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Microbes and Microbial Technology

Vol-1

JV'n Ms. Anshika Kushwaha

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INDEX

CHAPTER 1

Fermentative production.

Fermentation,

Chemical process by which molecules such as glucose are broken down anaerobically. More broadly, fermentation is the foaming that occurs during the manufacture of wine and beer, a process at least 10,000 years old. The frothing results from the evolution of carbon dioxide gas, though this was not recognized until the 17th century. French chemist and microbiologist Louis Pasteur in the 19th century used the term *fermentation* in a narrow sense to describe the changes brought about by yeasts and other microorganisms growing in the absence of air (anaerobically); he also recognized that ethyl alcohol and carbon dioxide are not the only products of fermentation.

Anaerobic breakdown of molecules

In the 1920s it was discovered that, in the absence of air, extracts of muscle catalyze the formation of lactate from glucose and that the same intermediate compounds formed in the fermentation of grain are produced by muscle. An important generalization thus emerged: that fermentation reactions are not peculiar to the action of yeast but also occur in many other instances of glucose utilization.

Glycolysis, the breakdown of sugar, was originally defined about 1930 as the metabolism of sugar into lactate. It can be further defined as that form of fermentation, characteristic of cells in general, in which the six-carbon sugar glucose is broken down into two molecules of the three-carbon organic acid, pyruvic acid (the nonionized form of pyruvate), coupled with the transfer of chemical energy to the synthesis of adenosine triphosphate (ATP). The pyruvate may then be oxidized, in the presence of oxygen, through the tricarboxylic acid cycle, or in the absence of oxygen, be reduced to lactic acid, alcohol, or other products. The sequence from glucose to pyruvate is often called the Embden–Meyerhof pathway, named after two German biochemists who in the late 1920s and '30s postulated and analyzed experimentally the critical steps in that series of reactions.

Industrial fermentation processes begin with suitable microorganisms and specified conditions, such as careful adjustment of nutrient concentration. The products are of many types: alcohol, glycerol, and carbon dioxide from yeast fermentation of various sugars; butyl alcohol, acetone, lactic acid, monosodium glutamate, and acetic acid from various bacteria; and citric acid, gluconic acid, and small amounts of antibiotics, vitamin B_{12}, and riboflavin (vitamin B_2) from mold fermentation. Ethyl alcohol produced via the fermentation of starch or sugar is an important source of liquid biofuel.

Yeast and Fermentation

In the seventeenth century, a Dutch tradesman named Antoni van Leeuwenhoek developed high-quality lenses and was able to observe yeast for the first time. In his spare time Leeuwenhoek used his lenses to observe and record detailed drawings of everything he could, including very tiny objects, like protozoa, bacteria, and yeast. Leeuwenhoek discovered that yeast consist of globules floating in a fluid, but he thought they were merely the starchy particles of the grain from which the wort (liquid obtained from the brewing of whiskey and beer) was made (Huxley 1894). Later, in

1755, yeast were defined in the *Dictionary of the English Language* by Samuel Johnson as "the ferment put into drink to make it work; and into bread to lighten and swell it." At the time, nobody believed that yeast were alive; they were seen as just organic chemical agents required for fermentation.

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- **Competitive questions from today topic (2 questions Minimum)-**

  The protection against smallpox afforded by prior infection with cowpox represents

  A. Polysipho antigenic specificity.
  B. antigenic cross-reactivity.
  C. innate immunity.
  D. passive protection.

  Exam NameDBT JRF 2015

  Why the Environmental Protection Agency does closely monitors the release of transgenic bacteria used for agricultural purposes?

  - They want to monitor the destruction of crops by the GMOs
  - They want to observe the effect the GMOs have on crops
  - They want to ensure the GMOs do not proliferate in the environment and pose a threat to humans
  - They want to ensure that people are aware that GMOs may have played a role in the production of a particular food product

  Exam NameDBT JRF 2015

- **Suggestions to secure good marks to answer in exam-**
  - Give answer with complete labeled diagrams.
  - Explain answer with key point answers

- **Questions to check understanding level of students-**
  - What is fermentation?
  - Explain fermentative production.

