CHAPTER 2

1) A syncytium is a collection of nuclei that share a cytoplasm. In the case of the *Drosophila* embryo it is a collection of all the nuclei that share the whole cytoplasm of the egg. You need to discuss how this allows for gradients of molecules to be easily established across the embryo to influence the activity of the individual nuclei.
2) A segment is a unit that is repeated along the length of an organism. This allows the generation of different structures in different segments in an autonomous manner by specific programmes of gene expression. You should relate this to Hox genes. Humans have segments; discuss spinal cord and muscles and relate to Hox genes and *Drosophila*.
3) Discuss pattern of cuticle in larva and how it allows searching for mutations that alter it. Describe the differences between zygotic and maternal screens (look up in a genetics textbook if necessary).
4) Discuss maternal products that set up the axis, how these lead to gap genes, and how the combination leads to segmentation.
5) Discuss the contrast between a gradient of a transcription factor established by diffusion (Bicoid-anterior/posterior) with a gradient of transcription factor activity (Dorsal) which results from a gradient of receptor activity (Toll) triggered by a gradient of ligand. Discuss thresholds and mechanisms.
6) This will require an explanation of the workings of transcription factors, the concept of affinities and how these can determine very sharp cut-offs for the activity of transcription factors.
7) Describe diffusion, the limits of diffusion to generate sharp cut-offs, and how one can get a gradient of ligand activity from a uniform distribution of a ligand.
8) This will require an understanding of, and an introduction to, transcription and how it is possible to define spatial domains of gene expression through combinations of transcription factors as determined by their binding sites. You should look up the details of eve stripe 2 if you need to.
9) You should introduce the notion of the 'selector gene', and how this relates to pattern, and integrate this with the notion that *engrailed* encodes a transcription factor and how its restricted expression in the posterior compartment of every segment, leads to the activation of genes specific to that region.
10) In segmented organisms, the basic pattern allows for segment specific patterning mechanisms to be in operation. A homeotic transformation results in the programme of one segment being activated inappropriately in another segment with morphological consequences. Mention and discuss homeotic genes.
11) Describe the morphology of the fly, in the embryo and the adult, and how every segment is different. Then show how loss of function mutations in the bithorax complex result in the transformation of one segment into another; normally of a more posterior segment into a more anterior one. Conversely, gain of function experiments result in the reverse transformation: from anterior to posterior. Describe how there are three transcription factors in the bithorax complex with defined but overlapping patterns of expression and how the genetic analysis of each and of the complex as a whole reveals that they work combinatorially by the nature of the phenotypes that one can obtain.