CHAPTER 6

1) Asymmetry in terms of the phenotypic outcome of the division and not in terms of the size of the daughter cells. One can have equally sized cells that do different things. The first division of *C. elegans* leads to two cells that will give rise to different parts of the worm through their daughters.
2) This requires a description of regulatory RNAs, how they work and, as indicated, attention to describe what is an experimental device and what is a natural product.
3) You should introduce the notion of determinants, proteins whose function is to determine the fate of the cells, and how in many cells, they are homogeneously distributed before a cell divides but become asymmetrically distributed when the cell divides. In the case of *C. elegans* this is clear in the first cell division when the alignment of the spindle during the first division results in the asymmetric distribution of a number of proteins -determinants-, to either pole of the dividing cell. As a result, there are two cells which will become different; one will be anterior (AB) and the other posterior (P). PAR stands for Partitioning defective, and represents a collection of proteins (PAR1-6) in *C. elegans* that are essential for the symmetry breaking event during the first division of the embryo. They code for cytoskeleton associated proteins and protein kinases which control fate determining proteins. They are conserved in all animals.
4) Go through the lineage. MS means that the cell gives rise to a mesodermal cell; p and a means that the cell results from anterior posterior division of a cell (convention). The sequence paapaaa indicates that the cell is derived from the P cell in the first division and then is derived from the posterior cell (p) of the division of the P cell, the anterior (a) cell of the division of the Pp cell, the anterior (a) cell of the division of the Ppa cell… and so on. The same can be reasoned for the apoptotic cell MSpaapp.
5) GLP-1 is a homologue of the Notch receptor and APX-1 is a homologue of its ligand Delta. These are elements of a highly conserved signaling system involved in establishing differences between otherwise similar cells. The signaling system operates early in the development of *C. elegans*, when the embryo has 4 cells: ABa and ABp derived from the AB cell, both of which express GLP-1, and EMS and P2, derived from P with P2 expressing APX-1. The arrangement of the cells means that P2 is next to ABp and signals to it, activating GLP-1 and specifying the ABp fate, and thus establishes a difference between dorsal and ventral cells with ABp being dorsal. The name of the mutant is derived from the observation that in the absence of APX-1, the ABp cell is not specified and this leads to an excess of anterior pharyngeal muscle cells.
6) They are genes that when mutated result in alterations in the timing of developmental events – a process/fate decision takes place earlier or later than it should. The deterministic lineage of *C. elegans* at the single cell level make it very appropriate for the identification of these mutations.
7) Write a diagram of the relationships between lin-4 transcription and translation and the effect that this has on the L1-L2 transition, then place the miRNA in the diagram with its effect on the process and work out the effect of the loss of function in lin-4 and the lin-4 miRNA.
8) Go to Figure 6.18 and remember that LIN-3 is EGF and LIN-12 is Notch.
9) That the site of invagination during gastrulation becomes the aboral/anal end rather than the mouth i.e. anus and mouth have separate origins.
10) Both have an animal and a vegetal pole and the first two cleavages are perpendicular to each other in both cases but the distribution of the yolk on the vegetal side, in the *Xenopus* egg (denser and more abundant than in sea urchins) means that the cleavages are incomplete on that side. There are similarities and differences. In both instances there is ß-catenin in the vegetal side but while in sea urchins it gets activated in situ (Fig. 6.25), in *Xenopus* it gets activated due to a rotation of Wnt ligands to the prospective dorsal side (see Fig. 4.3). Regulative development means that the loss of part of the embryo is recovered. This is true in both cases, as long as the cut/cleavage is done across the

animal/vegetal axis (two full embryos will emerge) but not if it separates the two halves (two aberrant embryos will ensue).

11) Elimination of the micromeres early on leads to abnormal development. Most significantly, the animal cap on its own will give rise to a group of disorganized epidermal cells but when placed in contact with the micromeres, a full embryo develops. See also Fig. 6.23.

12) Work from Figures 6.25 and several in Chapter 4, particularly 4.18.