Ministry of Education and Science of Ukraine
V. N. Karazin Kharkiv National University

SOIL AS AN ENVIRONMENTAL FACTOR

Methodical recommendations
to prepare 3rd year students for practical classes
for the discipline of "Hygiene and ecology"

Electronic resource

Kharkiv – 2024

УДК 614.77(072)
S 70

Reviewers:

H. M. Danylenko – Doctor of Medical Sciences, Professor, director of the State Institution "Institute for children and adolescents health care of the National Academy of Medical Sciences of Ukraine", Kharkiv;

L.V. Podrigalo – Doctor of Medical Sciences, Professor, Head of the Department of Medical and Biological Foundations of Sport and Physical Culture of the Kharkiv State Academy of Physical Culture.

Approved for distribution in the Internet by the decision of the Scientific and Methodical Council of V. N. Karazin Kharkiv National University (Protocol № 8 of February 22, 2024)

S 70 **Soil** as an environmental factor : methodical recommendations to prepare 3rd year students for practical classes for the discipline of "Hygiene and ecology" [Electronic resource] / compil.: Iryna V. Redka. – Kharkiv : V. N. Karazin KhNU, 2024. – (PDF 47 с.)

The methodical recommendations set out the main aspects of the hygienic significance of the soil: ecological, endemic and epidemiological; the role of the soil in the spread of diseases; main sources of soil pollution and mechanism of soil self-purification. For 3rd year students to prepare for practical classes in the discipline "Hygiene and ecology".

УДК 614.77(072)

© V. N. Karazin Kharkiv National University, 2024
© Redka I. V., compiler, 2024

CONTENTS

PLANNED LEARNING OUTCOMES

Soil plays a crucial role in ecosystems and human health. Ecologically, it serves as the basis for plant growth, nutrient cycling, and biodiversity support. However, soil can also contain various pathogens and pathogens, which negatively affects both the environment and human health. Doctors play a crucial role in implementing preventive measures, promoting awareness among the served population, and adopting responsible practices that are essential for minimizing these risks and ensuring soil-related health hazards are mitigated.

According to the requirements of the educational and professional program, students must

know:

- soil classifications;
- hygienic significance of the soil;
- nitrogen cycle;
- main soil pollutants;
- consept of soil health;
- concept of biogeochemical provinces;
- biogeochemical endemic diseases;

be able to:

- identify the sourses of soil pollution;
- explain the mechanism of soil self-purification and its role in waste management;
- demonstrate mastery of risk assessment of the impact of soil on public health;
- substantiate the implementation of preventive measures to predict soil related diseases.

Studying this topic will ensure that students acquire the following **program learning outcomes (PLO):**

- PLO 1. Have thorough knowledge of professional activity structure. To be able to carry out professional activities that require updating and integration of knowledge. To be responsible for professional development, the ability for further professional training with a high level of autonomy.
- PLO 2. Understanding and knowledge of fundamental and clinical biomedical sciences at a level sufficient for solving professional tasks in the health care area.
- PLO 3. Specialized conceptual knowledge, which includes scientific achievements in the field of health care and is the basis for conducting research, critical understanding of problems in the medicine field and related interdisciplinary problems.
- PLO 4. Determinate and identify leading clinical symptoms and syndromes; according to standard methods, using preliminary data of the patient's history, data of the patient's examination, knowledge about the person, his/her organs and systems, establish a preliminary clinical diagnosis of the disease.
- PLO 19. Plan and implement a system of anti-epidemic and preventive measures regarding the occurrence and spread of diseases among the population.
- PLO 21. Search for the necessary information in the professional literature and databases of other sources, analyze, evaluate and apply this information.
- PLO 25. It is clear and unambiguous to convey one's own knowledge, conclusions and arguments on health care problems and related issues to specialists and non-specialists.
- PLO 27. Communicate freely in the official language and in English, both orally and in writing to discuss professional activities, research and projects.

2. INTRODUCTION

Lithosphere (the earth's crust) – mineral and organic covering of the Earth, which extends from its surface to magma. It consists of lithosphere itself, which is formed from magma rocks destroyed by physical, physicochemical and chemical processes before beginnings of life on Earth, and soil.

Soil is a surface layer of lithosphere (from few millimeters in mountains and up to 10 kilometers in lowlands), which was formed after beginnings of life on Earth as the result of climate, flora and life (microorganisms and roots of higher plants) influence.

Soil as the weathered and fragmented outer layer of the earth's terrestrial surface. It is formed initially through disintegration, decomposition, and recomposition of mineral material contained in exposed rocks by physical, chemical, and biological processes (fig. 1). The material thus modified is further conditioned by the activity and accumulated residues of numerous microscopic and macroscopic organisms (plants and animals). In a series of processes that may require hundreds or even thousands of years and that is called *soil genesis*, the loose debris of rock fragments is transmuted into a more or less stable, internally ordered, actively functioning natural body.

Soils are a very complex natural resource, much more so than air and water. Soils contain all naturally occurring chemical elements and combine simultaneously solid, liquid and gaseous states. Moreover, the number of physical, chemical and biological characteristics and their combinations are nearly endless. No wonder then that many different approaches have been proposed to come to a sensible grouping of different soils.

Soil classification provides a structured conceptual framework for describing and understanding soil properties and soil formation, and helps to organize soil knowledge, often through national soil survey.

For example, the Unified Soil Classification System (USCS) is used in engineering and geology to describe the texture and grain size of a soil (table 1).

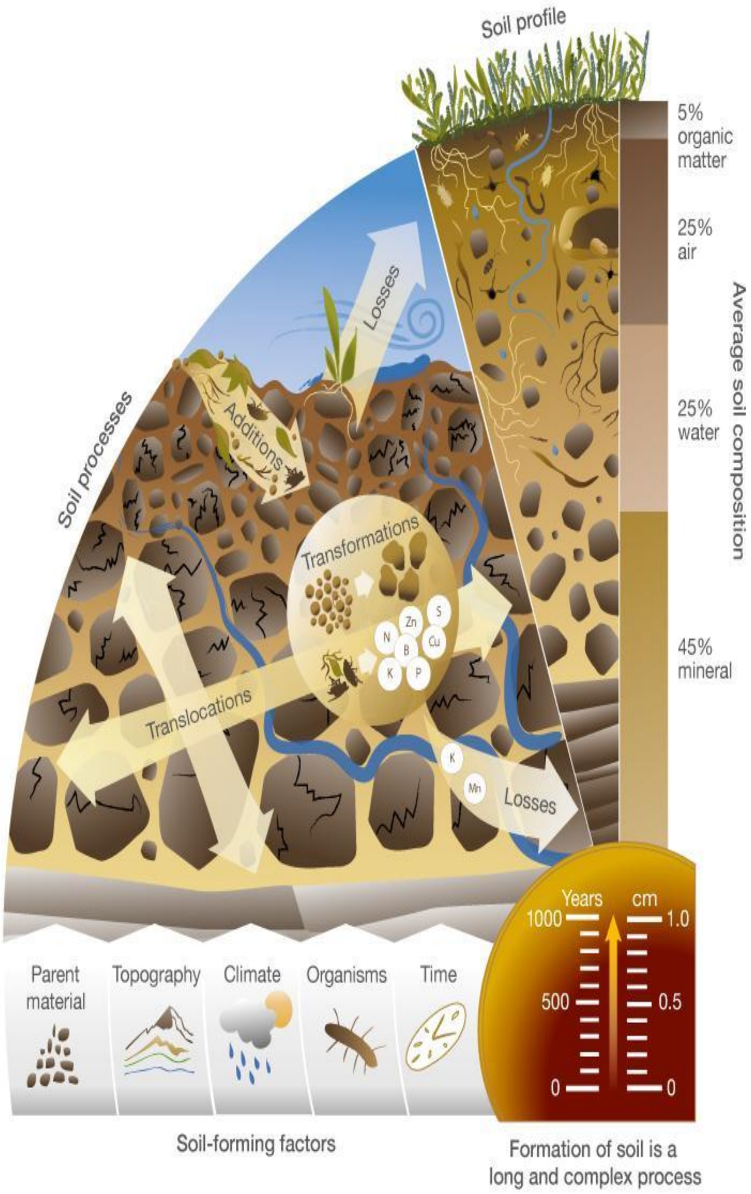


Figure 1. The formation of soil

(from © Agriculture and Horticulture Development Board 2023, https://ahdb.org.uk/knowledge-library/geology-and-soil-formation, accessed 07 November 2023)

The USCS uses a two-letter system to name different soil types. The first letter in the naming describes the major constituents of the soil (Ggravel, S-sand, M-silt, C-clay, O-organic). The second letter describes characteristics of the soil. For coarse-grained, the second letters are: P-poorly graded (uniform particle sizes), W-well-graded (diversified particle sizes), M-silty fines, and C-clayey fines. For fine-grained soils, the second letters are: H-high plasticity (fat soil) and Llow plasticity (lean soil).