CHAPTER 2

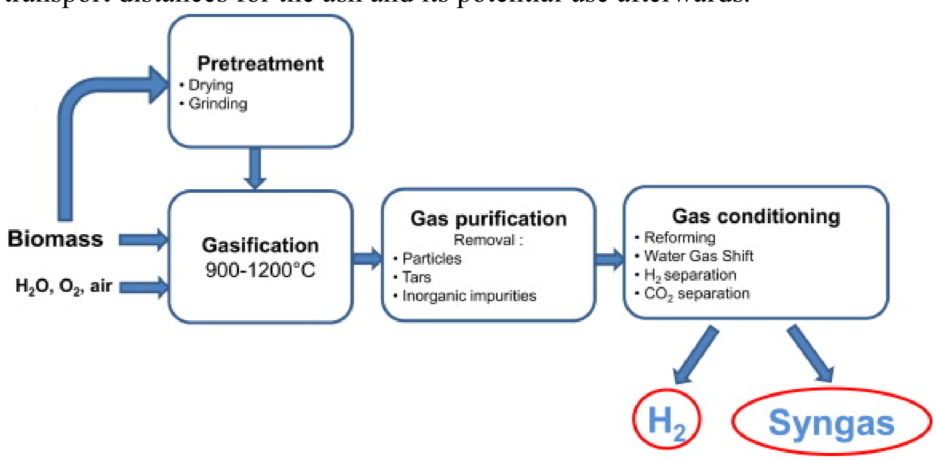
Purification of biomass.

Purification of biomass:

A wastewater treatment system including a screen, a vermifilter, macrophytes ponds, and constructed wetlands has been built after a pig housing on slatted-floor. The aims were, all at once, to recycle water for excretion washing and to produce, from the nutrients contained in the effluent, organic matter and plants that can be either sold or reused on the farm to reduce inputs. Analyses, made on the effluent at different steps of the treatment plant, show that the concentrations of the nitrogen, microorganisms and endocrine disruptors are drastically reduced, while the phosphorus and potassium removal go through the byproducts harvesting.

Biogas purification with biomass ash:

The aim of the study was to investigate the option to purify biogas from small-scale biogas plants by entrapping CO_2 and H_2S with regionally available biomass ash. Connected to the existing biogas plant Neustift (Tyrol) wood ash placed in a 1 m^3 container was used as a trap for CO_2 and H_2S in the biogas. With the process conditions chosen, for a period of a few hours CO_2 was trapped resulting in pure methane. The removal of H_2S was much longer-lasting (up to 34 d). The cumulative H_2S uptake by the biomass ash ranged from 0.56 to 1.25 kg H_2S per ton of ash. The pH of the ash and the leachability of Lead and Barium were reduced by the flushing with biogas, however toxicity towards plants was increased thus reducing the potential of ash use in agriculture. It can be concluded that biomass ash may be used for removal of hydrogen sulphide from biogas in small and medium biogas plants. The economic evaluation, however, indicated that the application of this system is limited by transport distances for the ash and its potential use afterwards.



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- **Competitive questions from today topic (2 questions Minimum)-**

Creutzfeldt-Jakob disease is caused by

- PrPC.
- PrPSc
- West Nile virus.
- Varicella-Zoster virus.

Exam NameDBT JRF 2015

Cells are broken to release the contents by using various enzymes. Which of the

- Lysozyme ? bacteria
- Cellulase ? plant cell
- Chitinase ? fungus
- Cellulase ? bacteria

Exam NameDBT JRF 2015

- **Suggestions to secure good marks to answer in exam-**
  - Give answer with complete labeled diagrams.
  - Explain answer with key point answers

- **Questions to check understanding level of students-**
  - What is Biomass?
  - Explain Biomass purification.

CHAPTER 3
Different Micro Organisms.

Different micro organisms:

- Microorganisms are divided into seven types: bacteria, archaea, protozoa, algae, fungi, viruses, and multicellular animal parasites (helminths).
- Each type has a characteristic cellular composition, morphology, mean of locomotion, and reproduction.
- Microorganisms are beneficial in producing oxygen, decomposing organic material, providing nutrients for plants, and maintaining human health, but some can be pathogenic and cause diseases in plants and humans.

Bacteria

Bacteria are unicellular organisms. The cells are described as prokaryotic because they lack a nucleus. They exist in four major shapes: bacillus (rod shape), coccus (spherical shape), spirilla (spiral shape), and vibrio (curved shape). Most bacteria have a peptidoglycan cell wall; they divide by binary fission; and they may possess flagella for motility. The difference in their cell wall structure is a major feature used in classifying these organisms.

According to the way their cell wall structure stains, bacteria can be classified as either Gram-positive or Gram-negative when using the Gram staining. Bacteria can be further divided based on their response to gaseous oxygen into the following groups: aerobic (living in the presence of oxygen), anaerobic (living without oxygen), and facultative anaerobes (can live in both environments).

According to the way they obtain energy, bacteria are classified as heterotrophs or autotrophs. Autotrophs make their own food by using the energy of sunlight or chemical reactions, in which case they are called chemoautotrophs. Heterotrophs obtain their energy by consuming other organisms. Bacteria that use decaying life forms as a source of energy are called saprophytes.

