Food microbiology

Food microbiology is the study of the microorganisms that inhabit, create, or contaminate food. Of major importance is the study of microorganisms causing food spoilage. "Good" bacteria, however, such as probiotics, are becoming increasingly important in food science. In addition, microorganisms are essential for the production of foods such as cheese, yogurt, and other fermented foods such as bread, beer and wine.

Food safety

Food safety is a major focus of food microbiology. Pathogenic bacteria, viruses and toxins produced by microorganisms are all possible contaminants of food. However, microorganisms and their products can also be used to combat these pathogenic microbes. Probiotic bacteria, including those that produce bacteriocins, can kill and inhibit pathogens. Alternatively, purified bacteriocins such as nisin can be added directly to food products. Finally, bacteriophages, viruses that only infect bacteria, can be used to kill bacterial pathogens. Thorough preparation of food, including proper cooking, eliminates most bacteria and viruses. However, toxins produced by contaminants may not be heat-labile, and some are not eliminated by cooking.

Fermentation

Fermentation is one way microorganisms can change a food. Yeast, especially Saccharomyces cerevisiae, is used to leaven bread, brew beer and make wine. Certain bacteria, including lactic acid bacteria, are used to make yogurt, cheese, hot sauce, pickles, fermented sausages and dishes such as kimchi. A common effect of these fermentations is that the food product is less hospitable to other microorganisms, including pathogens and spoilage-causing microorganisms, thus extending the food's shelf-life.

Food fermentations are ancient technologies that harness microorganisms and their enzymes to improve the human diet. Fermented foods keep better, have enhanced flavours, textures and aromas, and may also possess certain health benefits, including superior digestibility. For vegetarians, fermented foods serve as palatable, protein-rich meat substitutes.

Some cheese varieties also require molds to ripen and develop their characteristic flavors.

Probiotics

Probiotics are living organisms that, when consumed, have health benefits apart from their inherent nutritional effects. There is a growing body of evidence for the role of probiotics in gastrointestinal infections, irritable bowel syndrome and inflammatory bowel disease.

Lactobacillus species are used for the production of yogurt, cheese, sauerkraut, pickles, beer, wine, cider, kimchi, chocolate and other fermented foods, as well as animal feeds such as silage. In recent years, much interest has been shown in the use of lactobacilli as probiotic organisms and their potential for disease prevention in humans and animals.

Bifidobacteria are considered as important probiotics, and are used in the food industry to relieve and treat many intestinal disorders. Bifidobacteria exert a range of beneficial health effects, including the regulation of intestinal microbial homeostasis, the inhibition of pathogens and harmful bacteria that colonize and/or infect the gut mucosa, the modulation of local and systemic immune responses, the repression of procarcinogenic enzymatic activities within the microbiota, the production of vitamins, and the bioconversion of a number of dietary compounds into bioactive molecules.
Microbial biopolymers

A variety of biopolymers\(^1\), such as polysaccharides, polyesters and polyamides, are naturally produced by microorganisms. Several microbially-produced polymers are used in the food industry.

Xanthan

Plant-pathogenic bacteria of the genus *Xanthomonas* are able to produce the acidic exopolysaccharide xanthan gum\(^1\). Because of its physical properties, it is widely used as a viscosifier, thickener, emulsifier or stabilizer in the food industry.

Alginate

Alginate is the main representative of a family of polysaccharides. Alginates can be used as thickening agents. Although listed here under the category 'Microbial polysaccharides', commercial alginates are currently only produced by extraction from brown seaweeds such as *Laminaria hyperborea* or *L. japonica*.

Cellulose

Cellulose is a simple polysaccharide, in that it consists only of one type of sugar (glucose). Currently, the key genes involved in cellulose biosynthesis and regulation are known in a number of bacteria, but many details of the biochemistry of its biosynthesis are still not clear. In spite of the enormous abundance of cellulose in plants, bacterial cellulosics are being investigated for industrial exploitations.

