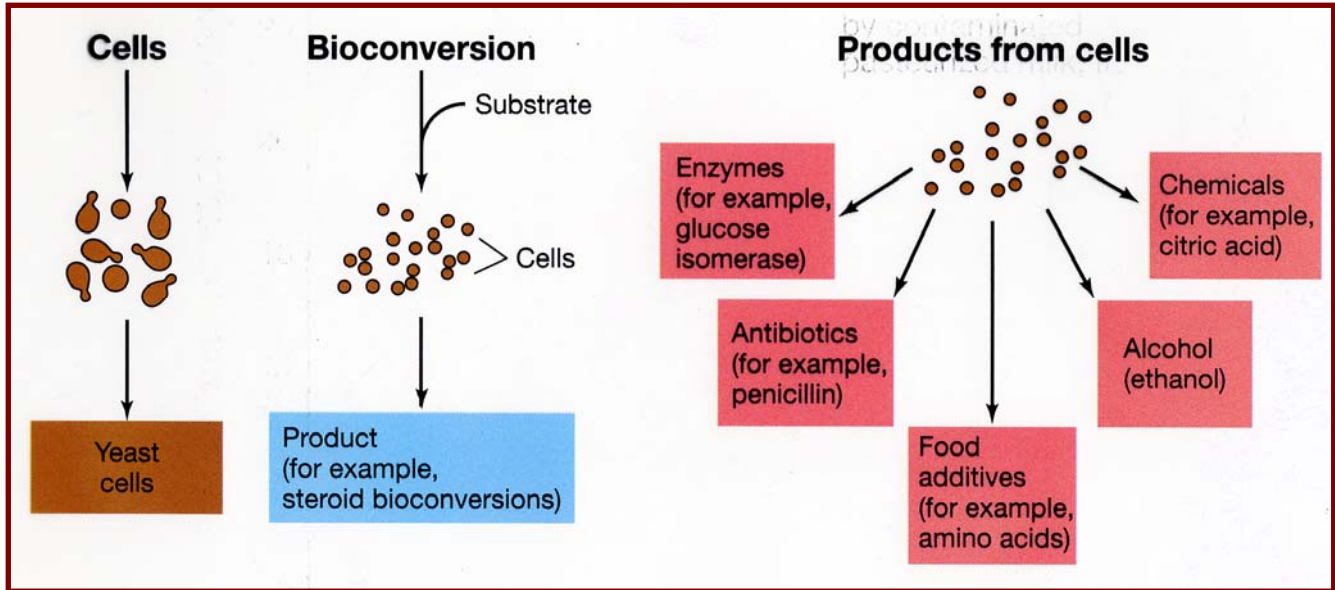


Industrial applications of Microbiology

(see text pgs 942-968)

What is this about?

- The use of living organisms or their metabolic products for large industrial or commercial processes. This includes the use of genetically engineered organisms.

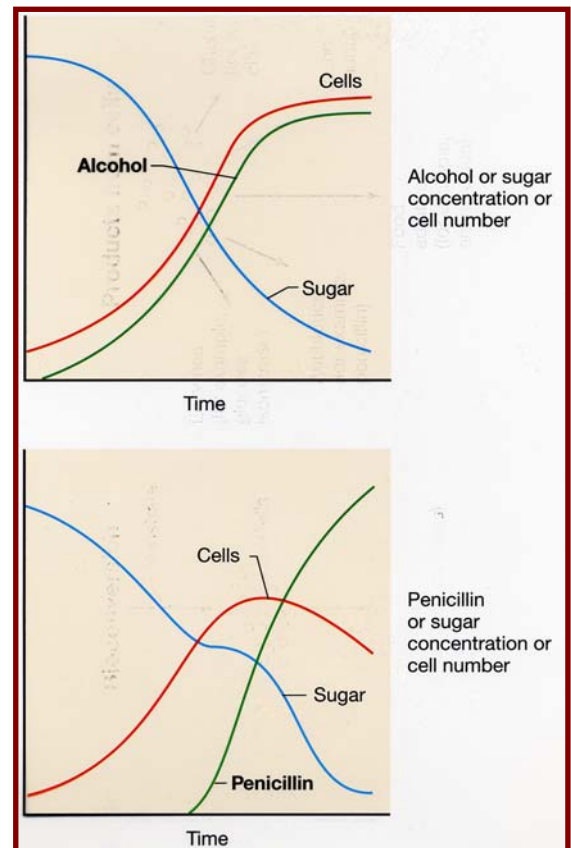


What makes this attractive?