Archaea

Archaea or Archaebacteria differ from true bacteria in their cell wall structure and lack peptidoglycans. They are prokaryotic cells with avidity to extreme environmental conditions. Based on their habitat, all Archaeans can be divided into the following groups: methanogens (methane-producing organisms), halophiles (archaeans that live in salty environments), thermophiles (archaeans that live at extremely hot temperatures), and psychrophiles (cold-temperature Archaeans). Archaeans use different energy sources like hydrogen gas, carbon dioxide, and sulphur. Some of them use sunlight to make energy, but not the same way plants do. They absorb sunlight using their membrane pigment, bacteriorhodopsin. This reacts with light, leading to the formation of the energy molecule adenosine triphosphate (ATP).

Fungi

Fungi (mushroom, molds, and yeasts) are eukaryotic cells (with a true nucleus). Most fungi are multicellular and their cell wall is composed of chitin. They obtain nutrients by absorbing organic material from their environment (decomposers), through symbiotic relationships with plants (symbionts), or harmful relationships with a host (parasites). They form characteristic filamentous tubes called hyphae that help absorb material. The collection of hyphae is called mycelium. Fungi reproduce by releasing spores.

Protozoa

Protozoa are unicellular aerobic eukaryotes. They have a nucleus, complex organelles, and obtain nourishment by absorption or ingestion through specialized structures. They make up the largest group of organisms in the world in terms of numbers, biomass, and diversity. Their cell walls are made up of cellulose. Protozoa have been traditionally divided based on their mode of locomotion: flagellates produce their own food and use their whip-like structure to propel forward, ciliates have tiny hair that beat to produce movement, amoeboids have false feet or pseudopodia used for feeding and locomotion, and sporozoans are non-motile. They also have different means of nutrition, which groups them as autotrophs or heterotrophs.

Algae

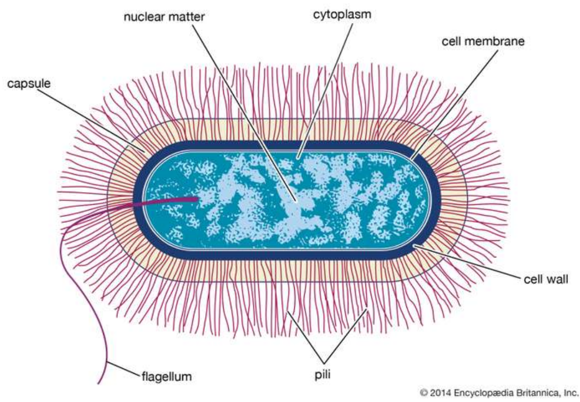
Algae, also called cyanobacteria or blue-green algae, are unicellular or multicellular eukaryotes that obtain nourishment by photosynthesis. They live in water, damp soil, and rocks and produce oxygen and carbohydrates used by other organisms. It is believed that cyanobacteria are the origins of green land plants.

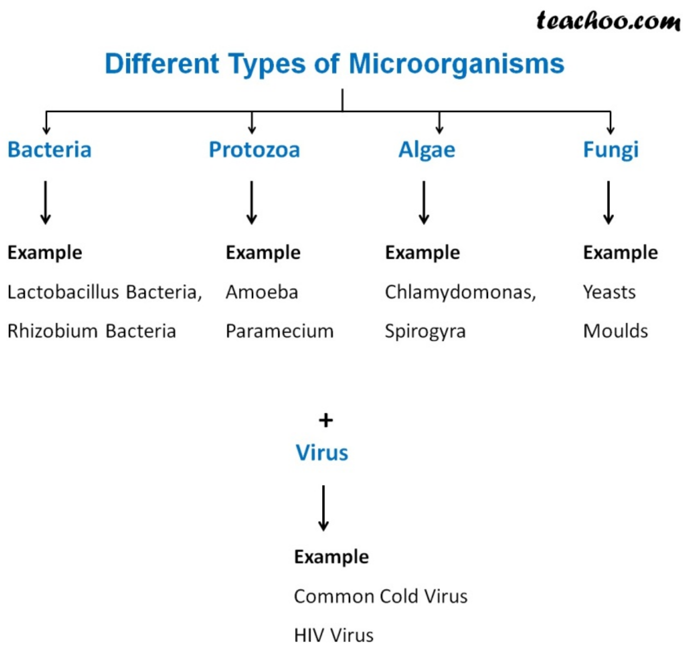
Viruses

Viruses are noncellular entities that consist of a nucleic acid core (DNA or RNA) surrounded by a protein coat. Although viruses are classified as microorganisms, they are not considered living organisms. Viruses cannot reproduce outside a host cell and cannot metabolize on their own. Viruses often infest prokaryotic and eukaryotic cells causing diseases.

