

Short Answer Questions

The Living Cell Macromolecules

2001

Write short notes on polysaccharide diversity and disulphide bonds in proteins.

2002

Draw a diagram to illustrate the relationship between K_m and V_{max} . How would this diagram be altered by the presence of a competitive inhibitor?

What is glycogen and how is it synthesised?

2003

What is the role of Coenzyme A in metabolism?

2004

What are the main components of the cell wall of plants, fungi and bacteria?

Write short notes on

- i) The potential for variability in polysaccharide composition
- ii) Irreversible enzyme inhibition

What properties of glycogen make it a good energy store in the cell?

2005

Write short notes on

- i) Ramachandran Plots
- ii) Allosteric enzymes

What is metabolomics and what are the major technologies used in this approach?

2006

Write short notes on both

- i) Chiral compounds
- ii) Competitive inhibition of enzymes

2007

What are the advantages of near-equilibrium enzymatic flux transfer?

Draw the linear forms of the D and L enantiomers of glucose. Which chiral centre determines whether glucose is in the D or L configuration? What new chiral centre is formed in the cyclic form of glucose and which enantiomer is more stable?

2008

Why are starch and glycogen curved while cellulose is linear, and how does this reflect their functions?

2009

Glycogen, starch and cellulose are all polymers of glucose. How are they different?

What is the difference between the way beta hairpins and alpha hairpins are held together?

2010

Sketch the titration curves for aspartic acid and alanine, and explain the difference between them.

2011

Sketch the energy diagram for an exergonic reaction. Include in your sketch the reaction for the same reaction catalysed by an enzyme. Briefly explain how enzymes help to drive endergonic reactions.

2012

What is the molecular basis for the differences between starch, glycogen and cellulose?

Why is the peptide bond planar? What stereoisomer does it normally form and why?

2013

Briefly compare and contrast the chemical structure of DNA and RNA.

How and why do proline and glycine differ from other amino acids in a Ramachandran plot?

2014

Use a diagram to describe how you would distinguish an enzyme that is allosterically controlled from one that obeys Michaelis-Menten kinetics.

Explain why uracil is one of the four bases in RNA, but DNA contains thymine instead.

Membranes

2014: (d) Briefly, describe an experiment that tests for rotational movement of FATPase sub-units.

2013: (d) Suggest an experiment that could be used to detect lateral mobility of an integral protein in the cell membrane of a eukaryotic cell.

2012: (d) How do sterols aid membrane stability?

2011: (c) Use an annotated diagram to explain how transport of glucose from the intestinal lumen across an epithelial cell is achieved.

2010: (c) Draw an annotated diagram describing the structural diversity in membrane phospholipids.

2010: (d) What are the roles of “signal sequences” and “stop transfer sequences”?

2009: (d) What is the experimental evidence that F-type ATPase alpha and beta subunits rotate?

2008: (c) Tabulate the differences between active and passive transport of solutes across membranes.

2008: (d) Draw a labelled diagram illustrating the main types of association between proteins and membranes.

2007: (d) How do the unsaturated fatty acids affect the phase transition temperature of a membrane?

2006: (c) Describe three ways in which proteins associate with membranes.

2005: (d) Describe the role of clathrin in endocytosis.

2004: (a) Describe briefly two rotary structures embedded in cell membranes (at least partly membranes, F-type ATPases, or V type)

2004: (d) Which characteristics distinguish facilitated diffusion from primary active transport?

2003: (c) Why is ATP a good source of potential chemical energy in the cell? Name two pathways which are used for ATP production.

2003: (i) Define the differences between passive transport and active transport, giving examples of each.

2002: (d) How is the transport of water across cell membranes distinct from the transport of solutes?

2001: (c) Define "active transport" and give an example of a transporter that mediates active transport

2001: (m) ATP frequently couples energy-requiring reactions in the cell to those that produce energy. Why is ATP well suited to this role?

Chemistry of Life

2014 (e) Outline the likely journey of a nitrogen atom from the atmosphere to a beef sandwich.

(f) In metabolism what are activated carriers and why are they so common in metabolic pathways?

2013 (e) Briefly describe the major differences between photosynthesis and respiration.

(f) Discuss the statement that "in mammals glucose cannot be synthesised from fat".

2012 (e) Briefly discuss why, in mammals, the conversion of pyruvate to acetylCoA is an important regulatory step.

(f) Outline three different strategies used by living organisms to capture energy from their environment.

2011 (d) How does the intermembrane space of the mitochondrion differ from the mitochondrial matrix?

(e) Briefly discuss why the conversion of glucose to glucose 6-phosphate is an important regulatory step in glycolysis.

(f) Describe the interconversion of photons, quanta and energised electrons during photosynthesis.

2010 (e) How does the chloroplast stroma differ from the thylakoid lumen?

(f) Discuss how the structure of pyruvate dehydrogenase contributes to its catalytic function.

2009 (e) What are the common features of electron transfer systems in chloroplasts and mitochondria?

(f) What features of the structure of pyruvate dehydrogenase are important for its catalytic function?

