effectively 'silenced'.

An outline of polypeptide synthesis (slide 2)

This summary recaps what students should already have learnt.

An outline of polypeptide synthesis (slide 3)

A diagrammatic summary to help visual learners.

RNA interference (RNAi) (slide 4)

RNAi prevents the translation of mRNA.

Prokaryotes and eukaryotes (including humans) have these mechanisms.

It might interest students to learn that scientists believe the selective advantage of these mechanisms might have been that it gave cells a defence against infection by viruses.

RNA-induced silencing complex (RISC) (slide 5)

Many students have picked up the term 'junk' DNA – the DNA that does not encode polypeptides.

In fact, much of this DNA encodes RNA that is involved in cell regulation.

- Small nuclear RNAs (snRNAs) operate within nuclei, where they are tightly bound to proteins to form small nuclear ribonucleoproteins, or snRNPs (often pronounced 'snurps'), that control the splicing of pre-mRNA.
- MicroRNAs (miRNAs) are formed as hair-pin bends of RNA but processed into single-strands about 22 to 26 nucleotides long. These single strands become incorporated into a protein-based RISC.
- Small interfering RNAs (siRNAs) are formed as double-stranded molecules about 21 to 25 base pairs long. One of their strands becomes incorporated into a protein-based RISC.
- When the single-stranded miRNA or siRNA within a RISC binds to a molecule of mRNA that contains a sequence of bases complementary to its own, the mRNA is either hydrolysed or its translation is stopped.

Students might be interested to know that the first discovery of a miRNA molecule was in 1993 but research into their role began only in 2000. This part of the specification is very much up-to-date.

RISC binds to mRNA (slide 6)

Students should find no problem understanding this slide – they are familiar with the 'rules' of base pairing.

The new concept for students is that, here, the pairs are between two strands of RNA.

Once mRNA is bound to a RISC (slide 7)

Further reading:

Stella Graham (2014), *MicroRNAs: small players in big diseases*, Biological Sciences Review, 27 (1), pp 22-25

Kate Timms (2016), *MicroRNA: minute molecules making a big splash*, Biological Sciences Review, 28 (3), pp 20-22

Animation with accompanying slide show:

nature.com Video animation: RNA interference

Model of a RISC (slide 8)

Molecular model of a bacterial RNA-induced silencing complex (RISC).

The RISC comprises an argonaute protein (grey) bound to a small interfering RNA (siRNA) molecule (pink and green).

Final note

No questions for students are supplied to accompany this topic due to the small size of the topic.