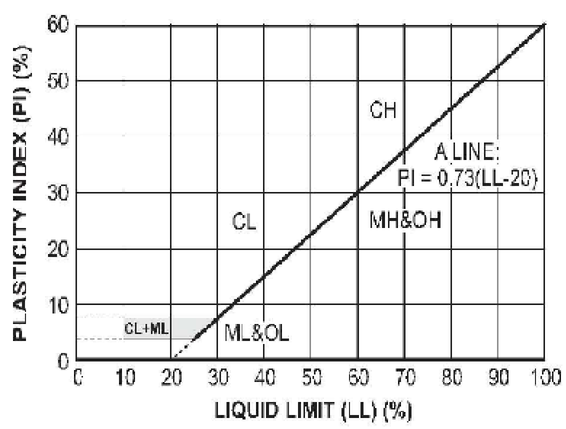
Table 1 – Unified soil classification system

UNIFIED SOIL CLASSIFICATION AND SYMBOL CHART			LABORATORY CLASSIFICATION CRITERIA	
COARSE-GRAINED SOILS (more than 50% of material is larger than No. 200 sieve size.)				
GRAVELS More than 50% of coarse fraction larger than No. 4 sieve size	Clean Gravels (Less than 5% fines)			
	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	GW: $C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{D_{30}}{D_{10} \times D_{60}}$ between 1 and 3	
	GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP: Not meeting all gradation requirements for GW	
	Gravels with fines (More than 12% fines)			
	GM	Silty gravels, gravel-sand-silt mixtures	GM: Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
	GC	Clayey gravels, gravel-sand-clay mixtures	GC: Atterberg limits above "A" line with P.I. greater than 7	
SANDS 50% or more of coarse fraction smaller than No. 4 sieve size	Clean Sands (Less than 5% fines)			
	SW	Well-graded sands, gravelly sands, little or no fines	SW: $C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{D_{30}}{D_{10} \times D_{60}}$ between 1 and 3	
	SP	Poorly graded sands, gravelly sands, little or no fines	SP: Not meeting all gradation requirements for GW	
	Sands with fines (More than 12% fines)			
	SM	Silty sands, sand-silt mixtures	SM: Atterberg limits below "A" line or P.I. less than 4	Limits plotting in shaded zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols.
	SC	Clayey sands, sand-clay mixtures	SC: Atterberg limits above "A" line with P.I. greater than 7	
FINE-GRAINED SOILS (50% or more of material is smaller than No. 200 sieve size.)				
SILTS AND CLAYS Liquid limit less than 50%	ML	Inorganic silts and very fine sands, rock flour, silty of clayey fine sands or clayey silts with slight plasticity		
	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays		
	OL	Organic silts and organic silty clays of low plasticity		
SILTS AND CLAYS Liquid limit 50% or greater	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts		
	CH	Inorganic clays of high plasticity, fat clays		
	OH	Organic clays of medium to high plasticity, organic silts		
HIGHLY ORGANIC SOILS	PT	Peat and other highly organic soils		

Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse grained soils are classified as follows:

Less than 5 percent .... GW, GP, SW, SP
More than 12 percent .... GM, GC, SM, SC
5 to 12 percent .... Borderline cases requiring dual symbols

PLASTICITY CHART



The two most widely used international soil classification systems are the World Reference Base (WRB) for Soil Resources (IUSS Working Group WRB, 2015) and Soil Taxonomy (Soil Survey Staff, 2014). The WRB is an international system for soil classification and developed under the direction of the Food and Agriculture

Organization of the United Nations (FAO). However, many countries also have their own national classifications.

For example, the classification used in Ukraine focused on the environment and the soil forming factors to classify soils in zonal soils (in which the pedogenesis was mainly determined by climate and vegetation) and azonal and intrazonal (in which pedogenesis was mainly determined by parent material and time of development). The difference between azonal and intrazonal soils was made on the basis of soil profile development. In Ukraine most common are chernozem (black earth soils, 54.0%), then — grey forest soils (18.2%) and sod-podsol soils (7.8%).

Soils are home to a remarkable array of biodiversity with some estimates stating that 25% of the Earth's species find their home in the soil. Of these organisms, the vast majority are not of any threat to human health, but rather function to provide numerous ecosystem services which emerge through the multitude of complex interactions between organisms within the soil and the soil itself. These ecosystem services range from those which are vital for maintaining life on Earth, such as the formation of soil, the cycling of nutrients with the result of maintaining soil fertility, and the filtering of water, as well as provision of useful compounds such as antibiotics, the majority of which have been isolated from soil organisms.

However, soils also contain microorganisms which are capable of causing diseases in humans. They act either as opportunistic pathogens which take advantage of susceptible individuals, such as those who are immuno-compromised; or as obligate pathogens which must infect humans in order to complete their life-cycles. These organisms may be capable of surviving within the soil for extended periods of time before infecting humans who come into contact with contaminated soil.

Contact with soil enriches the human microbiome, affords protection against allergies and promotes emotional well-being. Medicinally relevant are soil substrates such as loams, clays and various minerals with curative effects as well as pharmaceutically active organic chemicals like antibiotics that are formed by soil microorganisms. By contrast, irritating minerals, soil dust inhalation and misguided soil ingestion may adversely affect humans.

3. Hygienic significance of soil

3.1. Ecological significance

The soil is not an isolated medium but is in constant dynamic interaction with the larger environment. Processes occurring in the soil are now seen to affect the entire terrestrial environment, including local and regional climates, the natural food chain, biodiversity, and the fate of the voluminous waste products of our civilization (among which are many pathogenic and toxic agents).

Soils are rich ecosystems, composed of both living and non-living matter with a multitude of interaction between them. Migration takes place both in short (soil — plant — soil, soil — water — soil, soil — air — soil) and long (soil — plant — animal — soil, soil — water — plant — soil, soil — water — plant — animal — soil, soil — air — water — plant — animal — soil etc.) migration chains. Soils play an important role in all natural ecological cycles—carbon, nitrogen, oxygen, water and nutrient.

The character of a soil has an important influence on humidity, radiation, evaporation, and in fact most of the factors going to make up "climate."

Soil also provides benefits through their contribution in a number of additional processes, called ecosystem services. These services range from waste decomposition to acting as a water filtration system to degrading environmental contaminants. Soils also play a central role in the management, processing and detoxification of a variety of wastes, both natural and man-made.

99% of the microorganisms living in an soil are saprophytic, which means that they are involved in the decomposition and mineralisation of dead organic matter, which is essential for maintaining soil fertility. Insects and mites initiate organic matter trituration, earthworms continue transforming the organic matter into humus, later nematodes refine the product, followed by fungi, which participate in the aggregation of organic matter, and finally bacteria proceed with the mineralisation and oxidation or reduction of minerals, making them available for the plant roots.

Soil organisms decompose many organic compounds such as manure, remains of plants, fertilizers and pesticides, preventing them from entering water and becoming pollutants. Soil organisms decompose carbohydrates into water and carbon dioxide; fats – into glycerin and fatty acids and then – also into water and carbon dioxide; proteins – into amino acids with ammonia and ammonia salts evolvement and their further oxidation to nitrites and nitrates; protein sulfur – into hydrogen sulfide etc. Human activity adds a wide variety of substances to the environment, some of which are hazardous or toxic. As long as the concentration is not greater than the ecosystem's ability to handle it, microorganisms in the soil can degrade or detoxify many of these substances, rendering them harmless to humans, animals, and the environment.

Soil cleans runoff and sewage in different ways:

1. physical way: the soil particles act as a filter and physically clean the water as in infiltrates its way to the groundwater;
2. chemical way: since soil particles are negatively charged, they can grab onto nutrients and hold on for the plants to use and they can also hold onto contaminants keeping them from reaching our groundwater;
3. biological way: microbes that live in the soil can transform and/or decompose organic chemicals that we do not want in the soil.

Nitrogen cycle is the most complex processes are responsible for recycling the chemicals necessary for life on Earth.

The **nitrogen cycle (fig. 2)** is the movement of nitrogen between the earth and the atmosphere. It consists of a series of processes that convert nitrogen gas to organic substances and these back to nitrogen in nature. It is a continuous cycle maintained by the decomposers and other bacteria.

The nitrogen cycle can be broken down into four types of reaction and micro-organisms play roles in all of these (table 2).

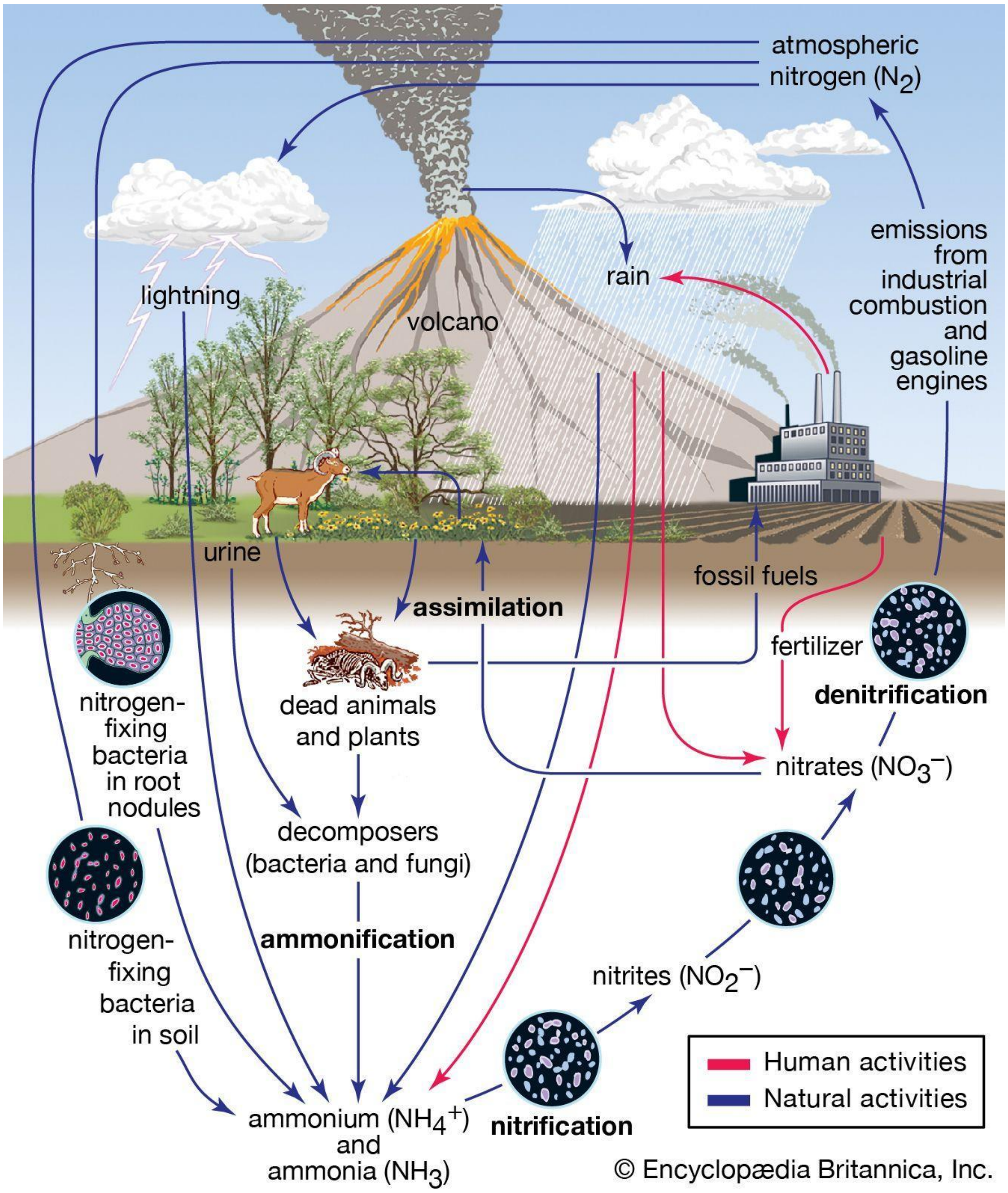


Figure 2. Nitrogen cycle

I. Nitrogen fixation

Nitrogen gas is composed of two atoms of nitrogen linked by a very strong triple bond. This makes it chemically unreactive and large amounts of energy are required to break the bond. Nitrogen gas can be fixed in three ways.

