UNIT 2 AQUACULTURE AND POLLUTION

Structure

2.0 INTRODUCTION

Aquaculture is the cultivation of fishes crustaceans, algae, and molluscs. Aquaculture includes developing freshwater and saltwater populaces under controlled conditions and can be diverged from business angling, which is the gathering of wild fish. It is also known as aquafarming. Aquaculture, in turn, is "the propagation and rearing of aquatic organisms in controlled or selected aquatic environments for any commercial, recreational, or public purpose." (NOAA, 2001). Mariculture is a specialized branch of aquaculture that involves the cultivation of marine organisms for food and other products particularly in the open ocean, an enclosed section of the ocean, or in tanks, ponds filled with seawater. This includes the farming of marine fish, including finfish and shellfish like prawns, or oysters and seaweed in saltwater ponds. Some examples of non-food products produced by mariculture include: fish meal, nutrient agar, jewellery (e.g. cultured pearls), and cosmetics.

Fish is a very good source of good-quality proteins, lipids and a wide variety of essential nutrients. Production of farmed fish, or aquaculture, is probably the fastest growing food sector worldwide, as now it accounts for nearly 40% of the world fish production.

As indicated by the Food and Agriculture Organization (FAO), aquaculture "is comprehended to mean the cultivating of oceanic life forms including fish, molluscs, shellfish and amphibian plants. Cultivating infers some type of intercession in the raising procedure to improve generation, for example, consistent stocking, nourishing, insurance from predators, and so forth. Specific sorts of aquaculture incorporate fish cultivating, shrimp cultivating, shellfish cultivating, mariculture, algaeculture, kelp cultivating, and the development of decorative fish. Specific strategies incorporate aquaponics and coordinated multi-trophic aquaculture, both of which use fish and plant cultivating techniques.

2.1 OBJECTIVES

After reading this unit you should be able to:

- define what is aquaculture and pollution;
- describe about the sources of aquaculture pollutants;
- define the feed practices in aquaculture;
- explain the effects of pollutants on environment and human health;
- describe the antibiotic usage and resistance; and
- understand the occupational health effects due to aquaculture.

2.2 SOURCES OF AQUACULTURE POLLUTANTS

Alongside the improvement, concerns are evoked about the conceivable impacts of consistently expanding aquaculture squander both on efficiency inside aquaculture frameworks and on the surrounding oceanic biological community. Escalated fish and shrimp cultivating, being characterized as throughput-based frameworks adds to eutrophication. Nitrogenous mixes (alkali, nitrite, and nitrate) are considered as real contaminants in aquaculture wastewater. Smelling salts is the primary nitrogenous waste delivered by oceanic creatures. Past, outdated advances and fragmented plan of waste administration frameworks in aquaculture contribute a ton to the decay of the aquaculture condition. Aquaculture contamination cause economic misfortunes in billion dollars.

Marine aquaculture usually consists of both land-based and offshore aquaculture. Off shore culture is mostly done in shallow seas, mud flats and protected bays. The main production types of offshore aquaculture are floating and semi-floating raft culture, net cage culture, sea ground sowing, vertical (hanging) culture and pond on tidal areas. Pond culture is also one of the most important methods among freshwater aquaculture. Also reservoir, lake, river and channel fish farming contributes most to the remaining fresh aquatic production forms. All these sources generate wastes and pollutants.

Aquacultural wastes include all materials used in the process which are not removed from the system during harvesting. These wastes mainly consist of uneaten feed or excreta, chemicals and therapeutic agents that are added to the ponds. They are discharged either in the sediments or in the farm effluents. The effluents contain both dissolved and particulate pollutants (inorganic and organic). An aquatic farm water quality depends mainly on the species

cultivated. Other conventional pollutants like nutrients, biological oxygen demand, and total suspended solids are mainly derived from feed, excreta and fertilizers. Fertilizers stimulate phytoplankton growth and fish production. Inorganic compounds of N and P are among the most usual fertilizers, but K, trace metals, and silicates may also be present. Since fertilizers increase the concentrations of nutrients in pond water, they may cause eutrophication in receiving water bodies. Pesticides, heavy metals and emerging pollutants used in intensive aquaculture also are some sources of pollutants. Heavy metals can also be found in pond effluents because they are common constituents of proteinates and vitamin/mineral premixes (e.g., Cu and Zn). They are also added as oxidizing agents for controlling phytoplankton and pathogenic organisms (e.g., KMnO4) or as algicides (e.g., CuSO4). Intensive fish farming is also a source of steroid hormones such as estrone, testosterone and androstenedione. Estrone is an important natural endocrine disrupting compound found in natural water due to its ubiquity and estrogenic potency. Steroids are found in the blood plasma of fish and can be excreted via urine or bile, especially during periods of reproduction. These contents are also seen in aquaculture effluents.

