Chapter 8

Human Health and Disease

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COMMON DISEASES IN HUMANS

Health has long been perceived as a condition encompassing both the body and mind, characterized by a harmonious balance of certain 'humors'. This belief was particularly emphasized by early Greek scholars like Hippocrates, often referred to as the father of medicine, and the Indian Ayurvedic system. According to this perspective, individuals with an excess of "black bile" were associated with a temperament prone to fevers and other ailments.

However, advancements in medical understanding challenged this traditional notion. William Harvey's discovery of blood circulation, achieved through experimental methods, and the use of thermometers to establish normal body temperatures in individuals with an excess of black bile, refuted the "good humor" hypothesis of health. It became evident that physical health was not solely determined by the balance of bodily humors.

In subsequent years, the field of biology expanded our understanding of health, highlighting the intricate interplay between the mind and the immune system. It was recognized that mental states influence the functioning of the immune system through neural and endocrine pathways, thus exerting a profound impact on overall health. Consequently, mental well-being came to be regarded as an integral component of health alongside physical health.

Physical health is defined by the normal structure and function of the body, while mental health encompasses the individual's emotional and psychological state. Moreover, it became apparent that mental states and social environments are intricately intertwined with health outcomes and cannot be viewed in isolation. Thus, a comprehensive understanding of health necessitates considering the interconnections between physical, mental, and social factors.

Health

The term "health" is commonly used by people from all walks of life. However, it encompasses more than just the absence of disease or physical fitness. Health is best understood as a comprehensive state of well-being, encompassing physical, mental, and social dimensions.

Various factors influence health, including genetic disorders, which encompass deficiencies present at birth and inherited traits from parents. Infections also play a significant role in determining overall well-being.

Lifestyle choices, such as dietary habits, water intake, rest, exercise routines, and personal habits, greatly impact health outcomes. Maintaining a balanced diet, practicing personal hygiene, and engaging in regular exercise are crucial components for achieving and maintaining good health.

Additionally, practices like yoga are increasingly recognized for their benefits in promoting both physical and mental well-being.

Good health not only enhances individual efficiency and productivity but also contributes to economic prosperity. Furthermore, it promotes longevity and reduces infant and maternal mortality rates, underscoring its importance in societal well-being.

A. Bacterial Diseases

(i) Typhoid (Enteric Fever)

- Pathogen: Salmonella typhi (A Gram-negative bacterium)
- Transmission: The pathogens responsible for typhoid typically enter the small intestine via contaminated food and water. Subsequently, they spread to other organs through the bloodstream.
- Symptoms: Typhoid manifests with persistent high fever ranging from 39° to 40°C, accompanied by symptoms such as weakness, abdominal pain, constipation, headache, and loss of appetite. Severe cases may lead to intestinal perforation and even death.
- Diagnostic Test: Typhoid fever can be diagnosed using the Wilda test, which detects specific antibodies produced in response to Salmonella typhi infection.

Note: A well-known case in the annals of medicine is that of Mary Mallon, famously dubbed Typhoid Mary. She worked as a cook and unknowingly carried the typhoid bacteria, persistently spreading the disease for several years through the food she prepared.

(ii) Pneumonia

- Pathogen: Bacteria such as Streptococcus pneumoniae and Haemophilus influenzae.
- Transmission: Pneumonia is typically transmitted when a healthy individual inhales droplets or aerosols released by an infected person. It can also occur through the sharing of glasses and utensils with an infected individual.
- Symptoms: Pneumonia primarily affects the alveoli of the lungs, causing them to fill with fluid, which significantly impairs respiration. Common symptoms of pneumonia include fever, chills, cough, and headache. In severe cases, individuals may exhibit cyanosis, characterized by a bluish discoloration of the lips and fingernails due to inadequate oxygenation of the blood.

(iii) Plague/Bubonic Plague (Black Death)

- Pathogen: Yersinia pestis
- Mode of Infection: Originally a disease of rodents, the bubonic plague can accidentally affect humans. It primarily spreads among rats through the rat flea (Xeno psylla). However, when infected rats perish, the fleas abandon their bodies and may bite humans, injecting the plague bacteria into their bloodstream. Humans are considered accidental hosts in this transmission chain.
- Symptoms: The bubonic plague is characterized by high fever and the development of a painful, swollen lump known as a bubo in the groin or armpit. Red patches appear on the skin, which may turn black, leading to the nickname "black death." Without prompt treatment, the disease often results in death.

(iv) Cholera

- Pathogen: Vibrio cholerae
- Transmission: Cholera is an acute infectious disease typically contracted through contaminated food and water sources.

- Symptoms: Cholera manifests with frequent, watery stools resembling rice-water and recurrent vomiting. Rapid loss of fluids and electrolytes through diarrhea and vomiting can lead to severe dehydration and electrolyte imbalances.
- Treatment: Oral rehydration therapy is crucial in managing cholera, as it helps replace lost fluids and electrolytes, thereby preventing dehydration and potential complications.