Poly-\(\gamma\)-glutamic acid

Poly-\(\gamma\)-glutamic acid (\(\gamma\)-PGA) is produced by various strains\(^2\) of *Bacillus*. It has potential applications as a thickener in the food industry.

Levan

Levan, a homopolysaccharide, has great potential as a functional biopolymer in foods, feeds, cosmetics, and the pharmaceutical and chemical industries. Levan can be used as food or a feed additive with prebiotic and hypocholesterolemic\(^3\) effects.

Exopolysaccharides

Microorganisms synthesize a wide spectrum of multifunctional polysaccharides, including intracellular polysaccharides, structural polysaccharides and extracellular polysaccharides or exopolysaccharides (EPSs). EPSs generally consist of monosaccharides and some noncarbohydrate substituents (such as acetate\(^4\), pyruvate\(^5\), succinate\(^6\), and phosphate\(^7\)). Owing to the wide diversity in composition, they have found multifarious applications in various food and pharmaceutical industries.

Foodborne pathogens

Foodborne pathogens are the leading causes of illness and death in less developed countries, killing approximately 1.8 million people annually. In developed countries, foodborne pathogens are responsible for millions of cases of infectious gastrointestinal diseases each year, costing billions of dollars in medical care and lost productivity. New foodborne pathogens and foodborne diseases are likely to emerge, driven by factors such as pathogen evolution, changes in agricultural and food manufacturing practices, and changes to the human host status. There are growing concerns that
terrorists could use pathogens to contaminate food and water supplies in attempts to incapacitate thousands of people and disrupt economic growth.

**Enteric viruses**

Food and *waterborne* viruses contribute to a substantial number of illnesses throughout the world. Among those most commonly known are hepatitis A virus, rotavirus, astrovirus, enteric adenovirus, hepatitis E virus, and the human caliciviruses consisting of the noroviruses and the Sapporo viruses. This diverse group is transmitted by the fecal-oral route, often by ingestion of contaminated water and food.

**Protozoan parasites**

Protozoan parasites associated with food and water can cause illness in humans. Although parasites are more commonly found in developing countries, developed countries have also experienced several foodborne outbreaks. Contaminants may be inadvertently introduced to the foods by inadequate handling practices, either on the farm or during processing of foods. Protozoan parasites can be found worldwide, either infecting wild animals or in water and contaminating crops grown for human consumption. The disease can be much more severe and prolonged in immunocompromised individuals.

**Mycotoxins**

Molds produce mycotoxins, which are secondary metabolites that can cause acute or chronic diseases in humans when ingested from contaminated foods. Potential diseases include cancers and tumors in different organs (heart, liver, kidney, nerves), gastrointestinal disturbances, alteration of the immune system, and reproductive problems. Mycotoxins occur mainly in cereal grains (barley, maize, rye, wheat), coffee, dairy products, fruits, nuts and spices. Control of mycotoxins in foods has focused on minimizing mycotoxin production in the field, during storage or destruction once produced.

Aflatoxins are still recognized as the most important mycotoxins. The expression of aflatoxin-related diseases is influenced by factors such as age, nutrition, sex, species and the possibility of concurrent exposure to other toxins. The main target organ in mammals is the liver, so aflatoxicosis is primarily a hepatic disease. Conditions increasing the likelihood of aflatoxicosis in humans include limited availability of food, environmental conditions that favor mold growth on foodstuffs, and lack of regulatory systems for aflatoxin monitoring and control.

**Yersinia enterocolitica**

*Yersinia enterocolitica* includes pathogens and environmental strains that are ubiquitous in terrestrial and fresh water ecosystems. Evidence from large outbreaks of yersiniosis and from epidemiological studies of sporadic cases has shown that *Y. enterocolitica* is a foodborne pathogen. Pork is often implicated as the source of infection. The pig is the only animal consumed by man that regularly harbors pathogenic *Y. enterocolitica*. An important property of the bacterium is its ability to multiply at temperatures near 0°C, and therefore in many chilled foods.

