HIGHER LEVEL

COMMAND TERMS

PEARSON BACCALAUREATE

HIGHER LEVEL

Biology

2nd Edition

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Supporting every learner across the IB continuum

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Command terms

The following command terms will be used in questions in IB exams. It is essential that you understand what is required when you encounter these terms. They are ordered in increasing levels of difficulty: group 1 contains the simplest terms and group 3 the most demanding.

Group 1

Define	Provide the meaning of the term or phrase as precisely and concisely as possible.
Draw	Use a pencil to represent what is requested. Always add labels unless directed not to do so.
Label	When not used with the 'draw' command term, it means to affix labels to a visual representation.
List	Supply a simple series of words or explanations without specific details.
Measure	Stipulate the dimensions called for. Include units when appropriate.
State	Provide the requested information without supporting calculations or reasoning.

Group 2

Annotate	Provide short critical or explanatory comments. It is usually applied to a graph or diagram.
Calculate	Produce an answer using mathematical methods. It is essential to show all your working out unless otherwise stated.
Describe	Provide all relevant information in furnishing a justification or explanation.
Distinguish	Differentiate between two or more different objects, structures, or details.
Estimate	Using information provided or scientific knowledge, determine an approximate value for a requested item.
Identify	When provided with a list of possible solutions, select the correct or best answer.
Outline	Indicate the principal features of a requested topic. Be concise.

Group 3

Analyse	Utilize data from tables, graphs, or scientific studies to develop a reasoned judgement.
Comment	Provide an inference based on a calculation or statement.
Compare	Supply information representing how two items or conditions are similar to one another. A table format is acceptable for this.
Compare and contrast	Supply information representing how two items are both different and similar to one another. A table format is acceptable for this.
Construct	Present information in some diagrammatical form, often as a graph.
Deduce	From data given, reach a justifiable conclusion.
Design	Devise a procedure, model, simulation, or plan.
Determine	Use information to arrive at a proper decision or answer.
Discuss	Present a detailed account including a range of possibilities, such as in an argument. Account for the importance of different factors or various hypotheses supporting these possibilities.
Evaluate	Appraise the limitations and logical relationships.

Biology Command Terms

Explain	Give a clear and detailed accounting of some subject, cause, or mechanism. Show logical developments or relationships. Be certain your accounting is clear and understandable.
Predict	Indicate an expected result based on observation, experience, or scientific reasoning.
Sketch	Produce a graph to indicate a proper representation. A proper line should be included on the graph, with labelled axes. However, scaling of the axes is not essential. Any features asked for should be clearly indicated.
Suggest	A solution or hypothesis should be proposed utilizing sound scientific knowledge and procedures.

Chapter 1: Cells

State

Provide the requested information without supporting calculations or reasoning.

Examples

State why interphase is considered to be a very active phase in the life of a eukaryotic cell.

State the name of the process most often used by prokaryotic cells to reproduce.

State the outermost structure of a typical plant cell.

State the compound that moves across selectively permeable membranes in osmosis.

State the commonly occurring organelle in prokaryotic cells.

State the process that occurs in cell division immediately after mitosis.

State the three specific phases of interphase.

Guidance

Responses to these types of exam questions should be direct. Students sometimes miss marks on these types of questions because they do not note the number of marks assigned to the question. In the last example above, '**State** the three specific phases of interphase', in an IB exam this question would probably be assigned 3 marks. The assigned marks are clearly shown in parentheses to the right of each question in the exam. The mark scheme for this question would require the following responses:

- G_1 phase
- S phase
- G_2 phase.

Notice that there is no explanation required or expected for the phases. When answering questions with this command term, use the vocabulary presented in the Understandings and Applications and skills parts of the course guidelines. In the example above, you would get no marks for explaining what happens in each phase of interphase.

Chapter 2: Molecular biology

Distinguish

Differentiate between two or more different objects, structures, or details.

Example

Distinguish between DNA and RNA molecules.

Guidance

Notice that the command term **distinguish** requires you to differentiate or give *differences*. In another question it may well be important to state that DNA and RNA are both nucleic acids and both are composed of nucleotide subunits. However, for this question neither of those pieces of information would show up in the mark scheme as neither is differentiating between these two molecules. Possible mark scheme items for this question might be:

- DNA is double-stranded; RNA is single-stranded
- DNA contains the genetic information of many genes; RNA (mRNA) contains the information of one gene
- DNA generally contains more nucleotides than RNA
- in eukaryotes, DNA is contained within the nucleus; RNA is found both inside and outside the nucleus

Compare

Supply information representing how two items or conditions are similar to one another. A table format is acceptable for this.