- Inexpensive production of large quantities of desirable materials on a large scale.

Exploiting metabolism

- Two basic types of microbial metabolites
 - Primary
 - Formed during the growth phase
 - Secondary
 - Formed near the end of the growth phase or in stationary phase
 - These are not essential for growth
 - Dependent on medium composition
 - Hardly ever produced as a 'pure' product but as a cluster of closely related materials
 - Over-production is possible



How do we take advantage of microbial metabolism on an industrial scale?

- Review Fermentors and Chemostats
- Review scale up from bench top to large scale

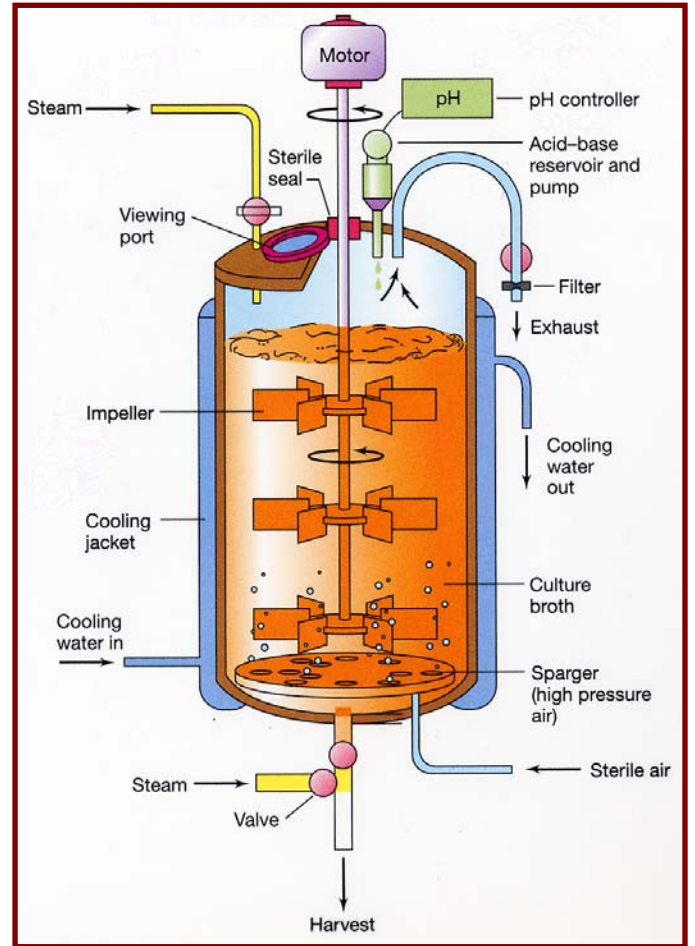


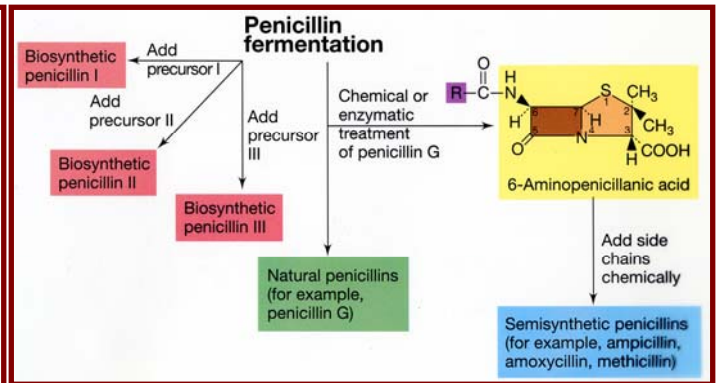
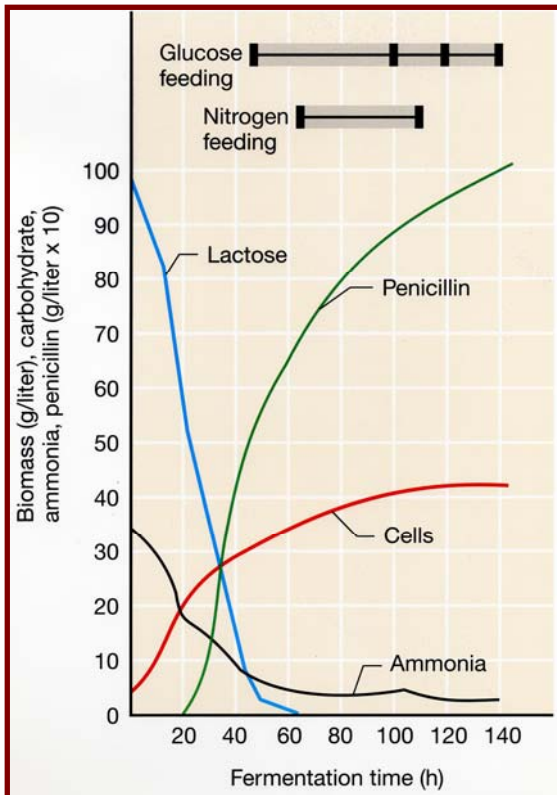
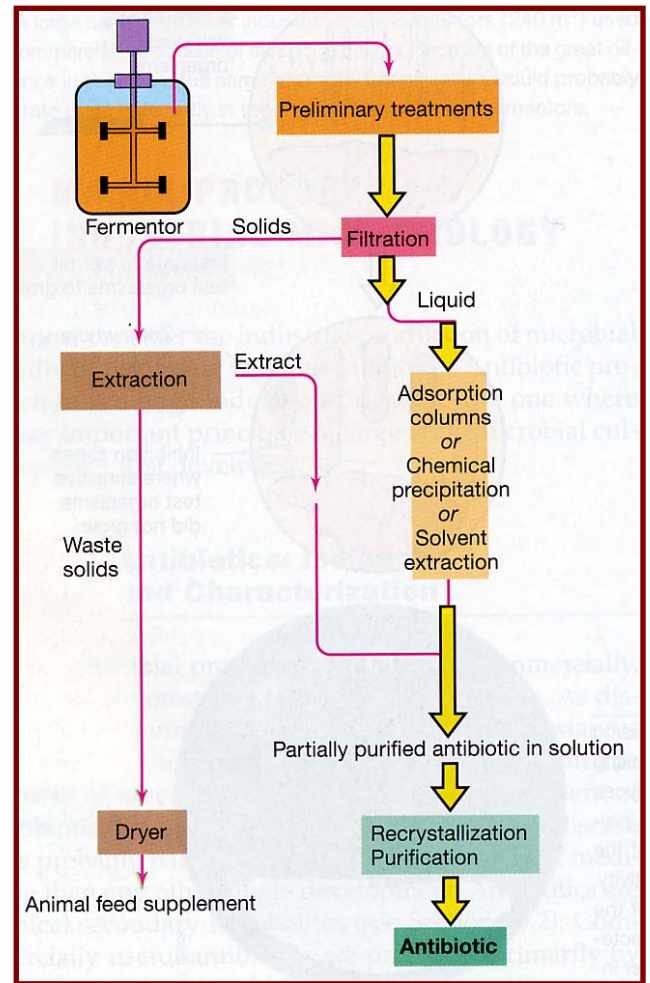
TABLE 30.1 Fermentor sizes for various industrial processes

Size of fermentor (liters)	Product
1–20,000	Diagnostic enzymes, substances for molecular biology
40–80,000	Some enzymes, antibiotics
100–150,000	Penicillin, aminoglycoside antibiotics, proteases, amylases, steroid transformations, amino acids, wine, beer