Multicellular Animal Parasites

A group of eukaryotic organisms consisting of the flatworms and roundworms, which are collectively referred to as the helminths. Although they are not microorganisms by definition, since they are large enough to be easily seen with the naked eye, they live a part of their life cycle in microscopic form. Since the parasitic helminths are of clinical importance, they are often discussed along with the other groups of microbes.





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- **Competitive questions from today topic (2 questions Minimum)-**

Which one of the following antibiotics attaches to 50S ribosome and inhibits peptidyl-

- Penicillin.
- Chloramphenicol
- Trimethoprim.
- Amphotericin.

Exam NameDBT JRF 2015

Which one of the following antibiotics attaches to 50S ribosome and inhibits peptidyl-transferase activity?

- Penicillin
- Chloramphenicol
- Trimethoprim
- Amphotericin

Exam NameDBT JRF 2015

- **Suggestions to secure good marks to answer in exam-**
  - Give answer with complete labeled diagrams.
  - Explain answer with key point answers

- **Questions to check understanding level of students-**
  - What is microorganism?
  - Explain Different microorganism.

CHAPTER 4

Storage of Biomass Different Micro Organisms.

Microbial Biomass:

- Microbial biomass (bacteria and fungi) is a measure of the mass of the living component of soil organic matter.
- The microbial biomass decompose plant and animal residues and soil organic matter to release carbon dioxide and plant available nutrients.
- Farming systems that return plant residues (e.g. no-tillage) tend to increase the microbial biomass.
- Soil properties such as pH, clay, and the availability of organic carbon all influence the size of the microbial biomass.

Factors affecting microbial biomass

The microbial biomass is affected by factors that change the water or carbon content of soil, and include soil type, climate and management practices. Rainfall is usually the limiting factor for microbial biomass in southern Australia (figure 2). Soil properties that affect microbial biomass are clay, soil pH, and organic C (figure 3). Soils with more clay generally have a higher microbial biomass as they retain more water and often contain more organic C (figure 4). A soil pH near 7.0 is most suitable for the microbial biomass.

Microbial Biomass

Microbial biomass, a small (1–5% by weight) but active fraction of soil organic matter, is of particular concern in soil fertility considerations because it is more susceptible to management practices than the bulk organic matter (Janzen, 1987). Soil microbial biomass (SMB) acts as a reservoir of plant nutrients and is a major determinant for governing the nutrient (like N, P, and S) availability in soils. Although SMB values are only a small portion of total C and N in soils, this living portion of soil contains a substantial amount of nutrients needed for crop growth. The amount of microbial biomass and microbial activity depends on the supply of organic substrates in soil. Therefore, regular addition of a sufficient amount of organic materials such as crop residue is important in the maintenance of microbial biomass and improvement of soil fertility.

Several researchers (Azmal *et al*., 1996; Sridevi *et al*., 2003) have reported a marked increase in microbial biomass following incorporation of crop residues. After straw incorporation, microbial biomass-C (MBC) increased by two- to fivefold in 10 days and reached the highest value by 30 days. For example, Ocio and Brooks (1990) observed that straw addition, compared to control, increased the microbial biomass by 87.5% in a sandy loam soil and by about 50% in a clay soil. Malik *et al*. (1998) found that application of wheat straw and green manure in a rice–wheat cropping system caused a large increase in microbial biomass during the initial phases of rice crop. An increase in microbial biomass was sustained throughout the growing season of rice and resulted in synchronization between N release and N uptake. Patra *et al*. (1992) found more biomass C in wheat straw than in cowpea residue-amended soil, but the amount of microbial biomass N (MBN) was significantly higher in the latter. Azmal *et al*. (1997) reported that the amount of microbial biomass C and N increased immediately after rice straw incorporation into a clay loam soil incubated under aerobic conditions, reached maximum values after 1 week of each application (2 g C as rice straw kg^{-1} soil after every 6 weeks), and decreased thereafter. The level of maximum biomass formation reached a ceiling after the second application, suggesting that soil has a certain capacity to hold biomass.

Singh (1991) reported that microbial C was maximum in the wheat straw (10 t ha^{-1}) plus fertilizer treatment (408–420 μg g^{-1}) followed by straw (360–392 μg g^{-1}) and fertilizer treatments (238–246 μg g^{-1}) in rice-lentil (*Lens esculenta*) crop rotation under dryland conditions. With time, straw plus fertilizer treatment accumulated 77% more microbial biomass C over control. The initial flush of microbial activity probably results from rapid catabolism of simple soluble C compounds initially present in crop residues.