Example

Compare DNA and RNA molecules.

Guidance

In this example, because the command term is now **compare**, you are required to give similarities. The mark scheme for this question would only include how DNA and RNA are similar to each other. A possible mark scheme might be:

- DNA and RNA are both nucleic acids
- DNA and RNA are both composed of nucleotide building blocks
- DNA and RNA both contain adenine, cytosine, and guanine nitrogenous bases.

Chapter 3: Genetics

Determine

Use information to arrive at a proper decision or answer.

Example

Determine the genotypes and phenotypes of the offspring of a monohybrid cross using a Punnett grid.

Guidance

Only one solution will be accepted as the right answer and, although you are not asked to explain how you got your answer, it is always a good idea to show any calculations or working out because intermediate steps can often earn marks. This is the case with past IB exam questions involving Punnett grids.

It is vital to be sure of the parents' genotypes before setting up the grid. This can be achieved by reading the question carefully.

Example question and answer

The allele for black fur in mice is dominant over the recessive allele for brown fur. A female mouse with black fur mates with a male mouse with brown fur. One of the female's parents had brown fur. **Determine** the genotypes and phenotypes of the offspring.

To answer this question, it is important to follow all the conventions for setting up and interpreting a Punnett grid correctly. The five steps are outlined in your textbook in Chapter 3: Section 3.4. Here they are for this example.

1. Recessive allele for brown fur = **b**, dominant allele for black fur = **B** (IB exams often tell you which letters to use).
2. The male parent's genotype must be **bb** because he has brown fur (homozygous recessive). The female must be **Bb** (heterozygous) because she has a black phenotype but one of her parents was **bb** (had brown fur).
3. The male can only produce gametes that contain **b**. However the female, because she is heterozygous for fur colour, could produce gametes containing either **B** or **b**.
4. The Punnett grid gives the following:

	b	**b**
B	**Bb**	**Bb**
b	**bb**	**bb**

5. What can be deduced from the above grid is that:
   - there is a 50% chance that the offspring will have a heterozygous genotype (**Bb**) and display a phenotype of black fur

- there is a 50% chance that the offspring will have a homozygous recessive genotype (**bb**) and display a phenotype of brown fur.

Note: This answer contains lots of precise scientific vocabulary so there is little chance for ambiguity. Students are encouraged to memorize and use vocabulary terms such as *heterozygous*, *gamete*, *phenotype*, and so forth.

Chapter 4: Ecology

Explain

Give a clear and detailed accounting of some subject, cause, or mechanism. Show logical developments or relationships. Be certain your accounting is clear and understandable.

Example

Explain how peat forms in wetlands.

Guidance

In exams, questions with the command term **explain** can be answered in bullet-point fashion when they appear in the short-answer section, but should be answered in prose when found in essay questions. Students are encouraged to use explanatory words and phrases such as *because*, *this is due to*, *the reason for this is*, *this is accomplished by* or *this results in*.

Here, the format shown for this example answer is in a bullet-point format.

- Peat, a kind of waterlogged soil found in certain types of wetlands, starts out as an accumulation of dead organic material.
- The high water content in the wetlands forces air out of the soil, creating an anaerobic environment.
- This prevents the dead material from fully decomposing because the decomposers cannot breathe in the oxygen-deprived soil and tend to be drowned.
- The high acidity (low pH) also prevents decomposers from surviving in the wetlands, and this further contributes to the build-up of dead organic material that cannot fully decay.
- The incompleteness of the decomposition of organic material results in the presence of many carbon-rich molecules remaining present in the peat: this is the reason why, when dried out, peat can burn to release valuable energy for human use.

Chapter 5: Evolution and biodiversity

Discuss

Present a detailed account including a range of possibilities, such as in an argument. Account for the importance of different factors or various hypotheses supporting these possibilities.

Example

Discuss how biochemical variations can be used as an evolutionary clock.

Guidance

One way to think about a **discuss** question is to imagine two or more people of very different backgrounds and opinions tackling the question while sitting around a table or participating in a formal debate. One would say 'Yes, this is true' whereas the other would say 'No, you are wrong, that's not how it is'. But they also need to present convincing arguments.