200,000–500,000	Amino acids (glutamic acid), wine, beer

Some examples of products and their manufacture

- Antibiotics
 - Initial production and purification
 - Modification during production or Post production modification
- Figures 30.10 30.9

Antibiotic	Producing microorganism ^a
Bacitracin	<i>Bacillus licheniformis</i> (EFB)
Cephalosporin	<i>Cephalosporium</i> sp (F)
Chloramphenicol	Chemical synthesis (formerly produced microbially by <i>Streptomyces venezuelae</i>) (A)
Cycloheximide	<i>Streptomyces griseus</i> (A)
Cycloserine	<i>Streptomyces orchidaceus</i> (A)
Erythromycin	<i>Streptomyces erythreus</i> (A)
Griseofulvin	<i>Penicillium griseofulvin</i> (F)
Kanamycin	<i>Streptomyces kanamyceticus</i> (A)
Lincomycin	<i>Streptomyces lincolnensis</i> (A)
Neomycin	<i>Streptomyces fradiae</i> (A)
Nystatin	<i>Streptomyces noursei</i> (A)
Penicillin	<i>Penicillium chrysogenum</i> (F)
Polymyxin B	<i>Bacillus polymyxa</i> (EFB)
Streptomycin	<i>Streptomyces griseus</i> (A)
Tetracycline	<i>Streptomyces rimosus</i> (A)