1. *Atmospheric fixation*. This occurs spontaneously by lightning; only a small amount (5–8%) is fixed this way. Lightning allows nitrogen and oxygen to combine to produce various oxides of nitrogen. These are carried by the rain into the soil where they can be used by plants.

2. *Industrial fixation*. The Haber–Bosch process is used to make nitrogen-containing fertilizers. This is a very energy-inefficient process.

3. *Biological fixation*. Nitrogen-fixing bacteria fix 60% of nitrogen gas in the atmosphere. The reduction of nitrogen gas to ammonia is energy-intensive. It requires 16 molecules of ATP and a complex set of enzymes to break the bonds so that the nitrogen can combine with hydrogen. Its reduction can be written as:

$$N_2 + 3H_2 \rightarrow 2NH_3$$

Relatively few bacteria (the nitrogen-fixing bacteria) are able to carry out this reaction (table 2). Fixed nitrogen is made available to plants by the death and lysis of free-living nitrogen-fixing bacteria or from the symbiotic association of some nitrogen-fixing bacteria with plants.

II. **Nitrification**

This is the oxidation of ammonium compounds to nitrites and then to nitrates by the nitrifying bacteria. During these oxidation reactions energy is released. The nitrifying bacteria are chemoautotrophs and are able to use this source of energy to produce organic compounds from inorganic ones (photo-autotrophs use light energy to produce organic compounds from inorganic ones).

Nitrification is a two-step process.

- Bacteria of the genus *Nitrosomonas* convert ammonium ions to nitrites (NO_2^-). (Nitrite is toxic to plants and animals in high concentrations.)
- Bacteria of the genus *Nitrobacter* convert nitrites to nitrates (NO_3^-). The nitrates can then be taken in by plants.

Nitrification occurs in well-drained and aerated soils at neutral pH.

The process of nitrification is especially important in soil because the transformation of NH_4^+ ion into NO_3^- ion results in the change in charge from positive (+) to negative (-). The positively charged ion tends to bound with negatively charged clay particles in soil while negatively charged NO_3^- ion tends to freely migrate in soil water so plants can radially take up nitrate ion by roots for assimilation into organic compounds.

Table 2 – Reactions of the nitrogen cycle.

Reaction	Micro-organism	Conditions	Process
Nitrogen fixation	Nitrogen-fixing bacteria, e.g. *Rhizobium*	Aerobic /anaerobic	The first step in the synthesis of virtually all nitrogenous compounds. Nitrogen gas is fixed into forms other organisms can use.
Ammonification (decay)	Ammonifying bacteria (decomposers)	Aerobic /anaerobic	The decomposers, certain soil bacteria and fungi, break down proteins in dead organisms and animal wastes, releasing ammonium ions which can be converted to other nitrogen compounds.
Nitrification	Nitrifying bacteria, e.g. *Nitrosomona, Nitrobacter,*	Aerobic	Nitrification is a two-step process. Ammonia or ammonium ions are oxidized first to nitrites and then to nitrates, which is the form most usable by plant.
Denitrification	Denitrifying bacteria, e.g. *Pseudomonas*	Anaerobic	Nitrates are reduced to nitrogen gas, returning nitrogen to the air and completing the cycle.

III. **Nitrogen assimilation and mineralization**

Inorganic nitrogen compound present in soil after nitrogen fixation are absorbed by plants as nutrients and metabolize them for biosynthesis of aminoacids, enzymes, nucleic acids etc. the process is known as Nitrogen assimilation.

When human or animal feeds on plants, nitrogen is deposited in the form of protein as well as converted in to other form such as urea, uric acids and excreted as faeces and urine.

Similarly, some of the nitrogen compound undergoes mineralization and get deposited in the soil as ammonium salts.

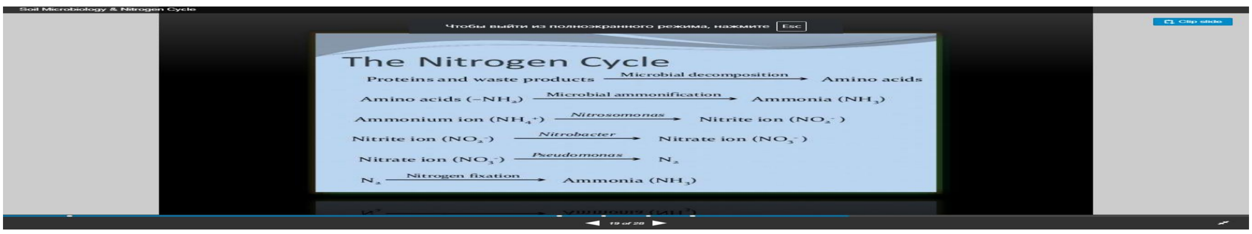
IV. Denitrification

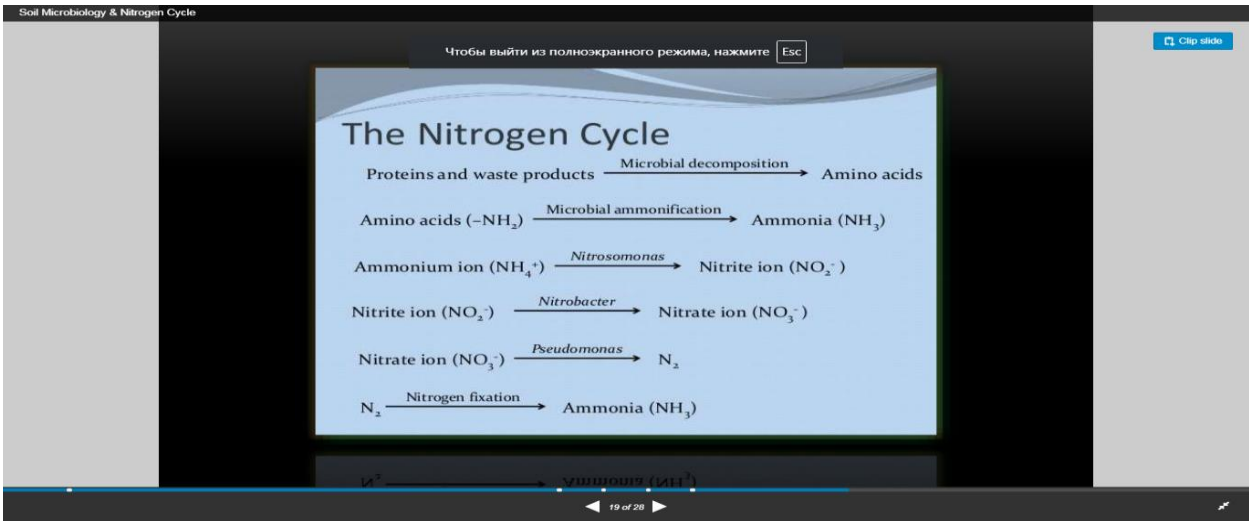
This is the conversion of nitrates into primarily nitrogen gas, but also nitrous oxide gas by the denitrifying bacteria, e.g. *Pseudomonas denitrificans, Bacillus licheniformis, Thiobacillus denitrificans, Hypomicrobium, Chromobacterium etc*. Denitrifying bacteria transform nitrate in extremely wet soils and swampy grounds where there is very little oxygen, i.e. the conditions are anaerobic. The bacteria get the oxygen they need for respiration from the breakdown of nitrates. The gases that are formed escape into the atmosphere completing the nitrogen cycle. This can be a harmful process as fixed nitrogen is removed from the soil making it less fertile.

V. Ammonification (decay)

This is the conversion of organic forms of nitrogen (e.g. in dead organisms and their excretions) into inorganic nitrogen. A wide range of soil bacteria (*Pseudomonas, Bacillus, Clostridium, Serratia*), fungi (*Alternaria*, *Aspergillus*, *Mucor*, *Penicillium*) and Actinomycetes (*Streptomyces*), called the decomposers, carry out the ammonification process. The decomposers consume the organic matter, and the nitrogen contained in the dead organism is converted to ammonium ions. The ammonium is then converted to nitrates by the nitrifying bacteria.

To some up, nitrogen cycle includes the following chemical reactions:





Healthy, fertile soil is a dynamic living system with physical, chemical and biological properties that promote plant and animal health and maintain environmental quality.

3.2. Endemic significance.

Trace elements correspond to a group of elements that are potentially toxic to human, animal and plants when the available content is in excess. They occur in minute but detectable quantities in minerals and rocks. Trace elements play an essential role in the normal metabolism and physiological functions of animals and humans. Twelve elements are established as being essential for good health (fig. 3).