We can imagine two opposing speakers taking the following views for the question above.

For	Against
Overall argument: *Yes, biochemical variations can be used as an evolutionary clock to determine how long ago species diverged.*	Overall argument: *No, these variations are not at all as precise and regular as a clock, and should not be used to time speciations.*
• Background information: define what biochemical variations are, give examples. • Explain how these variations come about and state that mutations happen relatively frequently when looking at millions of years of evolution. • State that two organisms that show little variation between each other are likely to be closely related whereas those with many variations between them are more distantly related. • By counting the number of variations, the time difference between speciations can be estimated.	• The mutations that are responsible for the biochemical variations are random: some periods of geological time are characterized by multiple mutations and speciations and others by relatively few. • Although rough estimations and averages can be calculated for the frequency of the mutations, they cannot be compared with the regularity of the ticking of a clock. • Environmental changes might cause sudden shifts in the gene pool during certain geological periods, whereas more stable environmental periods of time might show very little variation. • Therefore, the number of mutations cannot be used to estimate with accuracy the time between speciations.

Chapter 6: Human physiology

Compare and contrast

Supply information representing how two items are both different and similar to one another. A table format is acceptable for this.

Example

Compare and contrast the structure and function of arteries and veins.

Guidance

Notice that the command term **compare and contrast** is a combination of the two command terms **compare** and **distinguish**. Any IB test question that begins with compare and contrast is going to have a mark scheme that allocates approximately half of the available marks for similarities and half for differences. You must make a full comparison or contrast to earn a single mark. In other words, you will not receive any mark for information that includes only one of the two things that are part of the question.

In the example question above, where arteries and veins are the focus, one or more paragraphs could be used to answer the question, or a side-by-side table could be used. Here are examples of each approach.

Paragraph approach

Arteries and veins are two of the major blood vessel types that comprise the circulatory system. Both arteries and veins are composed of walls that are made up of multiple cell layers, and thus no 'exchanges' can occur between the blood and body cells to and from either of these two vessel types. That being said, arteries have thicker walls as they have a layer of smooth muscle, in contrast with the thinner walls of veins that have little smooth muscle tissue. The blood flowing in arteries has not yet reached a capillary bed and thus the blood is exerting a high blood pressure on the inside wall of the artery and is moving rapidly. Veins carry blood that has already been to a capillary bed and thus the blood is under lower pressure and is relatively slow moving. Veins contain internal passive valves that keep the low-pressure, slow-moving blood moving in a single direction; arteries contain no such internal valves. Arteries and veins are not identified by whether they are carrying oxygenated or deoxygenated blood; instead, they are identified by whether it is a blood vessel coming from the heart and has not yet reached a capillary bed (an artery) or it is a blood vessel that is receiving blood from a capillary bed and is carrying that blood back to the heart (a vein).

Side-by-side table approach

Point	Characteristics of arteries	Characteristics of veins
1	Multicellular layer wall	Multicellular layer wall
2	No exchanges occur between blood and body cells	No exchanges occur between blood and body cells
3	Thicker walls	Thinner walls
4	Contain smooth muscle	Contain little to no smooth muscle
5	Contain blood that has not yet reached a capillary bed	Contain blood coming from a capillary bed

Point	Characteristics of arteries	Characteristics of veins
6	Blood at a relatively high pressure	Blood at a relatively low pressure
7	Contain blood that is moving rapidly	Contain slow-moving blood
8	Interior of vessels has no internal passive valves	Interior of vessels has internal passive valves
9	Carry blood away from the heart	Carry blood back to the heart

Notice the following about the design and content of the table.

- The content in each cell provides full details; very brief information can be considered incomplete.
- The table contains both similarities and differences (**compare and contrast**).
- The items being compared and contrasted are lined up in the table, side by side.
- To make this clear, numbering the items is a good idea, with a single number for each complete point.

Chapter 7: Nucleic acids

Describe

Provide all relevant information in furnishing a justification or explanation.

Examples

Describe the structure of DNA, including the antiparallel strands, 3'-5' linkages, and hydrogen bonding between purines and pyrimidines.

Describe the action at the antisense strand of DNA in transcription.

Describe the process of DNA replication.

Describe how nucleosomes help to regulate transcription in eukaryotes.

Describe the forces at work in determining the tertiary structure of proteins.

Describe how bound ribosomes differ from free ribosomes in the products they are most likely to produce.