Check Your Progress 1

Note: a) Write your answer in about 50 words.
b) Check your answers given at the end of this unit.

1) Describe about aquaculture.

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2.3 FEED PRACTICES

One of the major expenses for farmers is fish feeding. Good fish feed administration can lessen general culture cost, enhance cultivation and guarantee solid development of fish stock. It is important to utilize a right sustaining technique, computing the feeding cost and guaranteeing the cost adequacy of fish cultivation.

Nutrients required for fish:

Protein, fat, starches, vitamins and minerals are the fundamental supplements for fish. Protein gives vitality and manufactures muscles. Protein Fat gives energetic fish. Carbohydrates: The energy required for growth is provided by carbohydrates. But it makes digestion difficult for carnivores aqua species. Vitamins and minerals are also important nutrients that are required for resistance. It is imperative that dietary prerequisites of fish fluctuate with various species, sizes, development stages and feeding habits. For instance flesh eating fish needs protein and fat than the omnivorous and herbivorous species, while marine fish require more protein and fat than freshwater fishes.

2.3.1 Common Fish Feed

The feeds are normally in the form of granules or pellets that provide the nutrition in a stable and concentrated form. It enables the fish to feed efficiently

and grow to their full potential. They are then combined with other ingredients such as vegetable proteins, cereal grains, vitamins and minerals and formed into feed pellets. There are two types of fish feed namely, vegetarian feed and trash fish. Pellet field is also a fish feed technology.

- Vegetarian feed:- It consists of Wheat grain, rice grain, weed, soy leftovers, flour and pea nut cakes are appropriate for freshwater fish
- Trash fish: - Fishing by-catch or fish caught and fed directly to larger species being raised in aquaculture pens.
- Hatchery feeds: - They are specialized feeds produced for fish hatcheries. In species such as salmon and trout, the newly hatched first feed from their yolk sacs and then can be fed with starter feeds. Marine species such as sea bass, sea bream, flounders and turbot consume the nutrition in their yolk sacs during the first few days post hatching and then are fed for several weeks on live prey, in the form of rotifers and brine shrimp. Special feeds can be used to enrich the nutritional value of the prey. Rotifers are usually bred in the hatchery while brine shrimp are generally collected from the wild, e.g. salt lakes.

2.3.2 How to Choose the Right Fish Feed

With such a significant number of assortments of fish feed, One basic route is to analyze the healthful requirement of the species, accessibility, value, stockpiling technique, cleanliness and ecological effects of different bolsters and see which one suits the necessities of your fish cultivate best.

- Nutrition: Trash fish and vegetarian feed might not have adequate supplements to fulfill the necessities of all refined fish. It might prompt ailing health which will disable the common protection of the refined fish and elevate the dangers of infections. Pellets can be encouraged for use with plant protein, different fats, vitamin complex and minerals as required by particular fish species. They are exceedingly nutritious and can viably enhance the wellbeing of fish stock.
- Hygiene: High moisture in fish feed can spoil them. Vegetarian feeds have low dampness content. Trash fish is high in dampness (around 70%). If not stored at low temperatures, it can get vigorously pervaded with microbes or parasites. The fat of waste fish oxidizes and spoils. Spoiled waste fish may cause sickness or death. Dry pellets do not decay on the grounds that it is low in dampness content (around 100/0). The moisture content of wet pellet is around 35% however the waste fish influences it to decay all the more effectively. Refrigeration is hence fundamental.
- Storage methods: The feeds can be stored for a few months when kept in a cool dry place. High moisture trash fish can be kept for around one week when kept at low temperatures of – 200°C. Else they should be utilized instantly after purchase.
- Environmental impacts: A fine vegetarian feed will contaminate the waters if left to suspend for a really long time. Waste fish shreds can cause contamination in lakes, sea-beds bringing about danger of anoxia and death rate in fishes. By utilizing proper pellet size and thickness, environmental contamination caused by the nourish deposits can be essentially decreased.