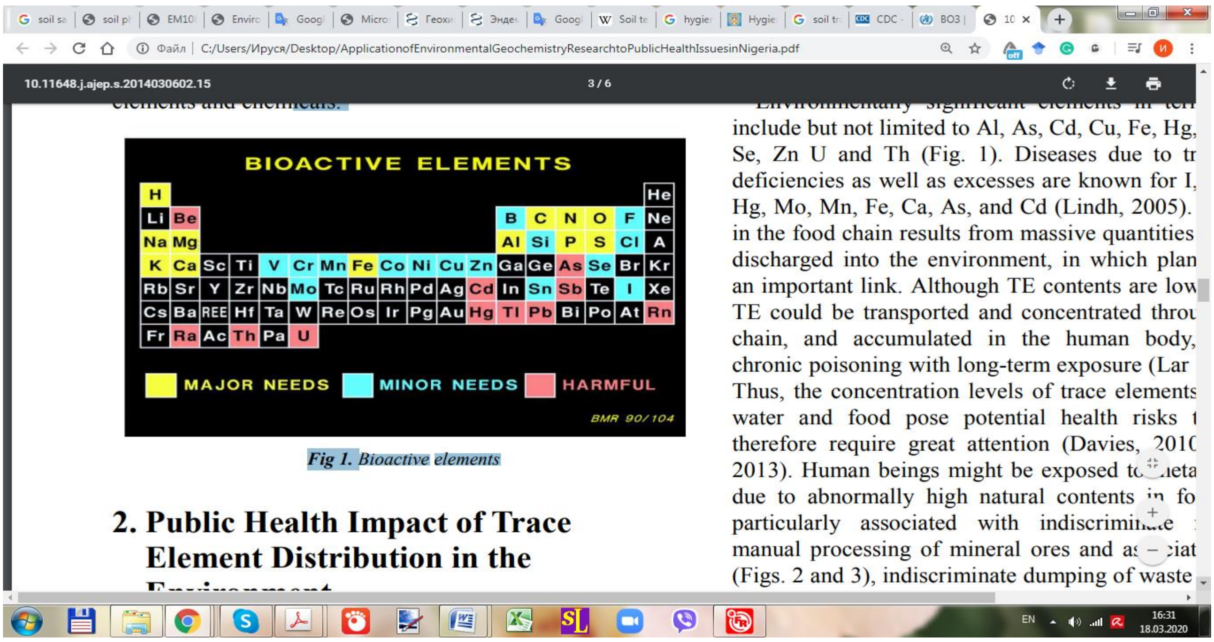


Figure 3. Biollogical significance of chemical elements

Ca, P, Mg, and F for example, are required for structural functions in bone and membranes. Sodium, K, and Cl are required for the maintenance of water and electrolyte balance in cells. Zn, Cu, Se, Mn, and Mo are essential constituents of enzymes or serve as carriers (iron) for ligands essential in metabolism.

Chemical elements are also important in the functioning of the endocrine system. For instance, iodine is an essential component of the thyroid hormone thyroxine, and chromium is the central atom of the hormone-like glucose tolerance factor. Because these are all critical life functions, the tissue levels of many “nutritionally essential elements” tend to be regulated within certain ranges, and dependent on several physiological processes, especially homeostatic control of enteric absorption, tissue storage, and/or excretion.

Changes in these physiological processes may exacerbate the effects of short-term dietary deficiencies or excess of trace elements. Food is a major source of trace elements in humans and animals. However, other sources such as the deliberate eating of soil (geophagia), inhalation and potable water may also contribute to dietary intake of trace elements into the human body system. Endemic diseases correlative with the deficiencies in selenium and iodine in the soils have been described in at least two general cases, the juvenile cardiomyopathy “Keshan Disease” and the Iodine deficiency disorders (IDD) including goiter and myxedematous cretinism.

Environmentally significant elements in terms of *potentially harmful elements* (PHEs) include but not limited to Al, As, Cd, Cu, Fe, Hg, Mo, Pb, Sb, Se, Zn U and Th. Diseases due to trace element deficiencies as well as excesses are known for I, Cu, Zn, Se, Hg, Mo, Mn, Fe, Ca, As, and Cd. Trace elements build-up in the food chain results from massive quantities of trace elements being discharged into the environment, in which plants constitute an important link. Although trace elements contents are low sometimes, trace elements could be transported and concentrated through the food chain, and accumulated in the human body, leading to chronic poisoning with long-term exposure. Thus, the concentration levels of trace elements in drinking water and food pose potential health risks to man and therefore require great attention. Human beings might be exposed to metallic hazards, due to abnormally high natural contents in food or water particularly associated with indiscriminate mining and manual processing of mineral ores and associated materials, indiscriminate dumping of waste and location of industrial estates in residential areas where the effluents are directly washed into the water bodies could be a major source of heavy metals into the environment, inhalation of particulate matter and dust in the mining environment or from other industrial sites, disposal of domestic and industrial wastewater, direct dermal contact with ores and associated materials). A human health concern is usually associated with excessive exposures to trace elements that cause toxic effects to biological organisms. Toxicity of potentially harmful elements includes hypertension, atherosclerosis, as well as alterations in carbohydrate, lipid metabolism, glycosuria, proteinuria, shortened longevity, reproductive abnormalities and weight loss in older persons.

To sum up, two different types of endemic diseases of geochemical origin are distinguished, each having a specifically spatial structure:

- *diseases of natural origin* due to natural element deficiency or excess in the particular zones or areas;
- *diseases of anthropogenic origin* related to chemical transformation of the environment in the course of agricultural or industrial production. Anthropogenically provoked diseases of geochemical nature always occur in conditions of already formed natural geochemical heterogeneity.

Abnormal natural chemical composition of soil in endemic provinces is a reason of local spreading of endemic diseases (geochemical endemic diseases): endemic fluorosis and caries, endemic goiter, foot-and-mouth disease (FMD), molybdenum gout, endemic osteoarthritis or Kashin-Beck disease, endemic cardiomyopathy (Keshan's disease), selenosis, boric enteritis, endemic nephropathy, drinking water-type arsenicosis, endemic selenium poisoning and endemic acute barium poisoning (Bi disease), etc.

Iodine Deficiency Disorders (IDD)

IDD is a syndrome induced by insufficient iodine intake due to the iodine deficiency of external environment. Decreased secretion of thyroid hormone is the main

A.

Figure 4. Endemic goiter resulting from iodine deficiency: A – soft diffuse goitre and B – a huge, longstanding multinodular goiter

pathogenesis. Its main damage to population health is manifested by different degrees of brain development retardation, which affects the quality of life of national population and is a significant public health problem. The IDD has a wide disease spectrum, including endemic goiter, which is the most common one, endemic cretinism, subclinical cretinism, neonatal congenital hypothyroidism, congenital anomalies, deaf-mutism, premature birth, miscarriage, stillbirth, etc. The IDD is the most widely distributed and the most prevalent disease in the world.

Endemic goiter is characterized by enlargement of the thyroid gland in a significantly large fraction of a population group, and is generally considered to be due to insufficient iodine in the daily diet. Endemic goiter exists in a population when >5% of 6-12 year-old children have enlarged thyroid glands.

Neurological Cretinism is characterized by extremely severe mental deficiency together with squint, deaf mutism and motor spasticity with disorders of the arms and legs of a characteristic nature.

Myxedematous Cretinism has a less severe degree of mental retardation than the neurological cretin, but has all the features of extremely severe hypothyroidism present since early life, as in untreated sporadic congenital hypothyroidism: severe growth retardation, incomplete maturation of the facial features including the naso-orbital configuration, atrophy of the mandibles, puffy features, myxedematous, thickened and dry skin, dry and decreased hair, eyelashes and eyebrows and much delayed sexual maturation.

A

B

Figure 5. Neurological Cretinism: A – Male from Ecuador about 40 years old, deaf-mute, unable to stand or walk. Use of the hands was strikingly spared, despite proximal upper-extremity spasticity. B – Male from South western China with the typical facies of neurological cretinism, who is also deaf-mute and suffering from less severe proximal muscle weakness in lower limbs.

Figure 6. Myxedematous endemic cretinism in the Democratic Republic of Congo.

Four inhabitants aged 15-20 years: a normal male and three females with severe longstanding hypothyroidism with dwarfism, retarded sexual development, puffy features, dry skin and hair and severe mental retardation.

Endemic Fluorosis

Endemic fluorosis is a geochemical disease in specific geographical environment. It is a cumulative chronic toxicity in the whole body due to a long-term exposure to excessive quantity of fluorine in drinking water, air, and food. Dental fluorosis and skeletal fluorosis are the essential clinical manifestations of endemic fluorosis (fig. 7).

A. Dental fluorosis

Figure 7. Clinical forms of endemic fluorosis

Fluorine was found about 200 years ago, which has the strongest electronegativity and strong oxidation ability. The fluorine is chemically very active, can replace other halogens from compounds, combines with lots of metal elements under normal temperature, and almost reacts with all elements under high temperature. Thus, it exists in the form of compound instead of element in nature. At the same time, the vast majority of inorganic fluoride can be dissolved in water and has high melting point and boiling point. So, the migration ability of fluorine is very strong, making it widely exists in rock, soil, water, air, and animals, and easily be obtained by human. In order to prevent the prevalence of fluorosis, 1.5 mg/L, the upper limit value of fluoride content recommended by WHO in drinking water is adopted in many countries. The national standard of China and India is 1.0 mg/L, and it is relaxed to 1.2 mg/L in China for the small size central water supplies (<1000 m^3 provided per day) in the countryside.

Endemic Arsenicosis

Endemic arsenicosis is a chronic systemic poison induced by excessive arsenic intake due to overtime exposure to high-level arsenic in the environment. Its main pathogenesis is skin depigmentation or hyperpigmentation, palmoplantar keraloderma, and canceralion (fig. 8). Arsenic (As) is a primary element which exists in the environment and mostly in the form of compounds, such as hydride, oxide, sulfide of arsenic, and so on.

Figure 8. Endemic arsenosis: A, B and C Arsenicosis symptoms in members from a single household. D Arsenicosis symptoms in exposed village population

According to the source of arsenic, humans are exposed through four pathways: life contact, occupational exposure, environmental pollution, and iatrogenic intake. Among them, life contact is the primary way to induce the occurrence of endemic arsenicosis. In life contact, endemic arsenicosis is mainly induced by drinking arsenic-rich groundwater, which is basically the same condition in all the arsenic-poisoning countries in the world. Moreover, besides the drinking water-type arsenicosis, there is another type of endemic arsenicosis in the affected remote mountainous areas in China. Since local residents burn high-arsenic coal, polluting the air and food in the room and inducing chronic arsenic poisoning, it is called coal-burning-type arsenicosis. This type of arsenicosis is unique in China, only found in Guizhou and Shanxi provinces, affecting 1.22 million residents from 12 counties.

Kashin-Beck Disease (KBD)

KBD as an endemic disease is characterized by multiple chronic osteoarthropathy whose pathological changes are degeneration, necrosis, and secondary osteoarthritis in children's articular cartilage of the extremities (fig. 9). The serious patients are manifested by short height, deformity, and disability for their life.

At present, the etiology and pathology of KBD remain under investigation. Various environmental etiologic hypotheses were proposed for KBD, such as selenium deficiency and cereal contamination by mycotoxins. Mycotoxins are believed to play an important role in the pathogenesis of KBD.