- Vitamins and Amino Acids

TABLE 30.3 Amino acids used in the food industry^a

Amino acid ^b	Annual production worldwide (metric tons)	Uses	Purpose
L-Glutamate (monosodium glutamate, MSG)	370,000	Various foods	Flavor enhancer; meat tenderizer
L-Aspartate and alanine	5,000	Fruit juices	"Round off" taste
Glycine	6,000	Sweetened foods	Improve flavor; starting point for organic syntheses
L-Cysteine	700	Bread Fruit juices	Improves quality Antioxidant
L-Tryptophan + L-Histidine	400	Various foods, dried milk	Antioxidant, prevents rancidity; nutritive additive
Aspartame (made from L-phenylalanine + L-aspartic acid)	7,000	Soft drinks	Low-calorie sweetener
L-Lysine	70,000	Bread (Japan), feed additives	Nutritive additive
DL-Methionine	70,000	Soy products, feed additives	Nutritive additive

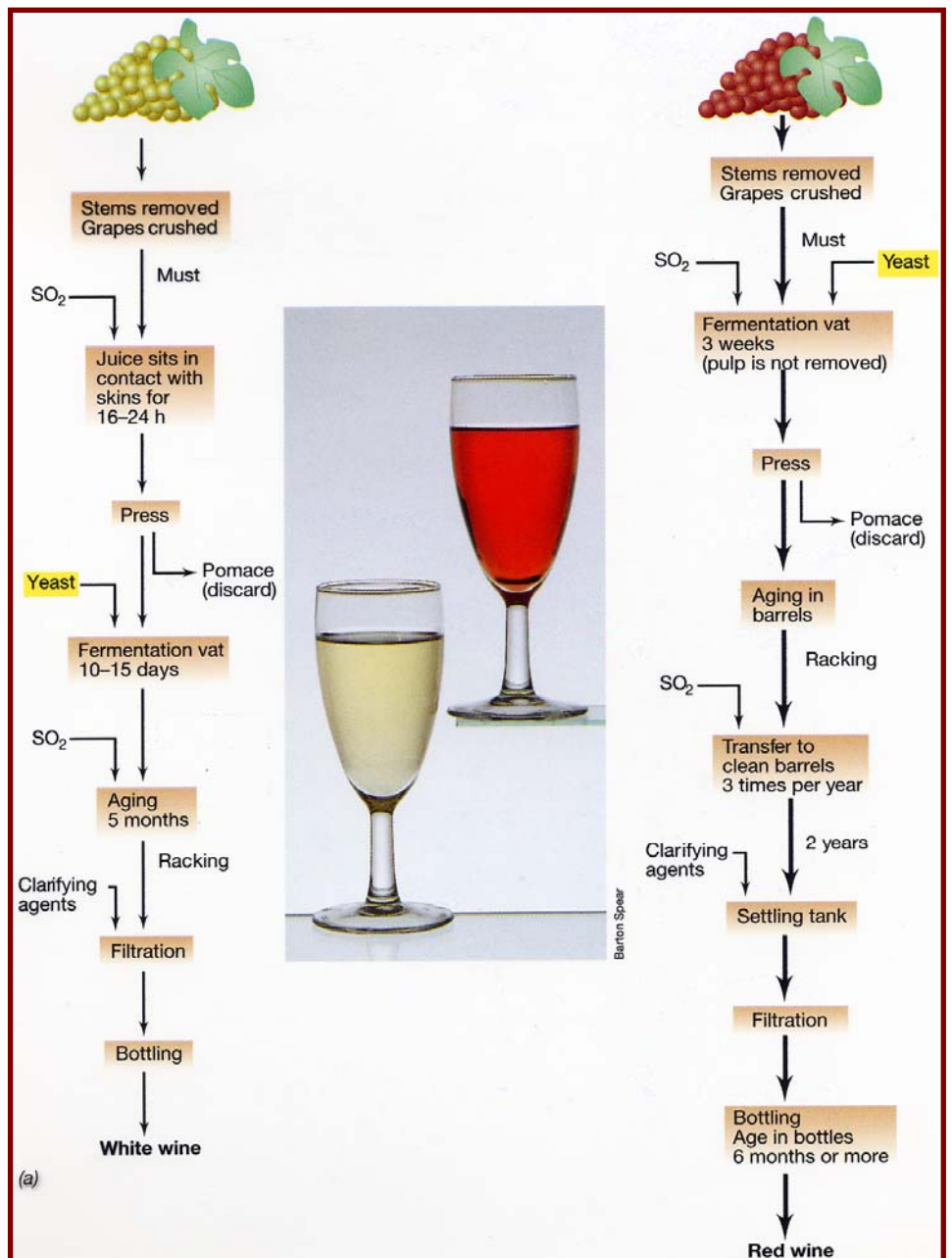
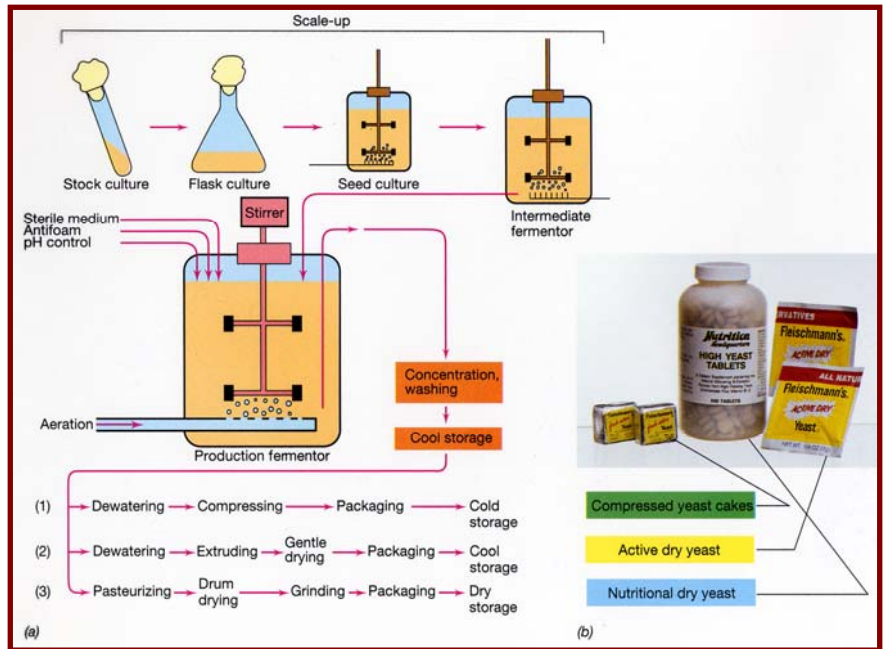
- Enzymes