Check Your Progress 2

Note: a) Write your answer in about 50 words.
b) Check your answers given at the end of this unit.

1) Describe about feed practices in aquaculture.

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2.4 EFFECTS OF POLLUTANTS ON ENVIRONMENT AND HUMAN HEALTH

In this section we will discuss the impacts of aquaculture pollution in human health and environment.

2.4.1 Effect of Pollutants on Environment

Aquaculture is necessary to keep overfishing under control, but it also negatively impacts the environment. Eutrophication is a common issue that comes along with aquaculture. Eutrophication refers to the excess enrichment in a given ecosystem of nitrogen and phosphorous. Aquaculture causes eutrophication in a number of ways. In open water aquaculture systems, the excess fish feed introduces extra nitrogen and phosphorous directly into the water (Talbot & Hole 1994). Closed off inland systems contribute to eutrophication as they dump effluent directly into natural waterways.

The emissions of marine animal waste from aquaculture facilities into the ecosystem will not only affect other fish, but will also result in nutrient pollution. For example, one of the most harmful aquaculture systems is open net-cage farming. It involves the use of large mesh fishing nets to hold the farmed fish, and there is no way to prevent waste from escaping into the water. This waste can contain antibiotics, pesticides and fish feces which pollutes the open water and makes it unsafe for human drinking, recreational use, and for other wildlife.

Another negative impact is through discharge. Just like any other animal production system, aquaculture generates waste throughout the process. Aquaculture waste can be separated into solid and dissolved waste, specifically carbon, nitrogen, and phosphorous. Solid waste is derived from uneaten and/or spilled feed and from fish feces. Dissolved waste comes mostly from metabolites excreted by the fish. These two types of pollutants grow within a location and eventually will reduce the water quality of that particular system, while also leads to an influx of disease-carrying fish.

Aquaculture also leads to algal blooms. These are toxic to humans and animals and can make local water unsafe for drinking, recreation, and destroy local wildlife. Natural wetland capacities can be reduced due to aquaculture practices. Aquaculture advancement can harm the natural biogeochemistry of the wetlands.

2.4.2 Effect of Pollutants on Human Health

Solid wastes from aquaculture consist of feces or uneaten food. This can cause oxygen depletion and ammonia toxicity when it decomposes. The urine and

feces from the aquatic animals can cause high content of ammonia nitrogen and an increase of biochemical oxygen demand. All this can lead to health impacts. A number of chemicals are used in the aquaculture industry, including compounds applied to construction materials such as stabilizers, pigments, antifoulants and so on. Also pigments incorporated into feeds, disinfectants and chemotherapeutants are used. Antimicrobials are administered in the diet and most end up in the environment. All these cause ecological and human health disorders. The abuse of chemicals can also destroy the effective microbes and bring an imbalance of the aquatic ecology system.

Industrious organochlorine pesticides, for example, aldrin, endrin, dieldrin, chlordane, toxaphene, chlordecone, dichlorodiphenyltrichloroethane (DDT), dichlorodiphenyldichloroethylene (DDE), l,l-dichloro-2,2-bis(p-chlorophenyl)ethane (DDD), heptachlor epoxide and mirex can pose dangers for a long time. Natural contaminants, particularly polychlorinated biphenyls and dioxins deposits, can likewise cause potential health issues.

Potential aquaculture creation destinations can be assessed to limit ecological pollution or to decide moderation needs. Issues are typically site-particular and can be managed well. Pesticides utilized as a part of aquaculture to control sea-going weeds or different bugs ought to be utilized sustainably. In zones where farming crops are developed near aquaculture lakes, a sufficient cushion zone ought to be set up. The past land-utilized history of a planned creation site ought to be explored.

Check Your Progress 3

Note: a) Write your answer in about 50 words.
b) Check your answers given at the end of this unit.

1) Explain the effect of aquaculture pollution on the environment.

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2) Describe how the aquaculture and pollutant is affecting the human health.