The KBD is distributed from Sichuan-Tibet region to the northeast of China and spreads to the eastern Siberia of Russia and the northern mountainous area of North Korea. No KBD patiems occur in other regions of the world.

Fig. 9. Characteristics of Kashin-Beck disease (KBD): A – Representative KBD patients with grade III KBD; B-C – Images of hands (B) and knees (C) from these patients; D – radiographic images of left hand exhibiting shortened phalanges, enlarged bone ends of phalanges and narrowed joint space.

Keshan Disease (KD)

KD is an endemic myocardial disease. In 1935, it attracted the world's attention for the first time due to its big prevalence in Keshan County of Heilongjiang province of China, hence named Keshan disease. The main pathological characteristics of KD are myocardial parenchymal degeneration, necrosis and scar formation, myogenic dilatation, heart enlargement, and thinner wall (fig. 10). The chief clinical manifestations are cardiac arrhythmia and cardiac decompensation, which is further classified into acute, subacute, chronic, and latent types. The KD is an independent, primary myocardial disease.

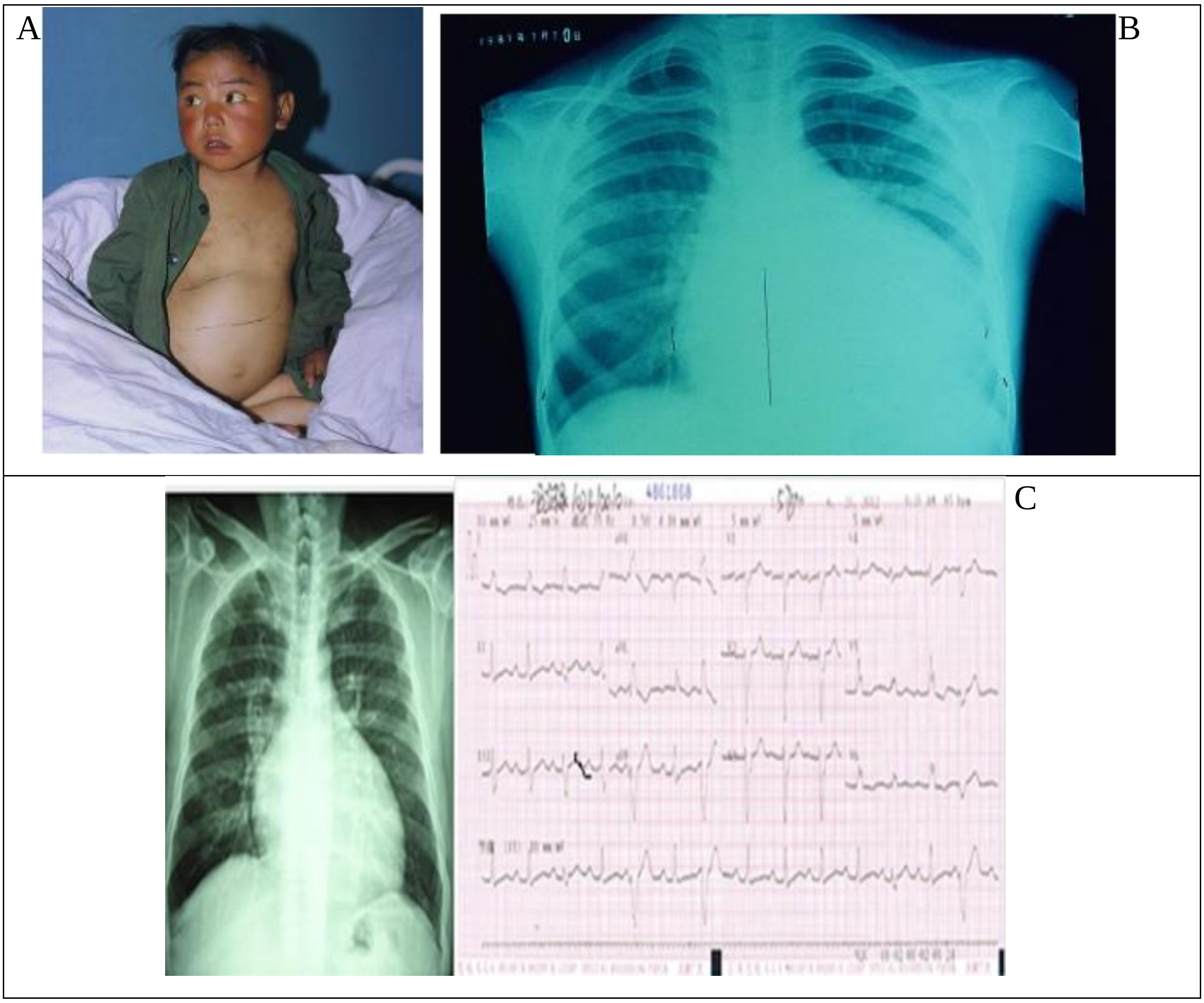


Figure 10. Kehsan disease: A – Heart failure of a chronic Kehsan disease patient, showing enlarged liver and ascites; B – X ray of a chronic Kehsan disease patient showing enlarged heart; C – ECG changes of an acute case of Keshan disease patien

3.3. Epidemic significance

The soil may be a cause of disease: indirectly and directly. *Indirectly* a damp soil may cause disease by acting as a means of lowering the vitality of man and diminishing his resistance to disease. It is in this way that it has been credited with causing such diseases as neuralgia, catarrhs, and rheumatism. It is one of the elements in producing a climate unfavourable to health. *Directly* the soil may transmit the actual contagia (micro-organisms) of disease either by means of the subsoil water or its air. In the former case the disease-causing material gains access to the drinking water of wells, springs, or rivers; in the latter case it may be borne to the surface of the soil by currents of the ground-air or by insects, and then inhaled as dust, or gain access to food.

Soil borne diseases are caused by soil borne pathogens, a group of microorganisms that can cause the reduction or limitation of yield in intolerant crops. Soil borne pathogens include nematodes, fungi, bacteria and even viruses.

The pathogens responsible for causing such diseases can be divided into two groups:

✓ euedaphic pathogenic organisms (EPOs), being potential pathogens which are true soil organisms, i.e. their usual habitat is the soil;

✓ soil transmitted pathogens (STPs) which, while they may be able to survive in soil for extended periods of time, are not true soil organisms, but rather are obligate pathogens who must infect a host in order to complete their life cycles.

Certain disease-producing microorganisms have been proved to be capable of living for some time in the soil. The main of these found in the soil are the bacilli of tetanus (lockjaw), of anthrax, of malignant oedema, and of enteric (typhoid) fever. There are reasons for thinking also that the microorganisms causing diphtheria, rheumatic fever, and epidemic diarrhœa, and possibly some other diseases, may occasionally live in the soil. In some diseases as enteric fever, cholera, dysentery and anthrax, the contamination of the soil can be shown to be derived from a patient suffering from the same diseases.

The conditions favourable to the production of malarial diseases have been generally considered to be the presence of a certain proportion of dead organic matter, the exposure of the soil to alternations of heat and moisture, with a limited access of air, and a temperature of at least 65°F. Though most common in marshy districts, and in recent alluvial soils, malaria may develop in connection with any geological formation. That it may be removed by drainage of the subsoil, is well known.

Man-soil-man transmission

Enteric bacteria and protozoa can contaminate the soil as a result of insanitary excreta disposal practices, or using sewage sludge as a fertilizer, or the direct irrigation of agricultural crops with sewage. Soil and crops can become contaminated with the bacterial agents of cholera, salmonellosis, bacillary dysentery (shigellosis) and typhoid and paratyphoid fever, or with the protozoan agent of amoeba dysentery. However, these diseases are most often water-borne, and transmitted by direct person-to-person contact, or by the contamination of food. Flies that breed in, or come into contact with fecal-contaminated soil can serve as mechanical carriers of disease organisms.

Soil-transmitted helminth infections are widely distributed in tropical and subtropical areas and, since they are linked to a lack of sanitation, occur wherever there is poverty. They are transmitted by eggs present in human faeces which in turn contaminate soil in areas where sanitation is poor. The main species that infect people are the roundworm (*Ascaris lumbricoides*), the whipworm (*Trichuris trichiura*) and the hookworms (*Necator americanus* and *Ancylostoma duodenale*). A large part of the world's population is infected with one or more of these soil-transmitted helminths:

- approximately 807-1,121 million with Ascaris
- approximately 604-795 million with whipworm
- approximately 576-740 million with hookworm

Intestinal worms produce a wide range of symptoms including intestinal manifestations (diarrhoea, abdominal pain), general malaise and weakness. Hookworms cause chronic intestinal blood loss that result in anaemia.

Morbidity is directly related to worm burden: the greater the number of worms in the infected person, the greater will be the severity of disease.

Soil-transmitted helminths impair the nutritional status of those infected in many ways, sometimes causing death by:

- negatively affecting nutritional status (causing intestinal bleeding, loss of appetite, diarrhoea or dysentery, and reducing absorption of micronutrients);
- worsening school performance;
- causing complications that require surgical intervention (i.e. intestinal obstruction and rectal prolapse).

Concomitant infections with other parasite species are frequent and may have additional effects on nutritional status and organ pathology.

Animal-soil-man transmission

A zoonosis (plural zoonoses, or zoonotic diseases) is an infectious disease caused by bacteria, viruses, or parasites that spread from non-human animals (usually vertebrates) to humans. Soil may play a major part in transmitting the infective agent from animal to man.

Leptospirosis is a widespread and potentially fatal zoonosis that is endemic in many tropical regions and causes large epidemics after heavy rainfall and flooding. Infection results from direct or indirect exposure to infected reservoir host animals that carry the pathogen in their renal tubules and shed pathogenic leptospires in their urine. Although many wild and domestic animals can serve as reservoir hosts, the brown rat *(Rattus norvegicus)* is the most important source of human infections. Individuals living in urban slum environments characterized by inadequate sanitation and poor housing are at high risk of rat exposure and leptospirosis.

Small mammals are the most important reservoirs, with large herbivores as additional significant sources of infection. Pathogenic Leptospira species have been isolated from hundreds of mammalian species, including bats and pinnipeds (see the chapter by W.A. Ellis, this volume). In addition, leptospires have been recovered from poikilothermic animals such as frogs and toads, and it is possible that these animals play a role in the circulation of leptospirosis in the environment, although they may not be significant reservoirs of human infection. Leptospirosis is primarily a zoonosis, with humans serving as accidental hosts.