(v) Diphtheria

- Pathogen: Corynebacterium diphtheriae
- Transmission: Diphtheria primarily affects children up to the age of five and is caused by the bacterium Corynebacterium diphtheriae.
- Symptoms: The disease typically begins with a sore throat, accompanied by chills, mild fever, vomiting, and headache. A characteristic feature is the formation of a gray membrane in the throat and tonsils, which may extend downward, leading to hoarseness and difficulty breathing.
- Prevention: Immunization with the DPT vaccine within the first six weeks of birth is the most effective preventive measure against diphtheria.

B. Viral Diseases

(i) Common Cold/Rhinitis

- Pathogen: Rhinovirus
- Transmission: Common cold is one of the most infectious human diseases, primarily transmitted through inhalation of droplets expelled by coughing or sneezing from an infected individual. It can also be spread indirectly through contact with contaminated objects such as pens, books, cups, doorknobs, and computer keyboards (fomite transmission).
- Symptoms: Rhinovirus infects the nose and upper respiratory tract but does not typically affect the lungs. Symptoms of the common cold include nasal congestion and discharge, sore throat, hoarseness, cough, headache, and fatigue, typically lasting for 3-7 days.

(ii) Influenza

- Pathogen: Influenza viruses (e.g., Mycovirus influenzae)
- Transmission: Influenza, commonly known as the flu, is highly contagious and caused by various strains of influenza viruses. It spreads through respiratory droplets released when an infected person coughs, sneezes, or talks.
- Symptoms: Influenza symptoms resemble those of the common cold and include fever, body aches, sore throat, nasal congestion, and cough. In severe cases, complications such as pneumonia, bronchitis, and ear infections may develop if left untreated.

(iii) Poliomyelitis

- Pathogen: Poliovirus (ssRNA virus)
- Transmission: Polio, formerly known as infantile paralysis, spreads primarily through fecal-oral transmission, with contamination of food, water, or surfaces by infected feces. Flies or other insects may also transmit the virus. Poliovirus enters the body via the gastrointestinal tract, multiplies, and eventually reaches the nervous system, particularly the spinal cord, through the bloodstream.
- Symptoms: The disease manifests with inflammation of the nervous system, leading to symptoms such as stiffness of the neck, inability to bend the head forward, and weakness or paralysis of skeletal muscles. Initial symptoms may include fever, headache, chills, and body pain. Severe cases may result in paralysis of the muscles involved in breathing, leading to fatal outcomes. There is no definitive cure for polio, and treatment mainly focuses on supportive care

and isolation of the patient. Prevention is achieved through vaccination, with multiple vaccines now available to protect against polio, diphtheria, whooping cough, and tetanus simultaneously.

(iv) Dengue Fever

Dengue fever is caused by an RNA-containing Arbovirus, belonging to the flavivirus group, which also includes the virus responsible for yellow fever (not endemic in India). Hence, the virus causing dengue fever is a mosquito-borne flavivirus. The transmission occurs through the bite of female Aedes aegypti mosquitoes (tiger mosquitoes), with an incubation period ranging from 3 to 8 days. Two distinct types of dengue fever are recognized: classical dengue fever and dengue hemorrhagic fever.

Symptoms of Classical Dengue Fever:

- Sudden onset of high fever.
- Severe frontal headache.
- Pain behind the eyes, exacerbated by eye movements.
- Muscle and joint pain.
- Loss of appetite and taste sensation.
- Appearance of a measles-like rash on the chest and upper limbs.
- Nausea and vomiting.

Symptoms of Dengue Hemorrhagic Fever:

The symptoms resemble those of classical dengue fever, with additional manifestations:

- Bleeding from the nose, mouth, gums, and skin bruising.
- Severe and persistent abdominal pain.
- Frequent vomiting, sometimes accompanied by blood.
- Pale, cold, or clammy skin.
- Excessive thirst and dry mouth.
- Rapid, weak pulse.
- Difficulty in breathing.
- Restlessness and continuous crying.

If fever is detected, immediate medical consultation is necessary. Paracetamol tablets should be taken under the guidance of a healthcare professional, while aspirin and Disprin should be avoided. Cold sponging may be required if the fever is high, and ample fluids should be administered to the patient. There is currently no vaccine available for Dengue fever. To prevent its spread, mosquito breeding grounds should be eliminated by covering small water containers and tanks, regularly changing the water in coolers, and addressing areas where Aedes mosquitoes breed. Additionally, children should be discouraged from playing outdoors in shorts and half-sleeved clothing. The use of mosquito repellents, repellent creams, and sleeping under mosquito nets are recommended measures for personal protection.

(v) Chikungunya

Chikungunya is caused by the Chikungunya virus, first isolated from human patients and Aedes aegypti mosquitoes in Tanzania in 1952. The name "Chikungunya" originates from the native word describing the way patients walk, "doubled up," due to severe joint pain. Symptoms include sudden fever onset, debilitating joint pain, lymphadenopathy, and conjunctivitis. Some individuals may exhibit hemorrhagic manifestations. Currently, there is no vaccine available for Chikungunya.

(vi) Hepatitis

1. Hepatitis refers to liver inflammation, which can be induced by viruses, drugs, and chemicals, including alcohol. Clinically, several viral types are distinguished. