

# 16.3 Gene Control

## Question Paper

Course	CIEA Level Biology
Section	16. Inheritance
Topic	16.3 Gene Control
Difficulty	Hard

**Time allowed:** 40  
**Score:** /29  
**Percentage:** /100

**Question 1a**

The tryptophan (*trp*) operon controls the synthesis of the amino acid tryptophan in many species of bacteria.

The synthesis of tryptophan occurs in five different steps, each requiring a different enzyme coded for by structural genes *trpA*, *trpB*, *trpC*, *trpD*, and *trpE*. The regulatory region of the *trp* operon includes the promoter (P), the operator (O), and a regulatory gene, *trpR*, which codes for a *trp* repressor protein.

The activation or repression of the *trp* operon is determined by the tryptophan levels in the environment of the bacteria.

Fig. 1 shows the structure of the *trp* operon in the presence of high tryptophan levels.

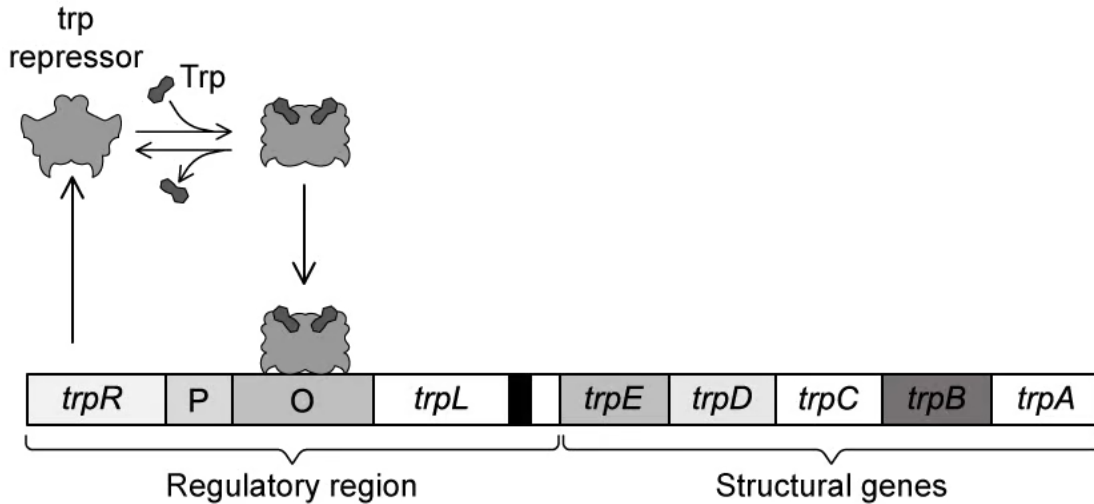


Fig. 1

State the difference between a structural and a regulatory gene.

[2 marks]

**Question 1b**

Using the information in Fig. 1, explain the effect of high tryptophan levels on the *trp* operon.

[4 marks]

### Question 1c

The enzymes produced by some structural genes can be classified as either inducible or repressible.

(i)  
State whether the enzymes produced by the structural genes of the trp operon are inducible or repressible.

[1]

(ii)  
Give a reason for your answer to part (i).

[1]

**[2 marks]**

### Question 1d

The trp operon can be regulated by another mechanism called attenuation; this involves a leader transcript, *trpL*. When tryptophan levels are high attenuation causes RNA polymerase to end the transcription of the structural genes prematurely.

Suggest how attenuation contributes to the regulation of tryptophan in bacteria.

**[2 marks]**

**Question 2a**

The hormone oestrogen can diffuse into human body cells. Once inside a cell, oestrogen diffuses through the nuclear pores into the nucleus where it attaches to a transcription factor called oestrogen receptor (ER). This allows ER to combine with a cofactor, which in turn allows the cofactor to bind to the promoter region of a gene. This enables RNA polymerase to bind to the promoter region.

In certain types of breast cancer ER is no longer regulated by control mechanisms and may lead to the development of oestrogen induced tumours. Tamoxifen was one of the first effective treatments for these types of cancers and is still used with great success.

Fig. 1 compares the action of oestrogen and tamoxifen.

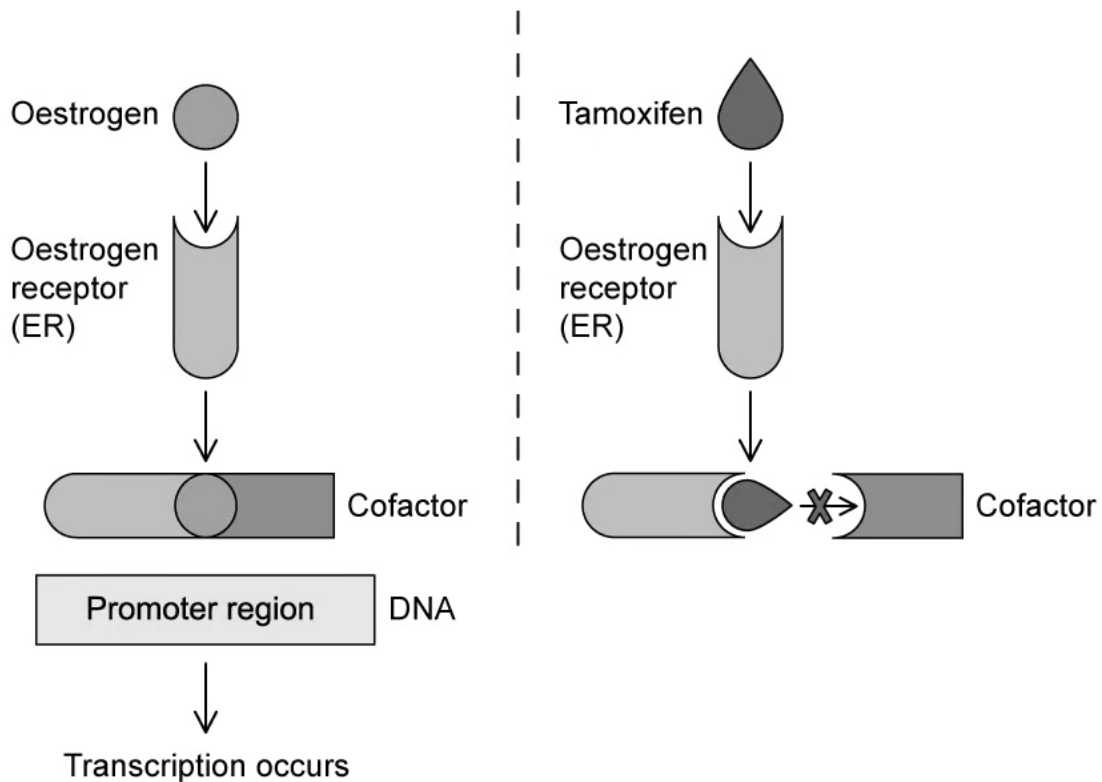


Fig. 1

Explain what is meant by the term **transcription**.

[2 marks]

**Question 2b**

With reference to Fig. 1, suggest how tamoxifen is an effective treatment for breast cancer.

[3 marks]

### Question 2c

While ER enables RNA polymerase to bind to the promoter region, some transcription factors can prevent transcription from taking place.

Suggest **two** ways in which transcription factors might prevent transcription.

[2 marks]

### Question 2d

Transcription factors control the transcription of genes by binding to specific regions of DNA.

State the importance of controlling gene transcription for an organism.

[1 mark]

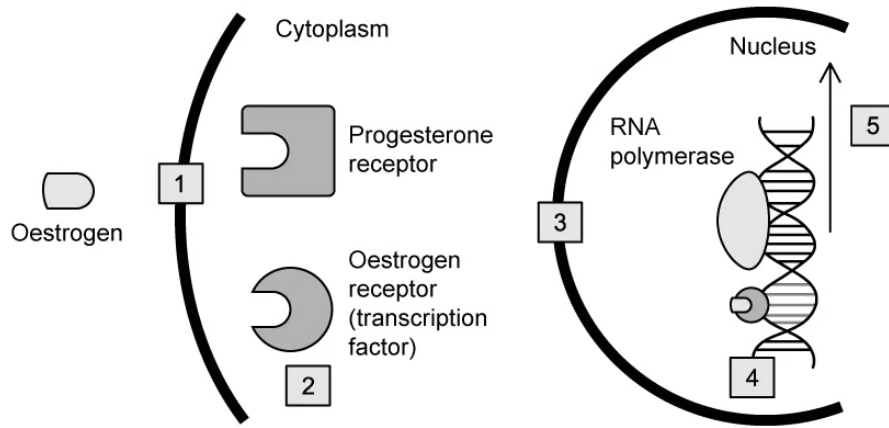
### Question 3a

Explain how transcription factors stimulate the expression of a gene.

[3 marks]

**Question 3b**

Fig. 1 below shows the mechanism by which oestrogen initiates gene expression.



**Fig. 1**

Compare and contrast the mechanism of action shown in the diagram with the process of non-competitive enzyme inhibition.

**[3 marks]**

**Question 3c**

Explain why oestrogen is unable to bind to the progesterone receptor in Fig. 1.

**[1 mark]**

**Question 3d**

Totipotent cells from one organism are genetically identical, however, not all of these genes are ultimately expressed. This is known as differential gene expression.

Explain how differential gene expression forms an organism with specialised cells.

**[4 marks]**