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2.5 ANTIBIOTIC USAGE AND RESISTANCE

Antimicrobial substances can be characterized as substances that have the ability to execute or repress the development of microorganisms. After their formal revelation by Fleming in 1928, anti-infection agents have been found to be useful in fundamental medications for human and creature wellbeing and welfare. Anti-toxins can be determined from common sources or have manufactured roots. Anti-infection agents ought to be sheltered, permitting their utilization as chemotherapeutic operators for the treatment of bacterial irresistible maladies. Antimicrobials are additionally utilized for aquaculture, and their utilization can be sorted as helpful, prophylactic or metaphylactic.

Remedial utilization relates to the treatment of set up contaminations. Metaphylaxis is a term utilized for solutions for mass medication of a group of animals, in advance of an expected outbreak of disease. Prophylaxis implies the protection measures designed to preserve health and prevent the spread of disease. In aquaculture, anti-infection agents are helpful for brief timeframes by means of the oral course to fish etc. All medications lawfully utilized as a part of aquaculture must be endorsed by the administration organization in charge of veterinary pharmaceutical, for instance, the Food and Drug Administration (FDA). The accompanying antimicrobials approved for use in aquaculture include: oxytetracycline, florfenicol, and Sulfadimethoxine/ ormetoprim. These administrative organizations may set guidelines for anti-microbial utilize, including admissible dosage, resistances, and use by species, including measurements rates and constraints.

In the vast majority of the nations with a vital aquaculture industry, government organizations apply some controlling activities. For instance, in Norway the utilization of antimicrobials requires a veterinarian's medicine, and subsequently, their utilization is helpful. They are sold in drug stores or in plants approved by the Norwegian Medicines Agency. In Norway, it is compulsory to report the measure of anti-infection agents utilized. Serious fish cultivating has advanced the development of a few bacterial illnesses, which has driven to an expansion in the utilization of antimicrobials. Current levels of antimicrobial use worldwide in aquaculture are difficult to decide in light of the fact that unique nations have diverse circulation and enrollment frameworks.

2.5.1 Mechanism of antibiotics

Antibiotic medications may have diverse kinds of substance structures, and they follow up on distinctive parts of bacterial hardware. The antimicrobials work by two instruments:

- A bactericidal impact, the antibiotic for the most part executes the microorganisms by meddling with either the development of the bacterium's cell divider or its cell substance. Example: Penicillin, fluoroquinolones, and metronidazole.
- A bacteriostatic impact, i.e., the anti-microbial prevents microorganisms from increasing by meddling with bacterial protein generation, DNA replication, or different parts of bacterial cell digestion. Example: Sulfonamides, chloramphenicol and macrolides.

A portion of the anti-toxins that restrain bacterial cell divider combination incorporate penicillins, cephalosporins and glycopeptides. Beta-Lactam drugs obstruct the union of the bacterial cell divider by meddling with the compounds required for the blend of the peptidoglycan layer. Antibacterial medications that work by restraining protein combination incorporate macrolides, aminoglycosides, antibiotic medications and chloramphenicol. These antibacterial medications take favorable position of the basic contrasts amongst bacterial and eukaryotic ribosomes to specifically restrain bacterial development. Macrolides, aminoglycosides, and antibiotic medications tie to the 30S subunit of the ribosome, while chloramphenicol ties to the 50S subunit. Fluoroquinolones apply their antibacterial impacts by disturbing DNA and cause twofold strand DNA breaks in DNA replication. For instance, the bactericidal

activity of ciprofloxacin comes about because of the hindrance of topoisomerase II (DNA gyrase) and topoisomerase IV (both Type II topoisomerases), which are required for bacterial DNA replication, translation, repair, and recombination. Sulfonamides and trimethoprim (TMP) hinder the pathway for folic corrosive amalgamation, which at last restrains DNA combination. Disturbance of bacterial film structure can also occur. It is hypothesized that polymyxins amass in the bacterial cell film and cause inhibitory impacts by expanding bacterial layer porousness.