Biomass

The **biomass** is the mass of living biological organisms in a given area or ecosystem at a given time. Biomass can refer to *species biomass*, which is the mass of one or more species, or to *community biomass*, which is the mass of all species in the community. It can include microorganisms, plants or animals. The mass can be expressed as the average mass per unit area, or as the total mass in the community.

How biomass is measured depends on why it is being measured. Sometimes, the biomass is regarded as the natural mass of organisms *in situ*, just as they are. For example, in a salmon fishery, the salmon biomass might be regarded as the total wet weight the salmon would have if they were taken out of the water. In other contexts, biomass can be measured in terms of the dried organic mass, so perhaps only 30% of the actual weight might count, the rest being water. For other purposes, only biological tissues count, and teeth, bones and shells are excluded. In some applications, biomass is measured as the mass of organically bound carbon (C) that is present.

The total live biomass on Earth is about 550–560 billion tonnes C, and the total annual primary production of biomass is just over 100 billion tonnes C/yr. The total live biomass of bacteria may be as much as that of plants and animals or may be much less. The total number of DNA base pairs on Earth, as a possible approximation of global biodiversity, is estimated at $(5.3\pm3.6)\times10^{37}$, and weighs 50 billion tonnes.

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- **Competitive questions from today topic (2 questions Minimum)-**

Which one of the following antibiotics is used to demonstrate the new/fresh protein synthesis in response to an inducer/ upon induction in a microbial system?

- Chloramphenicol.
- Carbenicillin
- Ampicillin.
- Tetracyclin.

Exam NameDBT JRF 2015

A yeast mutant shows decreased expression of 5.8S rRNA, 5S rRNA and cdc2 mRNA. In which of the following might mutation lie?

- TATA binding protein (TBP)
- Upstream binding factor (UBF)
- RNA polymerase III
- RNA polymerase I

Exam NameDBT JRF 2015

- **Suggestions to secure good marks to answer in exam-**
  - Give answer with complete labeled diagrams.
  - Explain answer with key point answers
- **Questions to check understanding level of students-**
  - What is Microbial biomass?
  - Explain biomass.

CHAPTER 5

Propagation of micro organisms in food (different propagation processes).

Role of microorganisms in food contamination, processing and safety

Introduction

Recent studies indicated that the advanced technologies that support modern civilization did not affect completely a large proportion of food supply for humans mainly due to spoilage or otherwise wasted. The development of agricultural and food preservation technologies is of great importance to provide large human populations with safe food .Many sources of microbiological contamination are found in or on soil, water, plants and animals. Several types of bacteria are mainly responsible for contamination of food such as coliforms, micrococci, pseudomonads, etc. Many of these bacteria colonize animals in their skin or in the gastrointestinal tract .Soil is an another source of contamination as many microorganisms including bacteria, yeast and molds thrive in most soils and can propagate to very large numbers. Direct contamination occurs during the production and harvesting of crops, however the indirect contamination with soil microorganisms occurs through the deposition of wind-born dust particles. The presence of microorganisms in water serves as a serious source and a vector of contamination . Many pseudomonad bacterial strains grow well in surface water, however enteric bacteria are present in waters polluted with sewage. The contamination mainly occur during irrigation by the contaminated water .

Yeasts and Molds

Yeasts are oval-shaped and slightly larger than bacteria. They reproduce most often by budding. In budding each cell can produce several buds, or swellings, which break away to form new, fully formed daughter cells.

Molds as found on bread, fruit, damp paper, or other surfaces are actually composed of millions of microscopic cells joined together to form chains. The chains usually have numerous branches, called hyphae. Molds can thrive in conditions too adverse for bacteria or yeasts. They reproduce by spores that are frequently present as green or black masses on the protruding hyphae.

Yeasts and molds grow on most foods, on equipment, and building surfaces where there are small amounts of nutrient and moisture. Since bacteria grow faster, they greatly outnumber yeasts and molds in most foods. However, bacteria find conditions of low pH, moisture, or temperature and high salt or sugar unfavorable. In such environments, yeasts or molds predominate. Thus, they can be a problem in dry foods, salted fish, bread, pickles, fruits, jams, jellies, and similar commodities.

Viruses

Viruses are the smallest and simplest microorganisms. Unlike bacteria, yeasts, and molds, viruses are incapable of reproducing independently. Instead, they must first invade the cells of another living organism called the host, before they can multiply. Hence, they are parasitic. Viruses are normally specific in their selection of host cells, some infecting but one species, while others are capable of infecting closely related species. As a result, viruses which infect bacteria, called bacteriophages, cannot infect human beings or other animals. On the other hand, several animal viruses, known as zoonotis, can infect human beings.