**Vibrio**

*Vibrio* species are prevalent in estuarine and marine environments, and seven species can cause foodborne infections associated with seafood. *Vibrio cholerae* O1 and O139 serotypes produce cholera toxin and are agents of cholera. However, fecal-oral route infections in the terrestrial environment are responsible for epidemic cholera.
**Staphylococcus aureus**

*Staphylococcus aureus* is a common cause of bacterial foodborne disease worldwide. Symptoms include vomiting and diarrhea that occur shortly after ingestion of *S. aureus* toxin-contaminated food. The symptoms arise from ingestion of preformed enterotoxin, which accounts for the short incubation time.

**Campylobacter**

*Campylobacter* is one of the major causes of bacterial gastroenteritis worldwide. Campylobacter infection is primarily a foodborne illness, usually without complications; however, serious sequelae, such as Guillain-Barre Syndrome, occur in a small subset of infected patients.

**Listeria monocytogenes**

*Listeria monocytogenes* is a Gram-positive foodborne bacterial pathogen and the causative agent of human listeriosis. Listeria infections are acquired primarily through the consumption of contaminated foods, including soft cheese, raw milk, deli salads, and ready-to-eat foods such as luncheon meats and frankfurters. Although *L. monocytogenes* infection is usually limited to individuals that are immunocompromised, the high mortality rate associated with human listeriosis makes it the leading cause of death among foodborne bacterial pathogens. As a result, tremendous effort has been made to develop methods for the isolation, detection and control of *L. monocytogenes* in foods.

**Salmonella**

*Salmonella* serotypes continue to be a prominent threat to food safety worldwide. Infections are commonly acquired by animal to human transmission though consumption of undercooked food products derived from livestock or domestic fowl. The second half of the 20th century saw the emergence of *Salmonella* serotypes that became associated with new food sources (i.e. chicken eggs) and the emergence of *Salmonella* serotypes with resistance against multiple antibiotics.

**Shigella**

*Shigella* species are members of the family *Enterobacteriaceae* and are Gram negative, nonmotile rods. Symptoms include mild to severe diarrhea with or without blood, fever, tenesmus and abdominal pain. Further complications of the disease may be seizures, toxic megacolon, reactive arthritis and hemolytic uremic syndrome. Transmission of the pathogen is by the fecal-oral route, commonly through food and water. *Shigella* spp. are one of the leading causes of bacterial foodborne illnesses and can spread quickly within a population.

**Escherichia coli**

More information is available concerning *Escherichia coli* than any other organism, thus making *E. coli* the most thoroughly studied species in the microbial world. For many years, *E. coli* was considered a commensal of human and animal intestinal tracts with low virulence potential. It is now known that many strains of *E. coli* act as pathogens, inducing serious gastrointestinal diseases and even death in humans.

**Clostridium botulinum and Clostridium perfringens**

*Clostridium botulinum* produces extremely potent neurotoxins that result in the severe neuroparalytic disease, botulism. The enterotoxin produced by *C. perfringens* during sporulation of vegetative cells in the host intestine results in debilitating acute diarrhea and abdominal pain. Sales of refrigerated, processed foods of extended durability including sous-vide foods, chilled ready-to-eat meals, and cook-chill foods have increased over recent years. Anaerobic spore-formers have been identified as the primary microbiological concerns in these foods.
Bacillus cereus

The Bacillus cereus is a normal soil inhabitant, and is frequently isolated from a variety of foods, including vegetables, dairy products and meat. It causes a vomiting or diarrhea illness that is becoming increasingly important in the industrialized world. Some patients may experience both types of illness simultaneously. The diarrheal type of illness is most prevalent in the western hemisphere, whereas the emetic type is most prevalent in Japan. Desserts, meat dishes, and dairy products are the foods most frequently associated with diarrheal illness, whereas rice and pasta are the most common vehicles of emetic illness.