2.5.2 Resistance Mechanism

The utilization of antibiotic medications in aquaculture has specific contrasts from their utilization in earthly creatures. In aquaculture, antimicrobials are routinely added to the feed, which is at that point put in the water where the fish are kept. Now and again, antimicrobials might be included specifically to the water. These methods result in a particular weight in the uncovered situations. The utilization of antimicrobials in aquaculture may include a wide natural application that influences a wide assortment of microscopic organisms.

A few bacterial animal categories may survive negative conditions or natural a great many choosing changes that enhance their wellness in the new conditions. Moreover, microscopic organisms exploit portable hereditary components, for example, plasmids and transposable components. With these components, microscopic organisms can get to an extensive pool of nomad qualities that move from one bacterial cell to another and can spread through bacterial populaces. Some of these qualities may give the capacity to oppose anti-toxin impacts. Anti-microbial protection occurs through:

- Natural protection: This might be because of the failure of the antibacterial species to enter the microorganism's cell. It has been proposed that a few types of microbes are naturally impervious to entire classes of antimicrobial operators. In such cases, all strains of that bacterial species are impervious to all individuals from the antibacterial classes.
- Obtained protection: For this situation, the bacterial species is ordinarily defenseless to a specific medication, however a few strains express tranquilized protection. At first defenseless populaces of microbes end up impervious to an antibacterial species and multiply and spread under the specific weight actuated by the utilization of that species.

Genes in charge of anti-infection protection can be exchanged between microbes by three procedures that include horizontal DNA exchange:

- Change, such as microbes obtain qualities from the take-up of (remote) DNA from the outer condition.
- Transduction: The microbes acquire qualities through contamination with viral DNA.
- Conjugation: The microbes acquire qualities by cell-to-cell mating. In this procedure, a plasmid is passed starting with one living being then onto the next through a pilus. This may happen between individuals from same species or between microbes from various genera or families. The spread of qualities coding for anti-infection protection is encouraged by versatile hereditary components called transposons, which can move from plasmids to the bacterial chromosome.

Check Your Progress 4

Note: a) Write your answer in about 50 words.
b) Check your answers given at the end of this unit.

1) Describe the mechanism of antibiotics in aquaculture.

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2) Explain resistance mechanism.

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2.6 OCCUPATIONAL HEALTH EFFECTS

This segment depicts the known impacts of aquaculture work and recognizes about the impacts related with various species. Aquaculture, including mariculture, is a fast growing sector globally. This sector also has some occupational safety and health issues. Many fish farming tasks are dangerous. A safety or health hazard is any work design or property (physiological, physical, chemical, biological, or psychological) that may cause harm to workers or bystanders. Potential occupational hazards in aquaculture have been associated with fatalities that include drownings, electrocutions, crushing-related injuries, hydrogen sulfide poisonings, and fatal head injuries. Non-fatal injuries have been associated with slips, trips, falls, machine operation and repair, strains and sprains, chemicals, and fires. Risk factors include cranes, aerators, tractors and lifting heavy loads, slippery surfaces, rotting waste due to hydrogen sulfide production, storm-related rushing water, diving conditions, night-time conditions, lack of training, no personal flotation devices (PFD), and so on. Other hazards include punctures or cuts from fish teeth or spines, needle-sticks, exposure to low temperatures, and bacterial and parasitic infections (Myers, 2010).

2.6.1 Identifying Occupational Hazards in Aquaculture

This section discusses the hazards associated with different species and rearing technologies. It will help fish farmers in recognizing hazards associated with their working conditions. The recognized hazards involves observed occupational injury or illness history. The endpoint for the recognition of hazards is an inventory that lists the hazards associated with all tasks, equipment, and substances: • Injury and illness information and data regarding the industry and related industries, e.g., farming or fishing. • Information from past incidents and workplace injuries. • Information from workers as well as family members • Product literature and information from suppliers. • Best industry practices. • Examine areas or activities where children or visitors may be present. To identify and better understand hazards before product use, employers need to obtain and read the manuals and safety sheets that are provided by equipment, machinery, and chemical manufacturers. Employers should develop and implement communication and emergency plans for timely response in the

