Answers to Workbook exercises Chapter 21

Exercise 21.1 Pectinase

a Any three from: they are very small and therefore easy to grow in large numbers; there are no ethical issues associated with their use; they have the same type of genetic material as other organisms (including humans); they have plasmids, which can be used to move genes from one organism to another; *accept other valid reasons*.

b Fungi

c the antibiotic, penicillin

d i The most likely choice of display is a bar chart. (A line graph would not be suitable, because the substrate is a discontinuous variable.) 'Substrate' should be on the *x*-axis. 'Production of pectinase / arbitrary units' should be on the *y*-axis, with a suitable scale with equally spaced intervals, ranging from 0 to 1500. Students may have six equally-spaced bars for the six types of substrate, but a better choice would be to have the bars for wheat bran and wheat bran + sugar cane bagasse next to each other (these could be touching), and the same for the other two pairs. Each bar could be separately labelled, or one of each of the pairs could be shaded to indicate that it includes sugar cane bagasse, and a key given to explain what the shading means.

ii If the waste materials are not used, then they have to be disposed of. They might pollute waterways, causing eutrophication (as they are likely to contain nutrients that could be used by bacteria, which would then use up a lot of oxygen as their increased populations respire.) Also, if waste materials are not used, then other plant material would have to be used to make the pectinase, which means more land would be used for growing plants that might otherwise be used for growing food, or for habitat for wildlife.

e Pectinase breaks down the pectin that holds together the cells in the fruit. This makes it faster and easier to extract the juice, and also increases the total yield of juice from a given mass of fruit. Pectinase also helps to make cloudy fruit juices clear.

Exercise 21.2 Yoghurt

a Yoghurt is made from milk. Bacteria convert the lactose in the milk to lactic acid, which is an acid and therefore has a pH below 7.

b Perhaps the bacteria were continuing to change more lactose to lactic acid.

c The changes in pH are all very small. The greatest change is in the yoghurt that did not contain stabilisers, where the pH fell by 0.5 (from 4.1 to 3.6). The changes in the other three experiments were even smaller.

d In the past, yoghurt was consumed soon after it was made, so it did not have time to separate. Nowadays, it is transported long distances so it is not consumed as soon after manufacture. The table shows that untreated yoghurt has separated to a value of 7.9 by only five days after manufacture, and to a value of 21.1 after 15 days. Adding stabilisers slows down separation, so the yoghurt is probably more pleasant to eat after being transported.

e Cornstarch worked best. The yoghurt to which cornstarch had been added only separated to a level of 6.9 after 15 days, which is lower than untreated yoghurt and the yoghurts to which pectin or carrageenan were added.

f The volume of stabiliser added to a fixed volume of yoghurt; the temperature at which the yoghurt was kept; the batch of yoghurt that was used (so the milk had exactly the same composition).

Exercise 21.3 Golden Rice

a Restriction enzymes would be used at step 1.

b i Sticky ends are unpaired lengths of DNA (i.e. just a single strand).

ii The bases on the sticky ends of two pieces of DNA will pair up with each other, as long as the unpaired bases are complementary to each other. This enables the joining of the DNA of the plant genes with the DNA of the plasmids.

c DNA ligase would be used at step 2.

d The plasmids are used to transfer the genes from the daffodils and *Erwinia* into *Agrobacterium*.

e *Agrobacterium* naturally infects plant cells, so it was able to carry the plasmids carrying the genes from the daffodils and *Erwinia* into the rice cells.

f With selective breeding, you can only build on variation that is already there, by selecting organisms with the best features for breeding. There is no natural variant of rice that has genes for making large amounts of beta carotene, so there was no real starting point for selective breeding. Instead, genes that were already present in other species had to be used.