2008 (e) What is functional Magnetic Resonance Imaging (fMRI) and how is it used to monitor metabolism in the brain? [not sure this is still on the syllabus]

(f) Sketch the events in a photosystem, from the absorption of a photon to the loss of an electron, indicating their timescales.

2007(e) Draw a labelled diagram of the orientation of the components of the electron transfer chain and the ATP synthase in mitochondria. Show the passage of protons.

(f) Describe how Glucose Transporter 4 (GluT4) controls glucose entry into the cell in adipose and muscle tissues.

2006 (e) Describe cyclic electron flow in chloroplasts.

2005 (e) What is nitrogenase, what does it do, and where is it found?

(f) What is metabolomics and what are the major technologies used in this approach?

2004 (e) Describe the pathway used by plants to assimilate NO_3^- into amino acids.

(f) What properties of glycogen make it a good energy store in the cell?

2003 (b) What does the abbreviated enzyme name 'Rubisco' stand for, and what reactions does it catalyse?

(c) Why is ATP a good source of potential chemical energy in the cell? Name two pathways which are used for ATP production.

(d) What is the role of Coenzyme A in metabolism?

2002 (i) Identify the processes whereby cells generate NADPH from NADP⁺.

2001 (m) ATP frequently couples energy-requiring reactions in the cell to those that produce energy. Why is ATP well suited to this role?

(o) Briefly explain how non-photosynthetic cells make NADPH. Why do they need to?

Hunting The Gene (Summers)

2014: (g) Petite mutants in yeast can be nuclear or cytoplasmic. What pattern of inheritance would you expect in the case of (i) nuclear and (ii) cytoplasmic mutations?

2013: (g) Describe three mechanisms of horizontal gene transfer in bacteria (i.e. mechanisms by which genes can be transferred, directly or indirectly, from one bacterium to another). Which is likely to be the most efficient in the natural environment? Justify your answer.

(h) Give TWO examples of how the study of bacteriophages contributed to our understanding of genetics in the second half of the twentieth century.

2012: (g) Describe briefly two experimental observations made by geneticists during the first half of the 20th century that appeared to contradict Mendel's view of inheritance. In each case state clearly which specific aspect of Mendel's hypothesis is being challenged.

Relevant? (h) Which two pieces of experimental evidence were instrumental to the development of Watson and Crick's model of B-form DNA?

2011: (g) Pre-Mendelian theories suggested that inheritance involved either irreversible mixing of the characteristics of the two parents (Hippocrates), or that information came from the male and raw materials from the female (Aristotle). Describe experiments performed by Mendel which demonstrated that both theories were wrong.

2010: (g) Outline briefly the experimental approaches used by Seymour Benzer to (i) construct a genetic map of the rII region of bacteriophage T4 and (ii) determine how many genes were present in this region.

(h) What is the main role of restriction endonucleases in nature? Explain, briefly, how restriction endonucleases enable cloning technology.

2009: (g) What are the main differences between mitosis and meiosis?

(h) Briefly describe how bacteria can acquire new DNA.

2008: (g) List three different mechanisms by which bacteria exchange genes. Considering the relative exposure of transferred DNA to chemical and physical hazards in each case, comment on the likely effectiveness in nature of these mechanisms of exchange.

(h) How are the genomes of retroviruses replicated?

2007: (g) Cite two pieces of experimental evidence obtained during the first two decades after the rediscovery of Mendel's work contradicting Mendel's assertion that reciprocal crosses give the same result.

2006: i) What are the main differences between mitosis and meiosis?

k) What is the role of restriction endonucleases in bacteria? Explain briefly how the properties of these enzymes can be exploited to allow a foreign gene to be cloned into a bacterial plasmid.

2005: (g) What are petite mutants of yeast? How does genetic analysis of these mutants reveal whether the mutation occurs in the nuclear or mitochondrial genome?

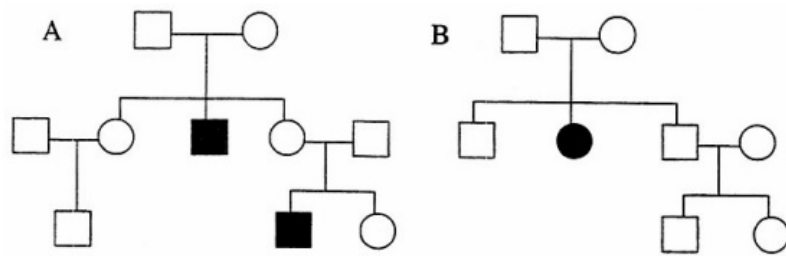
(h) Write short notes on gene transfer by:

(i) Conjugation.

(ii) Transduction.

2004: (g) How is genetic dominance defined? Describe Mendel's observations and conclusions on the nature of dominance and explain how these have come to be modified in the light of further research.

2003: (f) Pedigrees A and B show symbolically the inheritance patterns of Cystic Fibrosis and Type VIII Haemophilia in two different families. Which pedigree corresponds to which trait, and why do these traits show different patterns of inheritance?



(g) Describe the experimental technique employed by Seymour Benzer to map mutations responsible for the rapid-lysis (rII) phenotype in bacteriophage T4.