event of an incident. The five important categories of hazards are 1) physiological (work design), 2) physical, 3) chemical, 4) biological, and 5) psychological (Moreau & Neis, 2009). Sudden deaths have occurred in hatcheries associated with hydrogen sulfide exposure, slips and falls. Other hazards associated with hatcheries include exposures to aerators, pumps, heaters, and other types of machinery; fuels, solvents, hypochlorite, formaldehyde, formalin, confined spaces, water jets, unguarded saws, ozone, and hair entanglement in hatching trough paddles. Some occupational hazards identified in African aquaculture include: noise, cuts, sprains, fractures, asthma, rhinitis, snake and fish bites, bronchitis, chemical burns, pesticides and disinfectant poisoning, parasites, and pathogens. In another review, Further, hazards such as machine entanglements, hearing loss, slips and falls, drowning, lacerations, infections, electric shock, hypothermia, repetitive strains, sleep deprivation, decompression illness, organophosphate poisoning, respiratory illness, sunburn, keratotic injury, leptospirosis, and dermatitis have also been observed. These are some of the occupational hazards associated with aquaculture farming practices.

2.6.2 Control of Hazards

Eliminating the occupational hazards caused from animals, equipments and so on are extremely important. These include the following. The faulty machines can be replaced. Safer chemicals can be used. Engineered controls include machinery guards and shields. Design controls include the locked fences. There can be active and passive controls. For safety, the workers are sufficiently protected through training, supervision, and personal protective equipments (PPE). They are also provided with safe clothing, and respirators during handling of hazardous chemicals and biological agents. Under passive controls the protection does not depend upon the worker's actions and under active controls the protection depends upon the worker's actions (Haddon, 1974).

The Global Aquaculture Alliance for Best Aquaculture Practices (BAP) is a standards-based certification system that combines site inspections and records review to help program participants meet the global demands for wholesome seafood produced in an environmentally and socially responsible manner. It has developed standards to certify shrimp hatcheries and shrimp, tilapia, channel catfish, pangasius, and salmon farms. This emphasizes on worker safety and employee relations, worker safety and health, storage and disposal of farm supplies, drug and chemical management, microbial sanitation, and harvest and transport.

Check Your Progress 5

Note: a) Write your answer in about 50 words.
b) Check your answers given at the end of this unit.

1) Describe the occupational health effects due to aquaculture.

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2.7 LET US SUM UP

In this unit we have studied about the:

- Sources of aquaculture pollutants
- Feed practices in aquaculture
- Effects of pollutants on environment
- Effects of pollutant on human health
- Antibiotic usage and resistance in aquaculture and
- Occupational health impacts in aquaculture.

Aquaculture is a threat to our environment. An efficient aquaculture system limits the environmental impact and also repairs the overfished oceans and lakes. Regulation of aquaculture can help in the manufacture of better products for human consumption, and can benefit the economy.

2.8 KEYWORDS

Aquaculture : It is the cultivation of different fishes, crustaceans, algae, and molluscs. Aquaculture includes developing freshwater and saltwater populaces under controlled conditions and can be diverged from business angling, which is the gathering of wild fish. It is also known as aquafarming.

Mariculture **:** It is a specialized branch of aquaculture that involves the cultivation of marine organisms for food and other products particularly in the open ocean, an enclosed section of the ocean, or in tanks, ponds that are filled with seawater. This includes the farming of marine fish, including finfish and shellfish like prawns, or oysters and seaweed in saltwater ponds. Some examples of non-food products produced by mariculture include: fish meal, nutrient agar, jewellery (e.g. cultured pearls), and cosmetics.

2.9 REFERENCES AND SUGGESTED FURTHER READINGS

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2.10 ANSWERS TO CHECK YOUR PROGRESS

Your answers should include the following points:

Answers to Check Your Progress 1

1. Your answers should include the following points:

   Definition of aquaculture

   Definition of mariculture

   Concepts

Answers to Check Your Progress 2

1. Nutrients required for fish

   Protein, vitamin, carbohydrates and minerals

   Common fish feed: -vegetarian feed, trash feed and pellet feed

   Choose the right fish feed: nutrition, hygiene, storage methods, and environmental impacts

Answers to Check Your Progress 3

1. Refer to section 2.4
2. Human sickness because of natural chemicals is regularly connected with long-term.

   Refer to section 2.4.2

Answers to Check your progress 4:

1. Refer to section 2.5.1
2. Refer to section 2.5

Answers to Check Your Progress 5

1. Refer to section 2.6