Glossary

1. **Fermentation**: Any enzymatic transformation of organic substrates, especially carbohydrates, generally accompanied by the evolution of gas. (Biochemistry) Any of many anaerobic biochemical reactions in which an enzyme (or several enzymes produced by a microorganism) catalyses the conversion of one substance into another; especially the conversion (using yeast) of sugars to alcohol or acetic acid with the evolution of carbon dioxide.

2. **Bacteriocins**: αντιβιοτικά

3. **Bacteriophages**: βακτηριοφάγος

4. **Heat-labile**: θερμοευαίσθητος

5. **Yeast**: ζυμομύκητας

6. **Saccharomyces cerevisiae**: is a species of yeast. It is perhaps the most useful yeast, having been instrumental to baking and brewing since ancient times.

7. **Kimchi**: A Korean dish made of vegetables, such as cabbage or radishes, that are salted, seasoned, and stored in sealed containers to undergo lactic acid fermentation.

8. **Irritable bowel syndrome**: (IBS, or spastic colon) is a diagnosis of exclusion. It is a functional bowel disorder characterized by chronic abdominal pain, discomfort, bloating, and alteration of bowel habits in the absence of any detectable organic cause.

9. **Inflammatory bowel disease**: (IBD) is a group of inflammatory conditions of the colon and small intestine. The major types of IBD are Crohn’s disease and ulcerative colitis.

10. **Lactobacillus**: γαλακτοβακτήρια

11. **Sauerkraut**: a dish made by fermenting finely chopped cabbage (ξινολάχανο)

12. **Bifidobacteria**: δισχιδοβακτήρια

13. **Homeostasis**: ομοιόσταση

14. **Gut mucosa**: μεμβράνη, βλεννογόνος των εντέρων

15. **Microbiota**: μικροχλωρίδα

16. **Bioconversion**: The conversion of biological material into usable products; but especially the conversion of biomass into biofuel (βιομετατροπή)

17. **Bioactive**: Having a biological effect (βιοδραστικός)

18. **Biopolymers**: βιοπολυμερή

19. **Acidic exopolysaccharide xanthan gum**: άξινο ξανθακικό πολυακχαριδικό κόμμι

20. **Strain**: A particular breed or race of animal, microbe etc. γένος
hypcholesterolemia: υποχοληστερολαιμική
acetate: οξεικό οξύ/ αιθανικό οξύ
pyruvate: πυροσταφυλικό
succinate: (organic chemistry) any salt or ester of succinic acid (ηλεκτρικό οξύ)
phosphate: φωσφορικό άλας
rotavirus: Any of a group of wheel-shaped viruses, of the genus Rotavirus, that causes gastroenteritis and diarrhea in children and animals. (ροταϊό)
astrovirus: (virology) Any member of the family Astroviridae of icosahedral viruses with a characteristic starlike surface structure
enteric adenovirus: εντερικός αδενοϊός
noroviruses: A genus of RNA viruses of the Caliciviridae family which causes gastroenteritis.
Sapporo viruses: A genus of the family CALICIVIRIDAE associated with worldwide sporadic outbreaks of gastroenteritis in humans.
fecal-oral route: through the feces and through the mouth
immunocompromissed: Having an immune system that has been impaired by disease or treatment. (ανοσοκατεσταλμένος)
secondary metabolites: are organic compounds that are not directly involved in the normal growth, development, or reproduction of an organism.
aflatoxicosis: a disease caused by the consumption of aflatoxins
yersiniosis: is an uncommon infection caused by the consumption of undercooked meat products, unpasteurized milk, or water contaminated by the bacteria.
serotypes: ορότυπος
sequela (lae, plural): a disease or condition which is caused by an earlier disease or problem
Gram-positive: Gram-positive bacteria retain the color of the crystal violet stain in the Gram stain. This is characteristic of bacteria that have a cell wall composed of a thick layer of a particular substance (called peptidolglycan). The Gram-positive bacteria include staphylococci ("staph"), streptococci ("strep"), pneumococci, and the bacterium responsible for diphtheria (Corynebacterium diphtheriae) and anthrax (Bacillus anthracis). The Danish bacteriologist J.M.C. Gram (1853-1938) devised a method of staining bacteria using a dye called crystal (gentian) violet. Gram's method helps distinguish between different types of bacteria. The gram-staining characteristics of bacteria are denoted as positive or negative, depending upon whether the bacteria take up and retain the crystal violet stain or not.
nonmotile rods
tenesmus: The painful and often ineffectual straining to relieve the bowels (τεινεσμός)
seizure: A sudden attack or convulsion, (e.g. an epileptic seizure).
toxic megacolon: τοξικό μεγάκολο: οξέα κολίτιδα, η οποία συνοδεύεται από συστηματικές τοξικές εκδηλώσεις και ανεκονοντικά ευρήματα τηματικής ή καθαυτικής μη αποφρακτικής διάτασης του παχέος εντέρου και αποτελεί μια συνήθη, καταστροφική, δυνητικά θανατηφόρο επιπλοκή κολίτιδας.
reactive arthritis: it can be the result of Salmonella infection or other gastrointestinal illnesses. The arthritis can be severe.
hemolytic uremic syndrome: σιμολυτικό ουραμικό σύνδρομο
sporulation: the process of a bacterium becoming a spore
sous-vide: Describing a method of cooking, intended to maintain the integrity of ingredients, in which food is heated in airtight bags for an extended period of time at relatively low, but tightly controlled temperatures.
*spore-formers: viruses producing spores