Guidance

Students often miss marks on **describe**-type exam questions because they do not fully answer the question. In many cases, students will produce answers that do not actually address the question. It is essential to read **describe** questions carefully and to understand fully what is required before you begin to write. Look at the last example given above. It is not important to account for the actual structure of a ribosome, nor is there a need to even mention what they may be bound to. This question simply wants an explanation of the products from these two types of ribosomes. The mark scheme would require a statement mentioning that bound ribosomes most often produce proteins primarily for secretion or for use in lysosomes. It would also require a statement mentioning that free ribosomes primarily produce proteins for use within the cell. When answering **describe** questions take special note of the number of assigned marks and read the question carefully so that you can specifically address what is asked. Do not be too brief in your response and be certain to have as many detailed points as the number of marks.

Chapter 8: Metabolism, cell respiration, and photosynthesis

Explain

Give a clear and detailed accounting of some subject, cause, or mechanism. Show logical developments or relationships. Be certain your accounting is clear and understandable.

Examples

Explain oxidative phosphorylation in terms of chemiosmosis.

Explain the light-dependent reactions.

Explain the concept of limiting factors in photosynthesis, with reference to light intensity and temperature.

Explain the induced-fit model of enzyme action.

Explain the production of ATP in the major phases of aerobic respiration.

Explain the relationship between the structure and the function of the major parts of the chloroplast in photosynthesis.

Explain the relationship between the structure and the function of the major parts of the mitochondrion in cellular respiration.

Explain the importance of photolysis in photosynthesis.

Guidance

Explain questions in the exam involve multiple marks. Be certain to include at least as many detailed points in your response as there are marks available. It is a good idea to include more detailed points than the number of marks available. This allows you to get full marks for this type of question even if one of your points or statements is incorrect. IB marks positively, which means it does not take off marks for incorrect responses. It only awards marks for correct responses. However, do not give conflicting or contradicting statements, as this would prevent the awarding of a mark.

Students are often intimidated by **explain** questions because of the high number of marks and the complexity involved. When encountering this command term, produce a basic outline of what you want to address before beginning to write your response on the exam booklet. There will be spare paper or extra exam booklets available for this purpose during the exam.

Students sometimes don't look closely enough at these types of questions. For example, in the last example given above, notice it asks for an explanation of the importance of photolysis to photosynthesis. Many students will only write about the value of photolysis in the light-dependent reaction. It would be most accurate to include the light-independent reaction in your explanation as well. Certainly, it is important to note that photolysis allows the replacement of energized electrons in the reaction centre of photosystem II and the H^+ necessary for the formation of NADPH in photosystem I in the light-dependent reaction. However, it is also important to note that the NADPH produced is essential for the Calvin cycle to form triose phosphate and ultimately glucose in the light-independent reaction.

Too often, examiners mention students not answering **explain** question clearly and in an organized manner. If you make a basic outline before you begin writing, this should help. Also, focus on sentence clarity and paragraph (if appropriate) structure. This will help the examiner understand your key points and will, no doubt, increase your total marks.

Chapter 9: Plant biology

Outline

Indicate the principal features of a requested topic. Be concise.

Examples

Outline the major events that allow the opening and closure of stomata in plants.

Outline the features of xylem tissue that allow it to move water and minerals from the roots to the upper plant regions.

Outline the major steps in the experimental set-up of a functional potometer.

Outline the pressure-flow hypothesis used to explain phloem tissue activity in plants.

Outline the actions of auxin in positive phototropism in plants.

Outline the factors that may affect successful seed germination.

Outline the function of P_{fr} in short-day plants to bring about flowering.

Outline the functions of the major parts of an animal-pollinated flower.

Guidance

It is important to note, when responding to exam questions using this command term, that it is not necessary to give detailed explanations using paragraphs or even sentences. Bulleted statements are usually quite adequate and are desired. Be direct in your responses and be certain your responses are appropriate to what is being asked. It is essential to note the number of marks assigned to the question. This will tell you the *minimum* number of points to produce. It is suggested that you include more points than marks called for. However, be careful of contradictions or conflicts.

Look at the last example given above. A simple table without sentences would be quite adequate to gain all the marks for this question. You would do well to produce a table such as the following.

