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INDUSTRIAL MICROBIOLOGISTS IN THE AREA OF MICROFUNGI

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The microbial fermentation industry employs microorganisms to produce different desired valuable products. A number of commercial products – including antibiotics, organic acids, steroids, vitamins, enzymes – are made by fungi. Many of these products can be produced both microbially and by chemical synthesis. The choice of which process to employ generally depends on economics. (The decision is dictated by variable costs.)

Below a short but not complete list of the most important primary and secondary metabolites which are produced by fungi.

Product	Microorganism
Penicillins	*Penicillium chrysogenum*, *P. notatum* Greek: *χρυσοζ... γενοζ*
Cephalosporin	*Acremonium chrysogenum*
Fumagillin	*Aspergillus fumigatus*
Griseofulvin	*Penicillium griseofulvum*, *P. urticae*, *P. nigricans*
Lovastatin	*Aspergillus terreus*, *A. oryzae*, *A. niger*, *A. nidulans*, *A. fumigatus*, *A. flavus*, *A. obscurus*, *Syncephalastrum nigricans*, *Mucor hiemalis*, *Pleurotus sapidus*, *P. saca*, *P. ostreatus*, *Coniothyrium fuckelii*
Cyclosporin	*Trychoderma polysporum*, *Tolypocladium inflatum*, *T. geodes*, *T. tundrense*, *T. terricola*, *T. cylindrosporum*, *Fusarium solani*, *F. javanicum*, *Neocosmospora vasinfecta*, *Beauveria nivea*, *B. bassania*, *Cylindrocarpum lucidum*, *Sesquicilliopsis rosariensis*
Riboflavin	*Eremothecium ashbyi*, *Ashbya gossypii*
Ergot alkaloids	*Claviceps purpurea*
Amino acids: (Tryptophan)	*Hansenula anomala*, *Candida humicola*, *Saccharomyces cerevisiae*, *Claviceps purpurea*
Giberellins	*Giberella fujikuroi*, *Sphaceloma manthoticola*, *Neurospora crassa*
Citric acid, Gluconic acid	*Aspergillus niger*
Ethanol	*Saccharomyces cerevisiae*

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Important activities of industrial microbiologists include the search for microorganism to produce substances of commercial importance, or creating specific strains of microorganisms that yield sufficient quantities of the desired product to permit commercial production economically, design the optimal production process and in the batch reactor to optimize the physical and chemical environmental conditions in order to achieve maximal product yields.

Production process technology includes defining the medium – containing the least expensive components – that will produce the highest yield of the desired product, recognizing that very often the presence or absence of even trace amounts of a component will vastly alter the yield of the desired product.

Microorganisms can carry out a number of chemical modifications more efficiently than synthetic chemical methods. For example: a number of fungi can introduce oxygen specifically at the position 11 in a single reaction into the steroids resulting in the desired products

Hydrocortison from Cortexolone	*Curvularia lunata*, *Cunninghamella blakesleana*
11α-hydroxyprogesterone from progesterone	*Rhizopus nigricans*, *R. arrhizus*

Different essential intermediates are produced for organic chemical synthesis by stereospecific reduction. For example: *Saccharomyces uvarum*, *S. bayanus*, *Zygosaccharomyces rouxii*, *Rhodotorula rubra*, *Geotrichum candidum*, *Aureobasidium pullulans*, *Schizosaccharomyces pombe, Hansenula anomala* and a number of other strains.

Various microbial enzymes are produced for commercial or industrial applications

Amylases	*Aspergillus oryzae*
Glucamylase	*Aspergillus niger*
Glucose oxidase	*Aspergillus niger*
Cellulase	*Trichoderma reesii*
Invertase	*Saccharomyces cerevisiae*
Lactase	*Kluyveromyces fragilis*
Lipase	*Saccharomycopsis lipolytica, Syncephalastrum racemosum, Pythium ultimum, Candida rugosa, Rhizopus niveus, Penicillium cyclopium, Aspergillus niger, Ustilago maydis, Geotrichum candidum, Fusarium oxysporum*
Pectinases and proteases	*Aspergillus foetidus*
Naringinase	*Penicillium decumbens, Aspergillus niger*
Microbial rennin (chymosin)	*Mucor pusillus, M. miehei, Rhizomucor* spp.

Most of them are used by food industry. Amylase is applied for bread baking and for breakfast foods. Pectinases are useful for clarification of wine. Fungal glucose oxidase is used for removing glucose from eggs prior to drying. Removing the glucose stabilizes and prevents deterioration of the dried egg product. Glucose oxidase is also used to

remove oxygen from different other products preventing any oxidative colour and flavor changes. Naringinase (α-L-rhamnosidase) can be used to remove bitterness from grapefruit juice. Rennin is used for curdling milk in the production of cheese.

The applied microbiology is economically feasible only if full advantages of the biological capacity of microorganisms to convert any kind of substrates into desired products are taken. A good knowledge of microbial physiology (metabolism and its control) with its molecular biological background is therefore of primary importance. It seems that we have to know more about this well regulated metabolic network. Unfortunately there are many important problems in metabolic regulation which have not been solved. The promise of recombinant DNA technology to permit the incorporation of foreign genetic information into microorganisms support the belief that microorganisms will become increasingly important in the production of many goods by microbial fermentation.