The viruses are important to the food process in two respects:

1. As a bacteriophage of lactic or other fermentative bacteria. Bacteriophage infections of starter cultures can interfere seriously with the manufacture of cheese, buttermilk, sauerkraut, pickles, wine, beer, and other desirable fermentative products.
2. As disease transmitted by food to human beings. Although viruses require a live host cell and cannot multiply in foods, they can remain viable and infectious for long periods of time, even under highly adverse conditions, such as drying, freezing, and pasteurization.

Factors Affecting Growth of Microorganisms

The food processor reduces potential problems from microorganisms in several ways:

- Removing or destroying them by trimming, washing, heating, pickling, by adding chemicals, or by encouraging competition by acid- or alcohol-forming organisms.
- Minimizing contamination from equipment, people, the environment, and from unprocessed food.
- Minimizing microbial growth on equipment, by cleaning and sanitizing, and in the product itself by adjusting storage temperature, pH, and other environmental factors.

Although each factor affecting growth is considered separately in the following discussion, these factors occur simultaneously in nature. When more than one condition is somewhat adverse to microbial growth, their inhibitory effects are cumulative.

Temperature

Temperature is the most efficient means to control microbial growth. Based on their tolerance of broad temperature ranges, microorganisms are roughly classified as follows:

1. Psychrophies grow only at refrigeration temperatures.
2. Psychrotrophs grow well at refrigeration temperatures, but better at room temperature.
3. Mesophiles grow best at or near human body temperature, but grow well at room temperature.
4. Thermophiles grow only at temperatures about as hot as the human hand can endure, and usually not at all at or below body temperature.

To be more specific about these temperature limits of growth is to enter the controversy that has continued since the infancy of microbiology, for there are many species that grow in temperature ranges overlapping these. However, for food microbiology these conclusions are pertinent:

Water Activity

Water activity (a_w) is a term describing the availability of water to microorganisms. It is only roughly related to percent moisture. Pure water has an a_w of 1.00, and the atmosphere above the water in a closed container will have an equilibrium relative humidity (ERH) of 100%. If we add an ounce of rocks to a quart of water in such a container, the ERH and the a_w will not change. But if we add an ounce of salt, the ERH will fall to about 98 % and the a_w to 0.98. Rocks do not dissolve in water but salt does, thereby reducing the proportion of water that can enter the atmosphere. Likewise, the amount of water available to microorganisms present in the solution is reduced. Yet the percent moisture is the same in the container with rocks as it is in the container with, salt, namely, 98%.

The GMP regulations for low-acid canned foods defined water activity as the vapor pressure of the food product divided by the vapor pressure of pure water under identical conditions of pressure and temperature. The regulations define low-acid foods as foods, other than beverages, with a finished equilibrium pH value greater than 4.6 and a water activity greater than 0.85.

pH

pH is a term used to describe the acidity or alkalinity of a solution. At pH 7, there is an equal amount of acid (hydrogen ion: H +) and alkali (hydroxyl ion: OH-), so the solution is "neutral". pH values below 7 are acidic, while those above 7 are alkaline. pH expresses the H + concentration logarithmically, that is, in multiples of 10. For example, at pH 5 there are 10 times as many H + as at pH 6; at pH 3 there are 100 times as many H + as at pH 5, and so on.

Population

A high initial bacterial load increases the likelihood that spoilage will occur under marginal circumstances (Chung and Goepfert, 1970) (see Figures 4 and 5). This fact is of major importance to the processor of refrigerated foods, the shelf-life of which is enhanced by good sanitation. A high level of spores also increases the possibility that a few will survive to spoil heat processed products.

Oxygen

Oxygen is essential for growth of some microorganisms; these are called aerobes. Others cannot grow in its presence and are called anaerobes. Still others can grow either with or without oxygen and are called microaerophilic. Strict aerobes grow only on food surfaces and cannot grow in foods stored in cans or in other evacuated, hermetically sealed containers. Anaerobes grow only beneath the surface of foods or inside containers. Aerobic growth is faster than anaerobic. Therefore, in products where both conditions exist, such as in fresh meat, the surface growth is promptly evident, whereas subsurface growth is not.

Lethal Effects of Temperature

Heat is the most practical and effective means to destroy microorganisms. Microbial cell reduction occurs slowly just above maximal growth temperatures. However, the rate of death increases markedly as the temperature is raised. Pasteurization, the destruction of vegetative cells of disease-producing microorganisms, consists of a temperature of 140°F for 30 minutes, or about 161°F for 16 seconds. Yeasts, molds, and the vegetative cells of spoilage bacteria also die at pasteurization temperatures. To render log-acid foods commercially sterile requires a retort capable of operating at temperatures above 212°F. Canners process certain canned foods at 240°F or 250°F for a considerable length of time, sometimes an hour or more depending upon the product and can size. Commercial sterility is the destruction and/or inhibition of the organisms of public health significance as well as organisms of non-health significance which could spoil the product. Microbiologists sterilize media at 250°F (121C) for 15 or 20 minutes. These examples illustrate the need for high temperatures and sufficient time to kill a population of bacteria.

