Fungi and Industry

We have already discussed one major importance of Kingdom Fungi: they are decomposers and help remove dead organic matter from our ecosystems. We will now go one step further and discuss how fungi and fungal products help us **directly**.

What is Biotechnology?

Biotechnology: industries use microbes, like bacteria and fungi that produce extremely useful substances. Some of these products are beneficial to our health and wellbeing.

►Question:	**Can you think of any products that depend on the use of fungi at any stage during manufacture?**

Use the box below to make a table listing those you can think of:

Fermentation and Yeast

► Yeast is a single-celled fungus	
► Yeast can respire:	► with oxygen (called aerobic respiration) ► without oxygen (called anaerobic respiration)
► During anaerobic conditions, yeast ferments sugar to produce alcohol, carbon dioxide and water in the process of **fermentation.**	
► Equation: Yeast + Glucose → Alcohol + Carbon dioxide + Water [NOTE: that the same chemistry is used in brewing and baking fermentations, but brewing uses the alcohol, and baking uses the carbon dioxide.]	

Brewing Industry ►	Brewer's yeast (*Saccharomyces cerevisiae*) ferments sugars in cereal grains to produce **alcohol**, in addition to various other products, producing beers and lagers.
Baking Industry ►	Baker's yeast (*Saccharomyces cerevisiae*) ferments sugars in the flour, but this time **carbon dioxide** is the useful product of fermentation. When the yeast in bread dough releases carbon dioxide it makes bubbles in the dough and causes the dough to 'rise' (increase in volume). The alcohol produced evaporates during baking.
Myco-protein ►	The product called Quorn is myco-protein. It is NOT a yeast or a mushroom, but a filamentous fungus called *Fusarium venenatum*. Myco-protein is used as an alternative to meat in health- and vegetarian products.

Find out more about the benefits of Myco-protein (Quorn) and discuss them. Find the information that will enable you to complete the table below with the amounts of each ingredient:

	Protein	Dietary Fibre	Fat
Myco-protein			
Beef steak			

Supermarket Challenge

Earlier we asked you to list some products that depend on the use of fungi in their manufacture. The table below includes a few you may not have thought of. Find out **HOW** they depend on fungi and write some notes in the last column of the table.

Marmite ►		
Fizzy Drinks ►		
Soy Sauce ►		
Chocolate and Coffee ►		

Local Industry

There are probably companies close to you and your school that use fungi or fungal products in their manufacturing processes. You could use local business directories to find out about them and then look at their websites to get more information.

Here's an unusual example:

The British Textile Technology Group (BTTG) is based in Didsbury in Manchester and works with the Welsh School of Pharmacy in Cardiff. Together they have designed and produced a range of filamentous fungal materials that help with the healing of wounds.

When you cut your finger you'll probably use a plaster to cover it up until it's healed. Even if you had a deep cut and had to go to hospital, the nurses would place a sterile pad over the wound and bandage it up. What these companies have produced incorporates filamentous fungi (the mycelial network) to produce a plaster with a difference:

► The secret's in the chitin (which maintains the rigidity and structure of fungal cell walls).

► Many experiments have been conducted which suggest that chitin can speed up the healing of wounds.

► It is thought that chitin actually encourages the growth of fibroblasts into the wound. Fibroblasts help build new tissue.

► The process has the potential to treat chronic ulcers and bed sores in hospital patients.

► If a patient's wounds heal faster then hospital and nursing resources will be saved.

► Discuss: Can you think of any other uses for this product?

How Can Fungi Benefit Our Health?

None of the products we have discussed so far are really essential for survival. Believe it or not, we can survive without chocolate and our favourite fizzy drinks! These products are manufactured for our enjoyment and to improve the quality of life.

However, for some people fungal products are really needed to treat infections, prevent serious diseases, or to improve poor diet. Some of these essential products are in the form of:

► **Antibiotics**

► **Statins**

► **Immunosuppressives**

► **Vitamins**

Use the information in the tables below as class discussion points.

Antibiotics ►	Antibiotics are used to treat bacterial and fungal infections. You probably know about **penicillin** -produced by the mould *Penicillium notatum* and discovered by Alexander Fleming in 1928. Other examples of antibiotics derived from fungi are: Cephalosporin from *Cephalosporium* sp. and Griseofulvin from *Penicillium griseofulvum* and *Penicillium patulum*. Today, most antibiotics used in medicine are derived from bacteria. Antibiotics produced by bacteria include streptomycin and terramycin.
► Discuss the effect of 'wonder drugs' on society (imagine the effect if antibiotics were not available). Discuss the effect of resistance to the drug in the disease-causing organism (e.g. newspaper stories about MRSA). How might you combat that? What's involved in finding new antibiotics?	

Statins ►	Statins are products of metabolic reactions in fungi. Lovastatin comes from *Aspergillus terreus* strains; mevastatin from *Penicillium citrinum*. Statins inhibit an enzyme involved in the synthesis of cholesterol and they've become very important for control of cholesterol levels in patients. **Cholesterol** is made in the liver, but we also get it from our food. Diets high in fat result in a build up of cholesterol in the arteries and this can lead to heart attacks or strokes.

► Discuss the influence of food on health and the use of medicines to control metabolism. Can you think of other examples?

Immuno-suppressives ►	Immune suppressants are essential for organ transplant patients. The T cells of the **human immune system** recognise the new organ as 'foreign' and begin to destroy the organ. The filamentous fungus called *Tolypocladium inflatum* was found to produce Cyclosporin A. This drug prevents organ rejection by inhibiting T cell activation.

► Discuss the ethics of organ donation and transplantation. What's involved in giving permission for a deceased loved-one's organs to be used for transplantation? Discuss the impact (on people and their families) of life-long, life-preserving medication.

Vitamins ►	All fungi are a good source of vitamins. Brewer's yeast synthesises B group vitamins; so yeast extract and yeast tablets are popular vitamin supplements. In industry the fungi *Nematospora gossypii* and *Eremothecium ashbyi* are now used to produce B vitamins.

► Discuss the general use of food supplements. Compare fresh and processed foods, and children and adults – are supplements needed? Are any safety issues raised?