Flower part	Function
Sepals	Protect the developing flower
Petal	Attract animal pollinators
Anther	Part of male stamen that produces pollen
Stigma	Sticky part of female pistil that receives the male pollen
Ovary	Base of the female pistil or carpel in which female sex cells develop and fertilization occurs

The parts placed in the table would vary depending on the number of marks assigned to the question. Notice the brevity of answers. Sentences and even paragraphs could be used here to get full marks. However, doing so may present problems with completing the exam within the time limits.

Chapter 10: Genetics and evolution

Distinguish

Differentiate between two or more different objects, structures, or details.

Example

Distinguish between mitosis and meiosis.

Guidance

Students often miss out on getting full marks for questions that involve the command term **distinguish** because they tend to **describe** each item rather than answer the question. This can also be the case with the command term **compare**.

You must know that the command term **distinguish** is asking only for the differences between items (whereas the command term **compare** asks you to give the similarities). You must also know, for each difference, that it is important that each sentence in your answer refers to both of the named items.

For example, if item A is being distinguished from item B, you should write sentences along the lines of: *A is* _____ *whereas B is* _____. Other useful generic sentence structures include: *A is faster/slower than B*. *A has a higher/lower value than B*. *A is more/less likely to happen than B*.

Many students write *A is* _____. and then another sentence saying *B is* _____. Such a structure is more compatible with the command term **describe** than the command term **distinguish**.

To answer the example question above, you should include sentences such as the following.

- Mitosis is for growth and repair of cells, whereas meiosis is reserved for the production of gametes.
- Mitosis generates 2 diploid daughter cells that are identical to each other, whereas meiosis produces 4 haploid daughter cells that are different from each other.
- Mitosis produces somatic cells, whereas meiosis produces gametes (sex cells).
- Mitosis can happen almost anywhere in the body, whereas meiosis only happens in the reproductive organs.

Notice how each sentence in the answer uses both the terms *mitosis* and *meiosis*. There are no sentences with only one of the terms.

Are tables useful?

Sometimes the IB accepts a **distinguish** answer in the form of a table like this one.

Aspect to distinguish	Mitosis	Meiosis
Purpose	for growth and repair of cells	for sexual reproduction
Number of cells produced	2	4
Amount of genetic information in daughter cells	diploid	haploid
Category of cells produced	somatic cells	sex cells (gametes)
Where it takes place	all over the body	only in the reproductive organs

However, this format is probably better suited to a short-answer question than an essay question. For an essay question, a table like this could be used as a rough draft when preparing your answer but you should write out your actual answer in prose, making each row of the table into a sentence.

Chapter 11: Animal physiology

Describe

Provide all relevant information in furnishing a justification or explanation.

Example

Describe the production method for monoclonal antibodies.

Guidance

In this particular example you are being asked to provide relevant information in furnishing an explanation of a process. You could **describe** the steps of this very long process by using only a paragraph(s)-style response or you could consider including a diagram or flowchart of the process in addition to your paragraph(s).

An appropriate response to the above question is given below.

Monoclonal antibodies are antibodies produced by a cell culture where each and every cell is producing and secreting the exact same antibody. In order to produce these pure cell cultures the following steps are followed. An antibody type is selected, typically for a research or diagnostic purpose. This explanation will follow the production of antibodies that recognize the hormone being produced only in the early stages of a pregnancy; that hormone is HCG. HCG is injected into a laboratory animal (e.g. a mouse) and the laboratory animal is allowed time to have a primary immune response against the HCG (HCG is acting as an antigen). Following this time period, the spleen of the animal is removed and a variety of B leucocytes are removed from the spleen. These B cells are grown in culture bottles along with a cancerous cell type known as a myeloma. Under the right conditions a few of the leucocytes will fuse with a myeloma to create a cell type known as a hybridoma. Hybridomas have characteristics of both of the cell types that they originated from. They produce and secrete a particular antibody and they also are very 'long-lived' cells capable of nearly unlimited cell divisions.

Each hybridoma cell is cultured in its own liquid medium to create multiple clones of the same cell type. Each culture is then tested with a diagnostic test known as ELISA to determine which culture bottle(s) contains a pure cell type that is producing the antibody desired. In this example, it would be a culture producing an antibody called anti-HCG that binds to the hormone HCG. This antibody then becomes the diagnostic basis of EPTs or Early Pregnancy Tests.

Chapter 12, Option A: Neurobiology and behaviour

Draw

Use a pencil to represent what is requested. Always add labels unless directed not to do so.

Label

When not used with the 'draw' command term, it means to affix labels to a visual representation.