- Review why this is important....detergents and high temperature activity or low temperature activity

TABLE 30.4 Microbial enzymes and their applications

Enzyme	Source	Application	Industry
Amylase (starch-digesting)	Fungi	Bread	Baking
	Bacteria	Starch coatings	Paper
	Fungi	Syrup and glucose manufacture	Food
	Bacteria	Cold-swelling laundry starch	Starch
	Fungi	Digestive aid	Pharmaceutical
	Bacteria	Removal of coatings (desizing)	Textile
Protease (protein-digesting)	Bacteria	Removal of stains; detergents	Laundry
	Fungi	Bread	Baking
	Bacteria	Spot removal	Dry cleaning
	Bacteria	Meat tenderizing	Meat
	Bacteria	Wound cleansing	Medicine
	Bacteria	Desizing	Textile
Invertase (sucrose-digesting)	Yeast	Household detergent	Laundry
Glucose oxidase	Fungi	Soft-center candies	Candy
		Glucose removal, oxygen removal	Food
Glucose isomerase	Bacteria	Test paper for diabetes	Pharmaceutical
		High-fructose corn syrup	Soft drink
Pectinase	Fungi	Pressing, clarification	Wine, fruit juice
Rennin	Fungi	Coagulation of milk	Cheese
Cellulase	Bacteria	Fabric softening, brightening; detergent	Laundry
Lipase	Fungi	Breaks down fat	Dairy, laundry
Lactase	Fungi	Breaks down lactose to glucose and galactose	Dairy, health foods
DNA polymerase	Bacteria	DNA replication in polymerase chain	Biological research;
	Archaea	reaction (PCR) technique (👓 Section 10.17)	forensics

- Food stuffs
 - Vinegar
 - Review... maybe some history
 - Citric acid
 - Single cell protein
 - Yeast
 - Alcohol products



- Whole organisms
 - Mushrooms



- Water and wastewater treatment



All figures in this section are taken from Madigan et al. 2002

References:

Madigan, M. T., J.M. Martinko, and J. Parker. 2002. Brock Biology of Microorganisms 10th ed. Prentice Hall.