*Nisin* (biochemistry) a polycyclic peptide produced by fermentation with the bacterium *Lactococcus lactis*; used as a preservative in processed cheese etc *νισίνη*

**Lactobacillus**

![Lactobacillus image]

**Bifidobacteria**

![Bifidobacteria image]
READING COMPREHENSION

a. Answer the following True or False statements. Provide the correct answer for the false ones.

1. Food microbiology studies the microorganisms that contaminate food. T/F?
2. Foodborne pathogens are responsible for infectious gastrointestinal diseases in underdeveloped countries. T/F?
3. Probiotics have nutritional effects only. T/F?
4. Food and waterborne viruses are the cause of many serious enteric illnesses worldwide. T/F?
5. Human Listeriosis is a leading cause of death among foodborne bacterial pathogens. T/F?
6. Botulism is a severe cardiovascular disease caused by Clostridium botulinum neurotoxins. T/F?
7. Bacillus cereus is never found in vegetables dairy products and meat. T/F?
8. Shigella is not a leading cause of foodborne diseases. T/F?
9. Escherichia coli can cause death in humans. T/F?
10. Food fermentation is a modern technique. T/F?
11. Many bacteria are used in food production. T/F?
12. Most biopolymers are artificially produced. T/F?
13. Environmental conditions lead to the appearance of aflatoxins. T/F?
14. Staphylococcus aureus does not affect the immune system. T/F?
15. Campylobacter is not a foodborne disease. T/F?