The “Indicator” Organisms

The “indicator” organisms are so called because their presence in large numbers in food signifies one of three contamination possibilities: disease bacteria or filth; spoilage or low quality; or preparation under insanitary conditions.

Aerobic Plate Count

The aerobic plate count (APC) measures only that fraction of the bacterial flora that is able to grow to visible colonies under the arbitrary test conditions provided in the time period allowed. It does not measure the total bacterial population in a food sample, but is the best estimate. Altering conditions, such as composition of the agar medium or temperature of incubation, changes the spectrum of organisms that will grow. It is necessary to adhere rigidly to the standardized test conditions that have encouraged some to call the APC a “standard plate count.”

Food Poisoning

Human illnesses caused by foodborne microorganisms are popularly referred to as food poisoning. The common use of a single classification is due primarily to similarities of symptoms of various food-related diseases (see Table 5). Apart from illness due to food allergy or food sensitivity, foodborne illness may be divided into two major classes, food infection and food intoxication. Food infection results when foods contaminated with pathogenic, invasive, food poisoning bacteria are eaten. These bacteria then proliferate in the human body and eventually cause illness. Food intoxication follows the ingestion of preformed toxic substances which accumulate during the growth of certain bacterial types in foods.

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- **Competitive questions from today topic (2 questions Minimum)-**

  Which one of the following diseases is caused by a bacteria?

  Measles

Tetanus

Marek's disease

Mumps

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The main difference between Gram positive and Gram negative bacteria is

- Cell membrane
- Cell Wall
- Ribosome
- Mitochondria

Exam NameDBT JRF 2015

- **Suggestions to secure good marks to answer in exam-**
  - Give answer with complete labeled diagrams.
  - Explain answer with key point answers

- **Questions to check understanding level of students-**
  - What is propogation process?
  - Give five food poisioning microbes.

CHAPTER 6

Baker's yeast production.

Baker's yeast:

Baker's yeast is the common name for the strains of yeast commonly used in baking bread and bakery products, serving as a leavening agent which causes the bread to *rise* (expand and become lighter and softer) by converting the fermentable sugars present in the dough into carbon dioxide and ethanol. Baker's yeast is of the species *Saccharomyces cerevisiae*, and is the same species (but a different strain) as the kind commonly used in alcoholic fermentation, which is called brewer's yeast. Baker's yeast is also a single-cell microorganism found on and around the human body.

The use of steamed or boiled potatoes, water from potato boiling, or sugar in a bread dough provides food for the growth of yeasts; however, too much sugar will dehydrate them. Yeast growth is inhibited by both salt and sugar, but more so by salt than sugar. Some sources say fats, such as butter and eggs, slow down yeast growth; others say the effect of fat on dough remains unclear, presenting evidence that small amounts of fat are beneficial for baked bread volume.

Saccharomyces exiguus (also known as *S. minor*) is a wild yeast found on plants, grains, and fruits that is occasionally used for baking; however, in general, it is not used in a pure form but comes from being propagated in a sourdough starter.

History:

It is not known when yeast was first used to bake bread; the earliest definite records come from Ancient Egypt. Researchers speculate that a mixture of flour meal and water was left longer than usual on a warm day and the yeasts that occur in natural contaminants of the flour caused it to ferment before baking. The resulting bread would have been lighter and tastier than the previous hard flatbreads. It is generally assumed that the earliest forms of leavening were likely very similar to modern sourdough; the leavening action of yeast would have been discovered from its action on flatbread doughs and would have been either cultivated separately or transferred from batch to batch by means of previously mixed ("old") dough. Also, the development of leavened bread seems to have developed in close proximity to the development of beer brewing, and barm from the beer fermentation process can also be used in bread making.

Types of baker's yeast

Baker's yeast is available in a number of different forms, the main differences being the moisture contents. Though each version has certain advantages over the others, the choice of which form to use is largely a question of the requirements of the recipe at hand and the training of the cook preparing it. Dry yeast forms are good choices for longer-term storage, often lasting more than a year at room temperatures without significant loss of viability. In general, with occasional allowances for liquid content and temperature, the different forms of commercial yeast are considered interchangeable.