Annotate

Provide short critical or explanatory comments. It is usually applied to a graph or diagram.

Examples

Draw and **label** the human brain, including the medulla oblongata, cerebellum, hypothalamus, pituitary gland, and cerebral hemispheres.

Label a diagram of the structure of the human eye.

Annotate a diagram of the retina to show the cell types and the direction in which the light moves.

Guidance

Practise how to **draw** and **label** the human brain, including the medulla oblongata, cerebellum, hypothalamus, pituitary gland, and cerebral hemispheres. Learn the functions of the parts while you are learning to draw them. Make your drawing at least the size of one-third of a page. **Draw** and **label** in pencil and write neatly. Be careful when you draw a line to label a part.

Learn to **label** the following diagrams. Use the diagrams in your textbook as a reference. Cover the labels and practise writing them. It is typical for one of these diagrams to be in paper 3. They are easy to learn if you practise.

- A diagram of the human eye, including the sclera, cornea, conjunctiva, eyelid, choroid, aqueous humour, pupil, lens, iris, vitreous humour, retina, fovea, optic nerve, and blind spot.
- A diagram of the ear, including the pinna, eardrum, bones of the middle ear, oval window, round window, semicircular canals, auditory nerve, and cochlea. Explain how sound is heard by using the eardrum, bones of the middle ear, oval and round windows, and the hair cells of the cochlea.
- A diagram of the brain, including the medulla oblongata, cerebellum, hypothalamus, pituitary gland, and cerebral hemispheres. Learn the functions of each part.

Annotate a diagram of the retina. This means to **label** the rod cells, cone cells, bipolar neurones, and ganglion cells, and show the direction in which light moves. You must also be able to **compare** rod cells and cone cells in a comparison table.

Chapter 13, Option B: Biotechnology and bioinformatics

Outline

Indicate the principal features of a requested topic. Be concise.

Example

Outline the use of a viral vector in gene therapy. (3)

Outline the method by which recombinant DNA can be placed into plants. (6)

Outline the emergent properties of biofilms. (6)

Guidance

Questions using the command term **outline** are found in Paper 3. You are expected to know a series of facts to answer the question fully. Answers can be in the form of bulleted points. Full sentences are not required for complete marks to be given.

Example questions and answers

Outline the use of a viral vector in gene therapy. (3)

You are expected to give at least 3 facts to answer this question. You can give more than 3 facts to make sure you have given enough information to be awarded all 3 points present in the mark scheme. If you need more room than that given on the test paper you can write on other sheets given to you during the exam. Make sure to refer to the exact question you are answering.

- Gene therapy involves the replacement of defective genes.
- Viral vectors are modified for safe use.
- The desired gene is inserted into the viral genome.
- An example is the use of SCID.
- The desired gene is inserted into the target cell.
- The cells are replaced into the patient so that the desired gene can be expressed.

Outline the method by which recombinant DNA molecules can be placed into plants. (6)

You are expected to give at least 6 facts to answer this question. You can give more facts to make sure you have given enough information to be awarded all 6 points.

- Introduce the 'recombinant DNA' (target gene from another organism + plasmid DNA) into a bacteria such as *Agrobacter.*
- Put it into leaf discs.
- For example, discs removed from tobacco plants are incubated with the genetically engineered *Agrobacter* for 24 hours. Eventually the plant cells will acquire the DNA from the bacteria.
- Insert it into whole plants.

- Submerge the plant in a bacterial solution containing the modified plasmid. Apply a vacuum to help force the bacterial solution into the air spaces between the plant cells. *Agrobacter* will move the plasmid into many of the cells of the plant.
- Insert it into protoplasts.
- Electroporation and microinjection use protoplasts, which are plant cells without the cell wall.
- Biolistics coats particles with DNA and fires them right through the cell wall.

Outline the emergent properties of biofilms. (6)

The emergent properties of biofilms include the following.

- A complex architecture.
- Microorganisms attach to barren substrates. As they join together in colonies, a more stable attachment is formed and the cells begin to produce EPS or extracellular polymeric substances.
- Quorum sensing.
- The first few bacteria make signalling molecules called inducers.
- Other bacteria have receptors that receive the signal of the inducer. The bacteria that received the first message then make even more inducer.
- Soon the quantity of inducer in the population is high. This stimulates the bacteria in the population to transcribe their genes all at the same time.
- A very strong biofilm of cells and matrix are made as a result of all the cells working together.
- Resistance to antimicrobials. Biofilms are very resistant to antimicrobial agents.