B. Scan the text and answer the following questions.

1. Which is a very important part of the food microbiology study?
2. What is the main focus of the food microbiology study?
3. What are possible contaminants of food?
4. What bacteria can be used to fight other bacteria?
5. What are the bacteriophages?
6. What can eliminate most bacteria and viruses?
7. Why are some contaminants not eliminated by cooking?
8. What is the function of yeast?
9. What is fermentation?
10. What is the use of lactic acid bacteria?
11. What is a result of most fermentations?
12. What are the benefits of fermentation?
13. What food involves “spoilage” by microorganisms to take its final form and taste?
14. What are probiotics?
15. Where are lactobacilli used?
16. What may be an important future application of lactobacilli regarding health?
17. What is the importance of bifidobacteria?
18. How is Xanthan used in the food industry?
19. Which microorganism is widely used as a thickening agent?
20. What is cellulose?
21. Where can cellulose be found in large quantity?
22. What are bacterial celluloses being tested for?
23. Which acid has a possible application as a thickener in food industry?
24. What are the effects of Levan as an additive?
25. Are exopolysacharides useful in any way?
26. What factors may help the development of new foodborne pathogens & food diseases?
27. Which factors influence the appearance of aflatoxins?
28. What is aflatoxicosis and conditions contribute to its appearance?
29. How are some very common enteric viruses transmitted?
30. How may protozoan parasites be transmitted to foods?
31. What are mycotoxins and what is their effect?
32. Where do mycotoxins mainly occur?
33. What kind of pathogen is Y. enterocolitica?
34. What is an important characteristic of the bacterium Y. enterocolitica?
35. Which is the most suspected source of Y. enterocolitica infection?
36. With what kind of food is vibrio infection associated with?
37. What is responsible for epidemic cholera?
38. What is Staphylococcus aureus responsible for worldwide?
39. What is a major cause of bacterial gastroenteritis worldwide?
40. How is listeriosis mainly acquired?
41. How is salmonella acquired?
42. How have salmonella serotypes developed since the second half of the 20th century?
43. What are the symptoms of shigellosis and how is it transmitted?
44. What is a “special ability” of shigella spp?
45. What kinds of foods are likely to carry Clostridium botulinum & C. perfrigens?
46. Where Bacillus cereus is normally found?
47. What kinds of foods are likely to carry B. cereus?
FOOD MICROBIOLOGY – VOCABULARY

Acute (adj): sharp; intense; very serious or dangerous: requiring serious attention or action

Abundance (n): a large amount of something

Agent (n): An active power or cause; something which has the power to produce an effect such as a physical, chemical, or medicinal agent; e.g., heat is a powerful agent.

Bioactive: Having a biological effect

Bioconversion (n): The conversion of biological material into usable products; but especially the conversion of biomass into biofuel

Bowel: large intestine

Colonize (v): to create a colony in or on (a place): to take control of (an area) and send people to live there; to move into and live in (a place) as a new type of plant or animal

Combat (v): fight

Commensal (n): (ecology) a form of symbiosis in which one organism gets a benefit while the other is unaffected

Commercial (adj): relating to trade

Concurrent (adj): Happening at the same time; simultaneous.

Contaminate (v): To introduce impurities or foreign matter; to soil or defile.

Contribute (v): to give something, that is or becomes part of a larger whole

Eliminate (v): to completely destroy (something) so that it no longer exists

Exploitation (n): The act of exploiting or utilizing. exploit (v): To usefully and effectively use what is available; to use for one's own advantage.

Exposure (n)-expose (v): to cause (someone) to experience something or to be influenced or affected by something — + to

Favor (v): to prefer; to be fond or something or someone (favour Br. English spelling)

Ferment (v)- fermentation (n): Any enzymatic transformation of organic substrates, especially carbohydrates, generally accompanied by the evolution of gas.

Foodborne (adj): Transmitted through food.

Foodstuff (n): A substance that can be used or prepared for use as food.

Fowl (n): A bird of the order Galliformes, including chickens, turkeys, pheasants, partridges, and quail.

Emerge (v): to come out of a liquid; to come into view; become known; appear

Emulsifier (n): A substance that helps to combine two liquids, esp. a water-based liquid and oil

Enhance (v): To make better, more useful, more beautiful through modification.
**Exert (v):** ασκώ (πίεση, επίδραση, δύναμη κλπ.)

**Extend (v):** To cause to last for a longer period of time; to increase in extent

**Evolution (n):** A gradual process of development, formation, or growth, especially, one leading to a more advanced or complex form; (biology) The change in the genetic composition of a population over successive generations.