Leptospirosis typically presents as a nonspecific, acute febrile illness characterized by fever, myalgia, and headache and may be confused with other entities such as influenza and dengue fever. The incubation phase from exposure to onset of symptoms averages from 7 to 12 days, though it can be as short as 3 days or as long as a month. Patients typically present with sudden onset of fever, chills, and headache.

Strategies for prevention of leptospirosis are based on awareness of leptospirosis epidemiology and transmission mechanisms. Once the local epidemiology and transmission risks have been defined, it is possible to greatly mitigate risk by taking steps to reduce exposure and implement protective measures, immunization, and pre- or postexposure chemoprophylaxis.

From a global perspective, human leptospirosis is strongly linked to poverty wherever poor housing standards and local infrastructure result in exposure to rodent reservoirs. Rodent abatement efforts may have short-term benefit but rodenticides create risks for children and wildlife and are not good long-term solutions.

Occupational activities that put workers at risk through exposure to contaminated water or infected animals should be identified. Personal protective equipment such as gloves, boots, goggles, and overalls for workers in high-risk occupations are important to prevent exposure of mucous membranes and skin, but can be difficult to implement in hot and humid environments. Abrasions, cuts, and damaged skin are particularly important as portals of entry. Walking barefoot and water sports in endemic areas are notoriously high-risk activities.

Source reduction through immunization of agricultural and companion animals with killed whole-cell vaccines is an extremely important strategy for reducing the risk of human leptospirosis. Humans may also become infected through exposure to acutely or chronically infected animals that are shedding leptospires in their urine.

Pre-exposure prophylaxis with doxycycline (200 mg orally once per week) was effective for military personnel undergoing high-risk jungle training exercises. Doxycycline has also been studied for postexposure prophylaxis of local populations after heavy rainfall in endemic areas.

Anthrax is a zoonotic bacterial disease caused by *Bacillus anthracis*, which primarily inhabits herbivorous wildlife and livestock and is usually fatal among these animals. Human infections can result in a high mortality rate if not diagnosed and treated promptly. Humans contract cutaneous anthrax through direct contact of skin or mucosal membranes with *B. anthracis*–infected animals as they are slaughtered or butchered or by handling by-products. *B. anthracis* spores can survive in the soil for many years and are distributed worldwide, although the disease is endemic to Africa, Central Asia, the Middle East, and South America. The foundation of anthrax control is vaccination of livestock accompanied by rapid outbreak response to limit environmental contamination and human exposure.

Visceral larva migrans (VLM) is a systemic manifestation of migration of second stage larvae of nematodes through the tissue of human viscera. Visceral larva migrans (VLM) was first described by Beaver *et al* in 1952. *T canis* and *Toxocara cati* are most important causes of VLM. Others like *Baylisascaris procyonis*, *Cappilaria hepatica*, *Ascaris suum* and some *Ankylostoma* species have also been implicated. Dogs and cats are definitive hosts for Toxocara, while humans are paratenic hosts. In humans, the ingested larvae hatch in the intestine, penetrate the intestinal wall, flow through the portal vein and reach the liver, lungs, orbit and brain. Some larvae move slowly in the liver (visceral larva migrans) or become encapsulated and remain in that state with no further growth for an indefinite period. VLM is due to migration of second stage larvae of nematodes through human viscera. In humans, the larvae are deposited in the liver, lungs, eye, heart and brain and may cause hepatomegaly, endophthalmitis and neurological disturbances. The clinical triad of toxocariasis is unexplained eosinophilia, liver or lung nodules on imaging studies and a history of eating animal liver.[4] Dog hair and soil also contain infective stage eggs, and infection can occur when eggs containing fully developed larvae are swallowed. VLM is more common in Korea and Japan.

Salmonellosis is an acute, gastroenteritis, typically acquired orally through contaminated water or comestibles. Annually, there are an estimated 1.3 billion cases of *Salmonella* gastroenteritis, leading to approximately 3 million deaths worldwide. It is among the most commonly isolated foodborne pathogens associated with fresh fruits and vegetables such as apples, cantaloupes, alfalfa sprouts, mangos, lettuce, cilantro, tomatoes, melons, orange juice, celery and parsley . The incidence of nontyphoidal salmonellosis gastroenteritis is highest in the developing world, but is also of considerable importance in developed countries. Salmonellosis is characterized by acute enterocolitis, which is accompanied by inflammatory diarrhea, a symptom rarely observed in individuals infected with invasive serovars (i.e. *S*. Typhi). Infection occurs after ingestion of >50,000 bacteria in contaminated food or water, with symptoms typically occurring 6–72 hours after consumption. Onset of symptoms is marked by abdominal pain and diarrhea with or without blood, while nausea and vomiting are also common. Typically, the gastroenteritis will resolve itself in 5–7 days without need for treatment although symptoms are usually more severe and longer lasting in children.

Soil-man transmission

Fungi and actinomycetes that grow normally as saprophytes in soil or vegetation cause most of the serious subcutaneous, deep-seated and systemic *mycoses*. Under certain circumstances, however, they become pathogenic and invade specific tissues or entire systems.

Tetanus is an acute disease of man induced by the toxin of the tetanus bacillus growing anaerobically at the site of an injury. The organism has a world-wide distribution, though cases of the disease are comparatively infrequent today. The infectious agent, *Clostridium tetani*, is excreted by infected animals, especially horses. The immediate source of infection may be soil, dust, or animal and human faeces.

Botulism is a frequently fatal type of poisoning caused by bacterial toxins produced by *Clostridium botulinum.* The reservoir of the organism is soil and the intestinal tract of animals. The toxin is formed by the anaerobic growth of spores in food, which is the immediate source of poisoning. The disease is usually transmitted by the ingestion, without previous cooking, of food from jars or cans imperfectly sterilized during canning, the canned or preserved food having been infected with soil contaminated by *Cl. botulinum*.

4. Soil pollution

Soil pollution is defined as the build-up in soils of persistent toxic compounds, chemicals, salts, radioactive materials, or disease causing agents, which have adverse effects on plant growth and animal health.

There are many different ways that soil can become polluted, such as:

- seepage from a landfill;

- discharge of industrial waste into the soil;
- percolation of contaminated water into the soil;
- rupture of underground storage tanks;
- excess application of pesticides, herbicides or fertilizer;
- solid waste seepage.

The most common chemicals involved in causing soil pollution are: petroleum hydrocarbons, heavy metals, pesticides, solvents.

Biological pollutants of the soil that cause people's disease in can be divided into three groups:

- pathogenic organisms are excreted by man and transmitted to man by direct contact with contaminated soil or by the consumption of fruit or vegetables that are grown in contaminated soil (man-soil-man);
- pathogenic organisms are excreted by animals and transmitted to man by direct contact with soil contaminated by infected animals' fecal (animal-soil-man);
- pathogenic organisms naturally live in soil and are transmitted to man by contact with contaminated soil (soil-man).

Effects of soil pollution:

1) Agricultural:

- Reduced soil fertility
- Reduced nitrogen fixation
- Increased erodibility
- Larger loss of soil and nutrients
- Deposition of silt in tanks and reservoirs
- Reduced crop yield
- Imbalance in soil fauna and flora

Table 3 – Examples of hazardous waste generated by business and industry

Waste generator	Typical wastes
Chemical manufacturers	Strong acids and bases Spent solvents Reactive wastes
Vehicle maintenance shops	Paint wastes containing heavy metals Ignitable wastes Used lead acid batteries Spent solvents
Printing industry	Heavy-metal solutions Waste inks Spent solvents Spent electroplating wastes Ink sludges containing heavy metals
Leather products manufacturers	Waste toluene and benzene
Paper industry	Paint wastes containing heavy metals Ignitable solvents Strong acids and bases
Construction industry	Ignitable paint wastes Spent solvents Strong acids and bases
Cleaning agents and cosmetics manufacturers	Heavy-metal dusts Ignitable wastes Flammable solvents Strong acids and bases
Furniture and wood manufacturers and refinishing	Ignitable wastes Spent solvents
Metal manufacturing	Paint wastes containing heavy metals Strong acids and bases Cyanide wastes Sludges containing heavy metals

2) Industrial:

- dangerous chemicals entering underground water
- ecological imbalance
- release of pollutant gases
- release of radioactive rays causing health problems
- increased salinity
- reduced vegetation

3) Urban:

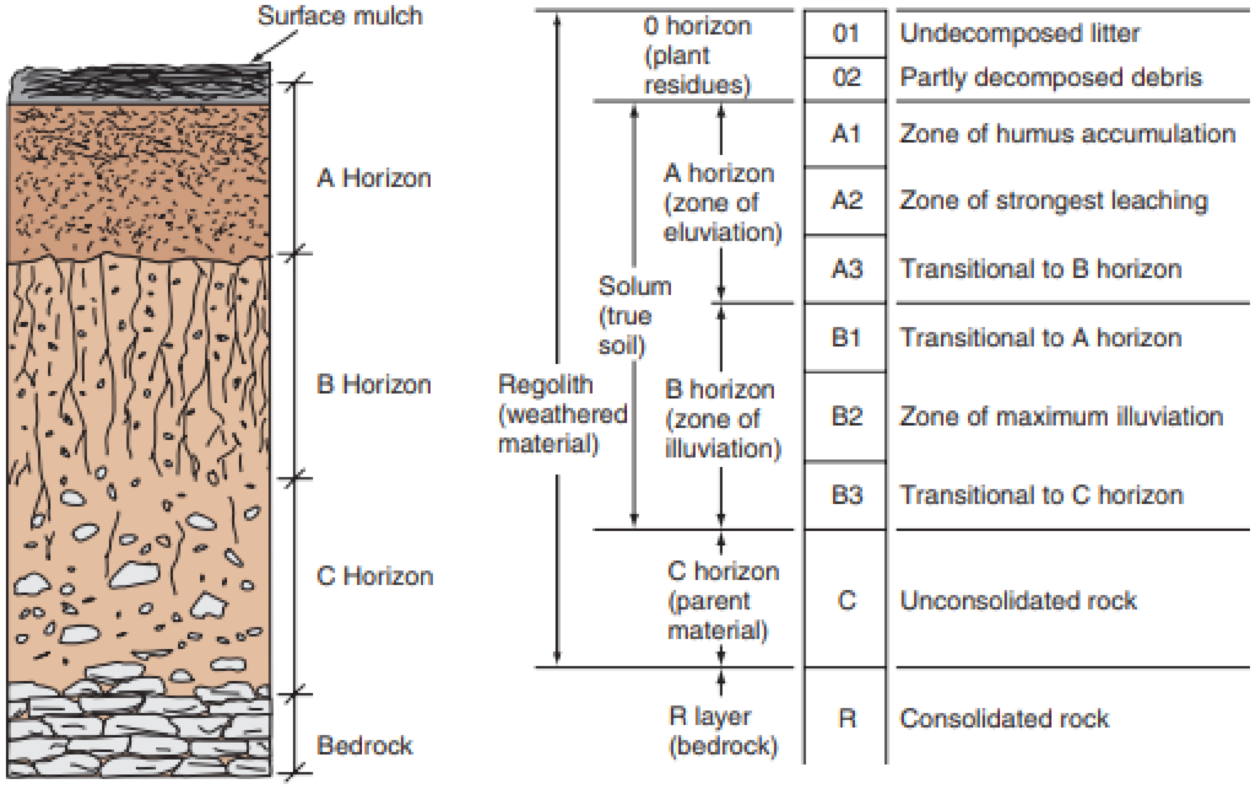
- clogging of drains
- inundation of areas
- public health problems
- pollution of drinking water sources
- foul smell and release of gases
- waste management problems