- **Cream yeast** is the closest form to the yeast slurries of the 19th century, in essence being a suspension of yeast cells in liquid, siphoned off from the growth medium. Its primary use is in industrial bakeries with special high-volume dispensing and mixing equipment, and it is not readily available to small bakeries or home cooks.

- **Compressed yeast** is, in essence, cream yeast with most of the liquid removed. It is a soft solid, beige in color, and best known in the consumer form as small, foil-wrapped cubes of **cake yeast**. It is also available in a larger-block form for bulk usage. It is highly perishable; though formerly widely available for the consumer market, it has become less common in supermarkets in some countries due to its poor keeping properties, having been superseded in some such markets by active dry and instant yeast. It is still widely available for commercial use, and is somewhat more tolerant of low temperatures than other forms of commercial yeast; however, even there, instant yeast has made significant market inroads.
- **Active dry yeast** is the form of yeast most commonly available to non-commercial bakers in the United States. It consists of coarse oblong granules of yeast, with live yeast cells encapsulated in a thick jacket of dry, dead cells with some growth medium. Under most conditions, active dry yeast must first be proofed or rehydrated. It can be stored at room temperature for a year, or frozen for more than a decade, which means that it has better keeping qualities than other forms, but it is generally considered more sensitive than other forms to thermal shock when actually used in recipes.

A single grain of active dry yeast. The numbered ticks on the scale are 230 μm apart

- **Instant yeast** appears similar to active dry yeast, but has smaller granules with substantially higher percentages of live cells per comparable unit volumes. It is more perishable than active dry yeast but also does not require rehydration, and can usually be added directly to all but the driest doughs. In general, instant yeast has a small amount of ascorbic acid added as a preservative. Some producers provide specific variants for doughs with high sugar contents, and such yeasts are more generally known as **osmotolerant** yeasts.
- **Rapid-rise yeast** is a variety of dried yeast (usually a form of instant yeast) that is of a smaller granular size, thus it dissolves faster in dough, and it provides greater carbon dioxide output to allow faster rising. There is considerable debate as to the value of such a product; while most baking experts believe it reduces the flavor potential of the finished product, *Cook's Illustrated* magazine, among others, feels that, at least for direct-rise recipes, it makes little difference. Rapid-rise yeast is often marketed specifically for use in bread machines.
- **Deactivated yeast** is dead yeast which has no leavening value and is not interchangeable with other yeast types. Typically used for pizza and pan bread doughs, it is used at a rate of 0.1% of the flour weight, though manufacturer specifications may vary. It is a powerful reducing agent used to increase the extensibility of a dough.

Industrial production:

The baking industry relies on industrial production of its ingredients, including baking yeasts. Much effort has been put into developing and marketing yeasts that will perform reliably in mass production. Since the end of the nineteenth century, baker's yeast has been produced by companies that specialize in its production.

The main ingredients for industrial production are yeast cultures; but a number of minerals, nitrogen and vitamins are also needed.

Fermentation happens in several phases, which vary depending on the manufacturer:

- pure cultures in a laboratory flask for 2 to 4 days, then batch fermentations for 13 to 24 hours (anaerobic);
- intermediate and stock fermentation with gradual feeding and constant aeration;
- pitch and trade fermentation with large air supplies for up to 15 hours;
- filtration, blending, extrusion, and cutting, drying.

The yeast grows from hundreds kg in the intermediate and stock fermentor to tens of thousands kg in the trade fermentor, where most yeast is produced. The earlier stages produce more ethanol and other alcohols, while in the final stages ethanol production is suppressed up to 95 % by controlling the amount of oxygen and sugar, in order to increase the yeast production instead.

The industry is highly concentrated, with 5 companies holding up to 80% of the worldwide market for dry yeast as of 2006. While dry yeast is exported over long distances and mostly sold in the developing countries, industrial customers often prefer to supply fresh yeast from local facilities, with a single wholesaler having up to 90% of the liquid yeast market in the UK in 2006. In USA companies like AB Vista, produced hundreds of thousands of metric tons of yeast in 2012.

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- **Competitive questions from today topic (2 questions Minimum)-**

If the doubling time of an organism is 0.693 h, the specific growth rate will be

A. 1 h-1
B. min-1
C. h-1
D. 10 min-1

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Which one of the following statements about the M13 bacteriophage is INCORRECT?

- It mediates transduction
- It is a single-stranded DNA phage
- It produces progeny without lysing the host cell
- It is useful in sequencing strategies

Exam NameDBT JRF 2015

- **Suggestions to secure good marks to answer in exam-**
  - Give answer with complete labeled diagrams.
  - Explain answer with key point answers

- **Questions to check understanding level of students-**
  - What is propogation process?
  - Give five food poisioning microbes.

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