**Host (n):** (biology) cell or organism which harbors another organism

**Harbor (v):** To provide a harbor or safe place for; (εγκωλπίζω - μεταφορική χρήση)

**Harness (v):** to capture, control or put to use; restrict

**Handling (n)-handle(v):** manage, treat, use

**Heat-labile (adj):** θερμοευαίσθητα, θερμοασταθή

**Hospitable (adj):** generous towards guests; receptive (μεταφορική χρήση)

**Inadequate (adj):** insufficient; Deficient; unequal to the purpose

**Inadvertently (adv):** by accident; without intention

**Infect (v):** to bring into contact with a substance that can cause illness λοιμωξή, μολυνσή

**Inflammatory (adj):** φλεγμονώδεις

**Inhabit (v):**

**Inherent (adj):** naturally a part or consequence of something. συμφυτος

**Inhibit (v):** to hinder; to restrain αναστελλω

**Immune (adj):** Unable to catch a certain disease.

**Implicate (v):** To connect or involve in an unfavorable or criminal way with something.

**Incubation (n):** (pathology) The development of a disease from its causes, or its period of incubation.

**Irritable (adj):** ευερέθιστος

**Isolation (n):** (microbiology) the separation of a microorganism from others for identification

**Gene (n):** (genetics) A unit of heredity; a segment of DNA or RNA

**Genus (n):** rank in a taxonomic classification between family and species

**lactic acid:** γαλάκτικο οξύ

**Leaven (v):** To cause to rise by fermentation. Any agent used to make dough rise or to have a similar effect on baked goods./ μαγια προζυμι

**Livestock (n):** Cattle, horses, and similar animals kept for domestic use especially on a farm.

**Luncheon (n):** pork meat in various forms usually canned

**Mold (n):** soft substance that grows on the surface of damp or rotting things
**Multifarious (adj):** Having multiplicity; having great diversity or variety; of various kinds; made up of many differing parts;

**Multifunctional (adj):** Having multiple functions

**Outbreak (n):** a sudden increase

**Palatable** Pleasing to the taste, tasty./εύγευστος

**Possess (v):** to have; to have ownership of

**Potential (adj):** existing in possibility, not in actuality; future; unrealized ability

**Prevalent (adj):** Most frequent or common; Superior or dominant; Widespread or preferred.

**Prominent (adj):** Immediately noticeable or standing out; distinguished above others

**Properties (n):** the abstract qualities associated with an object; Attribute or characteristic of an object that is used to define its state, appearance, or value e.g., the properties of hydrogen

**Relieve (v):** to reduce or remove (something, such as pain or an unpleasant feeling); relieve of: to take (something that is difficult or unpleasant) from (someone); remove pain

**Representative (adj):** typical of a particular group of people or of a particular thing

**Repression (n):** the act of not allowing a condition or state to be expressed (καταστολή)

**Ripen (v):** To cause to mature;

**Seaweed (n):** marine plants and algae

**Shelf-life (n):** the length of time that food may be stored and still be good to eat

**Silage (n):** Fermented green forage fodder stored in a silo

**Simultaneously (adv):** actions or activities or events occurring at the same time

**Spectrum (n):** range; Specifically, a range of colours representing light (electromagnetic radiation) of contiguous frequencies; hence electromagnetic spectrum, visible spectrum, ultraviolet spectrum, etc

**Stabilizer (n):** substance added to something in order to stabilize it (σταθεροποιητής)

**Substantial (adj):** large in size, quantity, or value ; most important; essential.

**Substitute:** To use in place of something else, with the same function. A replacement or stand-in for something that achieves a similar result or purpose. (Ἀναπληρώω ἀποκαθιστώ αντικαθιστώ)

**Substituent(n):** (chemistry) Any atom, group, or radical substituted for another, or entering a molecule in place of some other part which is removed.