2002: (g) What strategies are used for replication of viral RNA?

(h) Why is meiosis important for sexual reproduction?

2001: (g) Write short notes on bacterial conjugation.

(h) What experiments would you do to test for cytoplasmic inheritance?

Genes in Action

2014 (h) How does a eukaryotic cell pack two metres of DNA into the nucleus?

(i) Describe the role of sigma factors in promoter recognition in prokaryotes.

2013 (i) Describe the structure of the nucleosome

2012 (h) Which two pieces of experimental evidence were instrumental to the development of Watson and Crick's model of B-form DNA?

(i) Describe the "loop" (also known as the "trombone") model for DNA replication in *E. coli*.

2011 (i) Briefly outline the post-transcriptional processing events that take place during the generation of eukaryotic mRNA.

2010 (i) Briefly, describe the key experimental observation that proved that the synthesis of the lagging strand during DNA replication is discontinuous.

(j) What does telomerase do and why is its activity important in eukaryotic cells?

2009 (i) Explain DNA footprinting and its use.

2008 (i) How do attenuators regulate transcription in bacteria?

2007 (h) What is the experimental evidence showing that DNA replication is semiconservative?

(i) Briefly explain how DNA lesions arise even in the absence of external chemical or physical influences.

2006 (h) How was the triplet nature of the genetic code proven?

(j) Why is a DNA topoisomerase ("DNA gyrase") necessary for DNA replication?

2005 (i) How was the RNA polymerase binding site identified in bacterial promoters?

2004 (i) Replication of the E. coli genome is believed to be semi-conservative, semidiscontinuous and bi-directional. What is meant by these three terms?

2003 (j) List the ways in which the nucleotide sequence of a eukaryotic mRNA may differ from the DNA that encoded it.

2001 (b) Describe the characteristics of telomeres

(d) Outline the role of protein kinases in mitotic control. (mentioned)

Genetic Revolution

Cell Signalling

2014: (n) Describe how quorum sensing controls bioluminescence in *Vibrio fischeri*

(o) Briefly describe two examples of signalling processes in eukaryotes that use cytosolic receptor proteins to detect the initial stimulus molecule.

2013: (o) What are DELLA proteins?

2012: (o) How are pseudopodia localised appropriately in the *Dictyostelium* chemotaxis response?

2011: (o) Describe an abscisic acid receptor of plants

2010: (m) What is quorum sensing? Provide an example.

2009: (o) Outline the different distances over which intercellular signalling can occur. Give examples of signalling molecules that act at each scale of distance.

2008: (m) What are the key steps whereby phytochrome regulates photomorphogenesis in plants?

2007: (m) Describe the mode of action of monomeric G proteins.

2006: (l) How does abscisic acid induce closure of stomata?

2005: (m) The emission of light by the marine bacterium *Vibrio fischeri* is only induced when a bacterial population reaches a critical cell density. Describe the population size sensing system of *V. fischeri*.

(n) Describe how cAMP acts as the aggregation stimulus in *Dictyostelium discoideum*.

2004: (m) How does phytochrome mediate responses to the environment?

2003: (h) List the ways in which steroid hormone signalling differs from other cell signalling pathways.

2002: (j) What are the elements of an intercellular signalling pathway? Illustrate your answer with 3 examples.

2001: (f) What are second messengers and what role do they play in signal transduction pathways?

Cell Proliferation

2001 (d) Outline the role of protein kinases in mitotic control.

(f) What is programmed cell death and why is it important?

(g) What strategies are used for replication of viral RNA?

(m) What are the steps that may occur in the conversion of a normal cell to a tumour

(l) Compare the modes of host cell transformation by RNA and DNA tumour viruses.

(k) What are stem cells and why are they important?

- (l) What are tumour suppressor genes and how are they linked to cancer?
- (f) What is programmed cell death and why is it important?
- (g) Give two examples of how eukaryotic viruses promote translation of their own mRNAs at the expense of the host cell mRNAs.
- (l) How is cell cytoplasm divided in two in plant and animal cells during mitosis?
- (l) List the mechanisms which are involved in (i) separating chromosomes and (ii) dividing cells during mitotic division.
- (k) What are tumour suppressor genes? Why is mutation of these genes damaging?
- (d) Outline the role of protein kinases in mitotic control.
- (h) How are the genomes of retroviruses replicated?
- (k) What are the functions of cyclins?
- (l) What are stem cells and why are they important?
- (l) What are oncogenes?
- (a) Using diagrams, illustrate the structures that bring about cytokinesis in (i) an animal and (ii) a plant cell.
- (k) Outline the role of protein kinases in mitotic control.
- (l) Describe connections between viruses and cancer.
- (n) What is a fate map? Illustrate with two annotated examples.
- (l) Give examples of how viruses alter the host cell cycle.
- (l) How do genomes of animal and plant viruses encode enough information to make virus particles and damage the host cell?
- (k) How is entry into mitosis regulated in eukaryotic cells?
- (k) How does p53 function as a tumour suppressor?
- (l) Describe three methods that can be used to detect apoptotic cells.

Development