4) Environmental:

- soil becomes unavailable to grow food;
- if contaminated soil is used to grow food, the land will usually produce lower yields;
- can cause even more harm because a lack of plants on the soil will cause more erosion;
- the pollutants will change the makeup of the soil and the types of microorganisms that will live in it;
- thus it's possible for soil pollution to change whole ecosystems.

5. Soil Profile

A ***soil profile*** is a vertical cross section of the soil that can be viewed by excavating a rectangular pit or sampling the soil layer by layer:



The ***O horizon*** is the upper layer of the topsoil which is mainly composed of organic materials such as dried leaves, grasses, dead leaves, small rocks, twigs, surface organisms, fallen trees, and other decomposed organic matter. It contains about 20 to 30% of organic matter. This horizon of soil is often black brown or dark brown in colour and this is mainly because of the presence of organic content.

The ***A horizon (topsoil)***, is the zone of major biological activity and is therefore generally enriched with organic matter and darker in color than the underlying soil. Here, plants and animals and their residues interact with an enormously diverse and labile multitude of microorganisms, such as bacteria, protozoa, and fungi, millions of which can be found in a mere handful of topsoil. In addition, there are usually varied forms of macroorganisms (including earthworms, arthropods, and rodents) that burrow in the soil. This layer is rich in organic material and is known as the humus layer. The A horizon is generally the most fertile zone of the soil, but it is also the zone most vulnerable to erosion by water and wind (especially if it is denuded of vegetative cover or its protective residues).

Underneath the A horizon is the ***B horizon (subsoil)***, where some of the materials (e.g., clay or carbonates) that are leached from the A horizon by percolating water tend to accumulate. The B horizon is often thicker than the A horizon. The pressure of the overlying soil tends to reduce the porosity of the deeper layers. In some cases, an overly dense or indurated B horizon may inhibit gas exchange, water drainage, and root penetration.

Underlying the B horizon is the ***C horizon (saprolite)***, which is the soil's parent material. In a soil formed of bedrock in situ (called a residual soil), the C horizon consists of the weathered and fragmented rock material. In other cases, the C horizon may consist of alluvial, aeolian, or glacial deposits

The ***R horizon (bedrock)*** is a compacted and cemented layer. Different types of rocks such as granite, basalt and limestone are found here.

6. Soil health

Soil is a vital natural resource and its health is fundamental for sustainable agricultural production. **Soil health**, also referred to as soil quality, is defined as the capacity of soil to function within ecosystem boundaries to sustain biological activity, maintain environmental quality, and promote plant, animal and human health. Soils function to provide ecosystem services that include increased soil water retention and availability, soil aggregation, nutrient cycling and storage, and microbial diversity and function.

Healthy soil should possess the following characteristics:

• High organic matter

• Good soil tilth and structure

• High water infiltration and retention

• Resistance to compaction

• High soil biological activity

• Plant nutrient recycling and availability

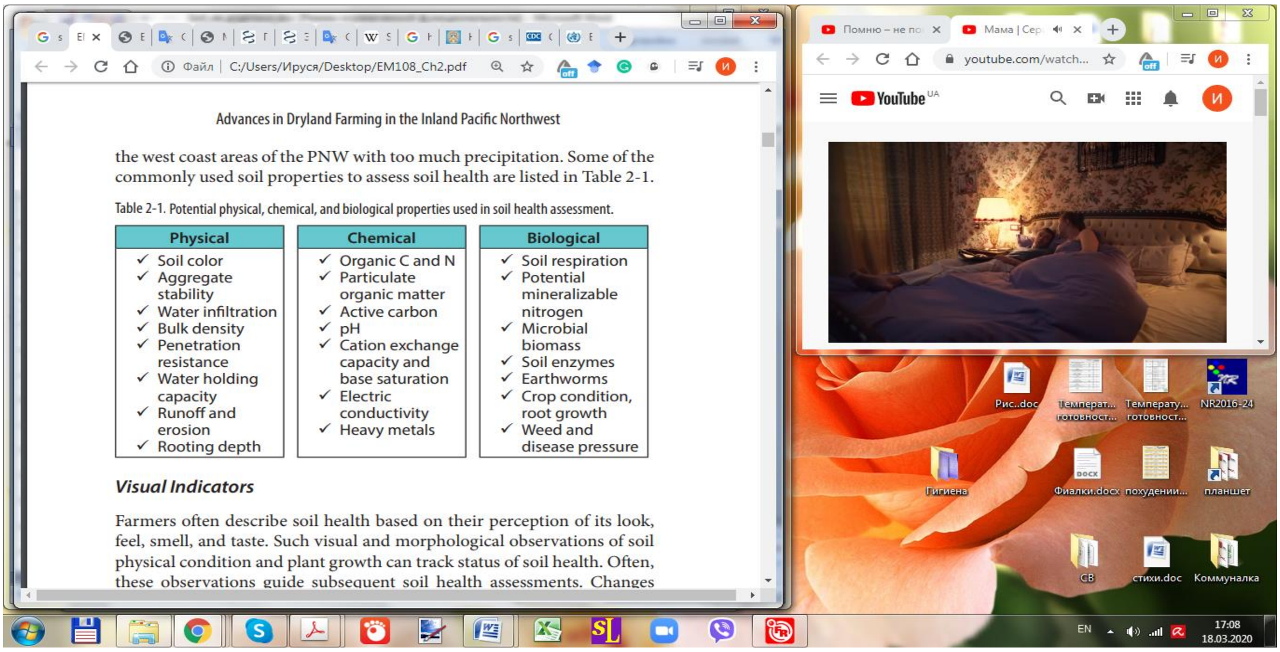
• Resistance to erosion

• Devoid of toxic chemicals

• Low in weed and disease pressures

Soil health indicators generally describe specific soil properties. Soil properties can be generally categorized as stable or dynamic. *Stable soil properties* are influenced by soil-forming factors such as climate, organisms, parent material, and topography, which change little with management practices. Examples of stable properties include soil texture, soil type, and soil depth. *Dynamic properties* can change with land-use and management practices over the course of a short time, generally within a human lifespan, and include soil organic matter, bulk density, and pH. Accordingly, soil health assessment programs that include measurement of various physical, chemical, and biological properties of soil that respond to management changes provide clues on soil processes.

Some of the commonly used soil properties to assess soil health are listed below:



Advances in Dryland Farming in the Inland Pacific Northwest

the west coast areas of the PNW with too much precipitation. Some of the commonly used soil properties to assess soil health are listed in Table 2-1.

Table 2-1. Potential physical, chemical, and biological properties used in soil health assessment.

Physical	Chemical	Biological
✓ Soil color	✓ Organic C and N	✓ Soil respiration
✓ Aggregate stability	✓ Particulate organic matter	✓ Potential mineralizable nitrogen
✓ Water infiltration	✓ Active carbon	✓ Microbial biomass
✓ Bulk density	✓ pH	✓ Soil enzymes
✓ Penetration resistance	✓ Cation exchange capacity and base saturation	✓ Earthworms
✓ Water holding capacity	✓ Electric conductivity	✓ Crop condition, root growth
✓ Runoff and erosion	✓ Heavy metals	✓ Weed and disease pressure
✓ Rooting depth		

Visual Indicators

Farmers often describe soil health based on their perception of its look, feel, smell, and taste. Such visual and morphological observations of soil physical condition and plant growth can track status of soil health. Often, these observations guide subsequent soil health assessments. Changes

The sanitary state of the soil is a combination of physico-chemical, biological properties of the soil that determine the quality and degree of its safety in an epidemic and hygienic sense.