**Superior (adj):** higher in rank or quality;

**Terrestrial (adj):** living or growing on land; not aquatic

**Texture (n):** The feel or shape of a surface or substance; the smoothness, roughness, softness, etc. of something.

**Thickener (n):** Any substance added to something in order to thicken it (πυκνωτικό)
**Vehicle (n):** a means of transportation; a medium through which something is transmitted or circulated; an agent

**Virulence (n):** The ability of a microorganism to cause damage to its host; its toxicity

**Viscosifier (n):** A substance which is used to make a liquid thicker -viscous (adj)- of a liquid: thick or sticky: not flowing easily

**Ubiquitous (adj):** be present everywhere
A. Skim the text and match the following descriptions with a suitable term

1. A pathogen transmitted through food.
2. Happening by accident or unintentionally
3. A product which is produced in large quantities and is sold widely in the market
4. To make a place or substance dirty or harmful by putting sthg such as chemicals or poison in it.
5. The enzymatic transformation of organic substrates, especially of carbohydrates, which is usually accompanied by the evolution of gas.
6. The soft substance that grows on the surface of things that rot
7. A substance that helps to combine two liquids into a milkfish form
8. The gradual process of development or growth, leading to a more advanced or complex form
9. A cell or organism which “carries” another organism
10. To bring sthg or somebody into contact with a substance that can cause illness
11. To restrain sthg from happening.
12. A substance which is used to make another substance thicker when added to it.
13. The development of a disease from its causes in the body until it shows its physical signs
14. A laboratory process which achieves the separation of a microorganism from others for identification
15. Farm animals kept for domestic use
16. A sudden increase or emergence of sthg
17. Something which has future possibility or ability
18. Something which is typical of a particular group of people or of a particular thing
19. The particular qualities or characteristics of an element that define its state, appearance etc.
20. The length of time that food may be stored and still be good to eat
B. Complete the table with the missing word forms.

<table>
<thead>
<tr>
<th>Colonize</th>
<th>prevalent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>thickener</td>
</tr>
<tr>
<td></td>
<td>substitute</td>
</tr>
<tr>
<td>expose</td>
<td>exploitation</td>
</tr>
<tr>
<td>contribute</td>
<td>representative</td>
</tr>
<tr>
<td>inhibit</td>
<td>irritable</td>
</tr>
<tr>
<td></td>
<td>fermented</td>
</tr>
<tr>
<td>eliminate</td>
<td>contaminating</td>
</tr>
<tr>
<td>isolate</td>
<td>incubation</td>
</tr>
<tr>
<td></td>
<td>implicated</td>
</tr>
<tr>
<td></td>
<td>stabilizer</td>
</tr>
<tr>
<td>emerge</td>
<td>inhabitant</td>
</tr>
<tr>
<td>exert</td>
<td></td>
</tr>
</tbody>
</table>
C. Prefixes

Prefixes are added to the beginning of words to change a) the word as part of the speech e.g., from noun to adjective b) the meaning of words; e.g., opposite, negative, c) to show degree, space, quantity etc.

The following are some common prefixes of Greek, Latin and French origin

- **en-, em-** derives a verb from a noun or adjective e.g.: *enforce* = make sthg larger
- **inter-** (means *between/ among*) e.g.: interact
- **re -** (means *again*) e.g.: reproduce
- **counter -** (means *against/ opposite to*) e.g.: counteract
- **over-** (means *too much/ in excess*) e.g.: overweight
- **under -** (means *too little*) e.g.: underweight
- **dis -** (means *the opposite*) e.g.: disconnect
- **de -** (means *cause not to be*) e.g.: dehydrate
- **im-, ir-, in-,** (means *not*) e.g.: impure, incorrect, irresponsible
- **un-** (means *not*) e.g.: unnecessary
- **super-** (means *above/ more than*) e.g.: supersaturated
- **sub-** (means *beneath, less than*) e.g.: subunit
- **for(e)-** (means *ahead, future*) e.g.: forward, forecast

**PRACTICE**

*Use the above prefixes to change the following words*

inhabited, essential, contaminated, infect, active, regular, digestible, possible, nourished, function, order, calculate, rate