Chapter 14, Option C: Ecology and conservation

Discuss

Present a detailed account including a range of possibilities, such as in an argument. Account for the importance of different factors or various hypotheses supporting these possibilities.

Examples

Discuss the use of DDT as an insecticide.

Discuss the impacts of alien species on ecosystems.

Guidance

Questions using the command term **discuss** are asking you to describe a specific occurrence and mention a range of arguments. Try to present something on both sides of the issue.

Example questions and answers

Discuss the use of DDT as an insecticide.

Benefits of not using DDT as a pesticide:

- peregrine falcons are off the endangered species list
- there is less DDT in the breast milk of nursing mothers
- there is a decline in DDT present in samples of human blood.

The harm caused by the ban of DDT as a pesticide in many countries:

- hundreds of mosquitos carrying diseases such as malaria can enter houses in Africa
- malaria is more of a problem in some nations than HIV
- malaria devastates large populations of people in tropical countries.

Discuss the impacts of alien species on ecosystems.

Alien species can be introduced into an ecosystem as an environmentally friendly alternative to chemical control. In 1987 the National Academy of Sciences in the USA argued that biological control or introduction of a non-native (alien) species should be the primary method of pest control. This is preferable to using chemicals that can damage the environment. However, there is always a risk when introducing a new organism into an ecosystem. Unexpected consequences may occur even though rigorous testing is carried out beforehand.

The cane toad was brought to Queensland, Australia, to control the beetles eating the sugar cane crops. Because this had previously been done in Hawaii, it was thought it would be a safe introduction of an alien species. Unfortunately, a risk assessment for Australia was not carried out and the cane toad multiplied very rapidly, outcompeting and predating on native species. It did not control the sugar cane beetles but became an even bigger pest than the beetles.

Chapter 15, Option D: Human physiology

Deduce

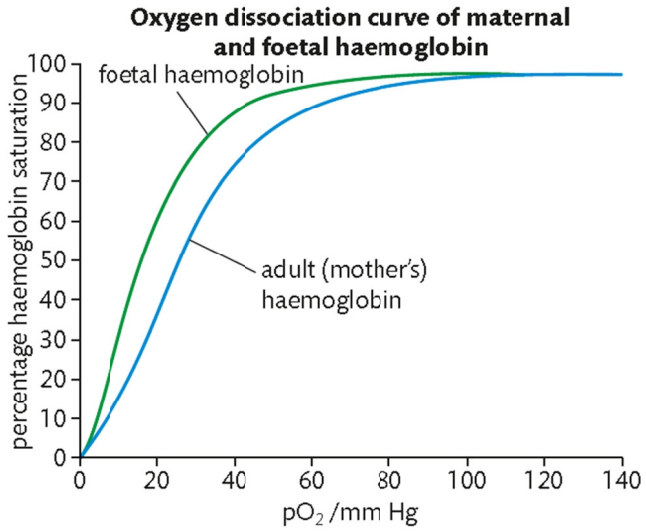
From data given, reach a justifiable conclusion.

Example

Given an oxygen dissociation curve showing both maternal and foetal haemoglobin, **deduce** the relative affinity of each type of haemoglobin for oxygen.

Guidance

In this example, you would be given a graph similar to the one shown below.



Deduce requires you to give a justifiable conclusion. Thus a good way to provide this justification is to use the graph to give support to any conclusion. One way to lend support is to use the intersect points of both lines of the graph. When the blood gets to body tissues (in capillaries), this is where oxygen is either retained by the blood or given up (dissociated). The typical partial pressure of O_2 within these capillaries is a little less than 40 mm Hg. If you draw a line up from around 38 mm of Hg and then get to the intersect of both the maternal and foetal haemoglobin lines, you can see that:

- approximately 85% of foetal haemoglobin has retained all of its oxygen
- approximately 70% of maternal haemoglobin has retained all of its oxygen.

This shows that foetal haemoglobin has a higher affinity for oxygen than maternal haemoglobin. This relates well to the idea that, in the capillaries of the placenta, if oxygen molecules are released, the foetal haemoglobin is the one that more often binds to them because this is the only source of oxygen for the developing foetus. In short, the graph shows that foetal haemoglobin has a higher affinity for oxygen compared with the mother's haemoglobin.