QUESTIONS FOR SELF-CONTROL

I. Test questions for self-control

1. *Nitrogen is absorbed by plant roots in the form of*

A. NO_3

B. NO_2

C. N_2O

D. N_2O_2

2. *The conversation of organic form of an element into inorganic form is termed as*

A. Mineralization

B. Immobilization

C. Nitrification

D. Denitrification

3. *The conversation of amino acids into ammonium is called*

A. Ammonifocation

B. Aminization

C. Mineralization

D. Nitrification

4. *The conversation of NH4+ into NO3- is called*

A. Nitrification

B. Ammonifocation

C. Mineralization

D. N fixation

5. *Which of the following is not a source of pollution in soil?*

A. Hydropower plants

B. Thermal power plants

C. Transport sector

D. Agriculture sector

6. *Which of the following is not a major pollutant which causes soil pollution?*

A. Nitrogen oxides

B. Hydrocarbons

C. Mineral oil

D. Heavy metal

7. In agricultural regions, gfroundwater can have significant concentration of

A. Nitrate

B. Lead

C. Cadmium

D. Selenium

8. Which of the following is/ar the source(s) of soil pollution?

A. Solid waste

B. Pesticides and chemical fertilizers

C. Effluent and sewage

D. All of the above

9. Name the components that make up the soil:

A. Organo-mineral complexes, water, air, microorganisms

B. Soil air, macroorganisms, mineral and organic substances

C. Macroorganisms, organo-mineral complexes, water, air

D. Organo-mineral complexes, vegetation, microorganisms

10. Define the concept of "soil":

A. The surface layer of the lithosphere, formed after the appearance of life on planet Earth, as a result of the action of climate, vegetation and living organisms

B. The surface layer of the lithosphere, formed as a result of the physical factors of the environment

C. The surface layer of the lithosphere, formed as a result of the action of environmental chemical factors

D. The mineral-organic shell of the planet Earth, which extends from its surface to the magma

11. The abnormal natural chemical composition of the soil is the cause of the following diseases:

A. Endemic diseases

B. Gastric ulcer disease

C. Hepatitis B

D. Dysentery

12. Geochemical provinces are areas with:

A. Anomalous natural chemical composition of the soil

B. Soil contaminated with geohelminths

C. Stony soils or wetlands

D. Extremely air-permeable and water-holding soil

13. Indicate the sanitary value of soil:

A. The soil is a natural environment for disposal of liquid and solid household and industrial waste due to self-cleaning processes

B. The soil has an important endemic value due to self-purification processes

C. Soil has a significant epidemiological significance due to self-purification processes

D. Soil has important sanitary and technical importance

14. Specify what self-cleaning of the soil consists of:

A. The ability of the soil to convert organic compounds into mineral substances suitable for assimilation by plants

B. The ability of the soil to transform inorganic compounds into mineral substances suitable for assimilation by plants

C. The ability of the soil to convert microorganisms into mineral substances suitable for assimilation by plants

D. The ability of the soil to transform mineral substances into organic compounds suitable for assimilation by plants

15. Hummus is products:

A. Microbial synthesis

B. Decomposition of proteins

C. Decomposition of fats

D. Decomposition of carbohydrates

16. Indicate the geochemical endemics caused by the abnormal content of iodine into the soil:

A. Endemic goiter

B. Endemic fluorosis and caries

C. Keshan Disease

D. Kashin-Beck Disease

17. A complex of soil horizons, that is typical for this type of soil formation is called:

A. Ground section

B. Soil profile

C. Soil cover

D. Grounds

18. Indicate the discrepancy in the content of which chemical substance in the soil contributes to the occurrence of endemic caries:

A. Reduction of fluoride

B. Increase in iodine

C. Increase in fluoride

D. Reduction of iodine

19. Indicate the way of transmission of leprosperosis

A. Animal-soil-man

B. Soil-man

C. Man-soil-man

D. All of the above

20. Indicate the way of transmission of Clostridium botulini

A. Soil-man

B. Animal-soil-man

C. Man-soil-man

D. All of the above

Keys: 1 – A, 2 – A, 3 – A, 4 – A, 5 – A, 6 – A, 7 – A, 8 – D, 9 – A, 10 – A, 11 – A, 12 – A, 13 – A, 14 – A , 15 – A, 16 – A, 17 – A, 18 – A, 19 – A, 20 – A

Self-control questions

1. Concept of soil and its structure.
2. Biogeochemical provinces
3. Geochemical endemics: definition, examples and prevention
4. Role of soil in the spread of infectious diseases among the population
5. Sources of soil pollution.
6. Processes and indicators of soil self-cleaning.
7. Influence of soil pollution on the health and sanitary living conditions of the population. I
8. ndicators of the sanitary state of the soil

SITUATIONAL TASKS

1. The locality has a developed ferrous metallurgy (iron ore production), which has been operating for more than thirty years. In the studied soil samples, priority chemical elements and chemical elements associated with this industrial facility were found, the concentrations of which exceed the regional background indicators by 4 and 5 times, respectively.

Tasks:

- Determine the degree of contamination of the soil of a given land plot with a complex of chemical substances, to establish the possible negative impact of this pollution on changes in health indicators of future patients during a sanitary and hygienic examination of the selection of a land plot for the construction of a somatic hospital.
- Make a hygienic conclusion on the possibility of using the land plot for the construction of a somatic hospital.
- Recommend health measures to cleanse the soil of the land plot.

2. Some region of Chinise is endemic by abnormal content of some chemical. In this areas brick tea is heavily consumed and there is the habit of burning bituminous coal, which has a high content of this chemical, to cook, and dry food. The population use drinking water from a well. Upon examination in most children, the enamel is covered with light chalky and brown spots, there are no areas of destruction, and surface heterogeneity of the enamel is noted.

Tasks:

- determine the content of which element exceeds the permissible level;
- make a preliminary clinical diagnosis;
- identify risk factors;
- develop a system of preventive measures.

References

Basic

1. General hygiene and environmental health / Edited by M. M. Nadvorny. – Odessa: Odessa State Medical University, 2018. – 688 p.
2. Hygiene and Ecology: Manual / Edited by V. G. Bardov– Vinnitsa: Nova Knyga, 2018. – 688 p
3. Hygiene and ecology: workbook for medical students / Teodora Dimitrova, Ruzha Pancheva, Darina Naydenova [et al.] – Varna: Varna Medical University Press, 2020. – 116 p.

Supporting

1. Abrahams P.W. (2006) Soil, geography and human disease: a critical review of the importance of medical cartography. *Progress in Physical Geography*, 30, 490-512
2. Chen, J. (2012). An original discovery: selenium deficiency and Keshan disease (an endemic heart disease). *Asia Pacific journal of clinical nutrition, 21 3*, 320-6 .
3. Eastman CJ, Zimmermann MB. The Iodine Deficiency Disorders. [Updated 2018 Feb 6]. In: Feingold KR, Anawalt B, Blackman MR, et al., editors. Endotext [Internet]. South Dartmouth (MA): MDText.com, Inc.; 2000. Available from: https://www.ncbi.nlm.nih.gov/books/NBK285556/
4. Espelund, M., & Klaveness, D. (2014). Botulism outbreaks in natural environments - an update. *Frontiers in microbiology*, *5*, 287. https://doi.org/10.3389/fmicb.2014.00287
5. Fu, G., Chen, X., Qi, M., Du, X., Xia, Z., Liu, Q., ... & Zhang, R. (2022). Status and potential diagnostic roles of essential trace elements in Kashin-Beck disease patients. *Journal of Trace Elements in Medicine and Biology*, *69*, 126880.
6. Ganguly, P (2023). Medical Geology Related to Different Trace Elements Deficiency and Toxicity Diseases. *International Journal for Research in Applied Science & Engineering Technology (IJRASET)*, 11 (IX), 113-127 https://doi.org/10.22214/ijraset.2023.55616

7. Jeffery, S., & Van der Putten, W. H. (2011). Soil borne human diseases. Luxembourg: Publications Office of the European Union, 2011, 49 pp. Available from: https://pure.knaw.nl/ws/portalfiles/portal/1047192/2011EUreport.pdf

8. Lehnert, N., Musselman, B. W., & Seefeldt, L. C. (2021). Grand challenges in the nitrogen cycle. *Chemical Society Reviews*, *50*(6), 3640-3646.

9. Münzel, T., Hahad, O., Daiber, A., & Landrigan, P. J. (2023). Soil and water pollution and human health: what should cardiologists worry about?. *Cardiovascular research*, 119(2), 440-449.

10. Samaddar, S., Karp, D. S., Schmidt, R., Devarajan, N., McGarvey, J. A., Pires, A. F. A., & Scow, K. (2021). Role of soil in the regulation of human and plant pathogens: soils' contributions to people. *Philosophical transactions of the Royal Society of London. Series B, Biological sciences*, 376(1834), 20200179. https://doi.org/10.1098/rstb.2020.0179

11. Shahroom, N. S. B., Mani, G., & Ramakrishnan, M. (2019). Interventions in management of dental fluorosis, an endemic disease: A systematic review. *Journal of family medicine and primary care*, 8(10), 3108.

12. Sun, G., Yu, G., Zhao, L., Li, X., Xu, Y., Li, B., & Sun, D. (2019). Endemic arsenic poisoning. Endemic Disease in China, 97-123.

13. Thiele-Bruhn S. (2021). The role of soils in provision of genetic, medicinal and biochemical resources. *Philosophical transactions of the Royal Society of London. Series B, Biological sciences*, 376(1834), 20200183. https://doi.org/10.1098/rstb.2020.0183

14. Wei, W., Pang, S., & Sun, D. (2019). The pathogenesis of endemic fluorosis: Research progress in the last 5 years. *Journal of cellular and molecular medicine*, 23(4), 2333-2342.

15. Yuan, J., Wen, T., Zhang, H., Zhao, M., Penton, C. R., Thomashow, L. S., & Shen, Q. (2020). Predicting disease occurrence with high accuracy based on soil macroecological patterns of Fusarium wilt. *The ISME Journal*, *14*(12), 2936-2950.

16. Yuan, L., Fei, W., Jia, F., Junping, L., Qi, L., Fangru, N., ... & Shulian, X. (2020). Increased health threats from land use change caused by anthropogenic activity in an endemic fluorosis and arsenicosis area. *Environmental Pollution*, 261, 114130.

17. Zheng, Q., Hu, Y., Zhang, S., Noll, L., Böckle, T., Dietrich, M., ... & Wanek, W. (2019). Soil multifunctionality is affected by the soil environment and by microbial community composition and diversity. *Soil Biology and Biochemistry*, *136*, 107521.

Електронне навчальне видання комбінованого використання
Можна використовувати в локальному та мережному режимі

Редька Ірина Василівна

ҐРУНТ ЯК ЕКОЛОГІЧНИЙ ФАКТОР

Методичні рекомендації до практичних занять
для здобувачів вищої медичної освіти 3-го року навчання
з дисципліни «Гігієна та екологія»

(Англ. мовою)

В авторській редакції

Підписано до розміщення 22.02.2024. Гарнітура Times New Roman.
Ум. друк. арк. 4,1. Обсяг 2,675 Мб. Зам. № 14/24.

Харківський національний університет імені В. Н. Каразіна,
61022, м. Харків, майдан Свободи, 4.
Свідоцтво суб'єкта видавничої справи ДК № 3367 від 13.01.2009

Видавництво ХНУ імені В. Н. Каразіна