The Cell Cycle

\* Describe the cell cycle, with reference to DNA and protein synthesis and control mechanisms and highlight the main differences between various tissues.

\* Describe the mechanism of apoptosis and differentiate it from necrosis.

\* Understand the role of apoptosis in development.

\* Describe the main signalling pathways that regulate gene activation and protein synthesis. Understand the role of oscillating signals.

\* Understand the concepts of tumour suppressors, proto-oncogenes and cytoprotective pathways.

**The Cell Cycle and its Regulation**

* Describe the cell cycle in terms of the named phases (G0, G1, G2, S, M) and explain what these mean in terms of protein and DNA synthesis.
* Identify (or sketch or describe) the named stages of mitosis.
* Explain the importance of checkpoints in controlling progression through the cell cycle, and give examples of external factors, which provide signals allowing cells to pass these checkpoints and enter cell division.
* Describe the way the cell cycle allows decision making about whether a cell divides, differentiates or undergoes programmed cell death (apoptosis).
* Introduce the principle of the molecular timing process which regulates the cell cyclethrough oscillating amounts or activities of cyclins and their kinases

**Signalling Mechanisms in Growth and Division and Apoptosis .**

* Explain how ligands which activate tyrosine kinase receptors signal through the small G protein, Ras, to activate the extracellular signal-regulated kinase (ERK) cascade.
* Describe how the ERK cascade pathway regulates gene expression and leads to progression through G1 of the cell cycle.
* Explain how mutagenic alteration of cell growth regulatory genes (oncogenes and tumour suppressors) can lead to cancer.
* Describe how the cell cycle is regulated by interactions between cyclins, cyclin- dependent kinases and inhibitor proteins.
* Explain in molecular terms the mechanism of action of the retinoblastoma (Rb) susceptibility tumour suppressor gene product.
* Explain how apoptosis can limit inappropriate cell division and discuss the role of cytoprotective pathways (e.g. the phosphoinositide 3' kinase pathway) in facilitating cell proliferation.
* Explain the difference between necrosis and apoptosis and describe how they may be differentiated.
* Discuss whether necrosis and apoptosis are the only forms of cell death.
* Describe the proteolytic caspase cascades which execute the apoptotic response.
* Discuss how apoptosis may be mediated through death receptors and/or mitochondria.
* Discuss how Bcl-2 family proteins can modulate apoptosis.

**DNA Damage and Repair, and the Genetic Factors Underlying Cancer**

* Describe the ways in which DNA can be damaged by exposure to radiation or chemicals (carcinogens) and the role metabolism can play in these reactions.
* Outline in general terms the role of p53 in the detection of and response to DNA damage.
* Summarise the natural repair mechanisms for damaged DNA.
* Explain how unrepaired or misrepaired DNA damage can become “fixed” as a mutation..
* Summarise how the potential of a chemical/agent to damage DNA can be assessed.
* Describe the relationship between mutations, cancer and genetics and what distinguishes hereditable predisposition to cancer.

**Oncogenes and Tumour Suppressors.**

* Define the terms protooncogene, oncogene and tumour suppressor gene.
* Explain how a protooncogene can be activated to an oncogene.
* Explain with an example how conversion of a protooncogene to an oncogene can lead to disruption of tightly controlled pathways in the cell.
* Describe with an example how rare heritable cancers have led to an understanding of the type of cancer-causing gene called a tumour suppressor.
* Summarise the role of the tumour suppressor gene p53 in cellular decision making.
* Using colon cancer as an example, describe the way in which successive gene mutations are thought to lead to clinical cancer.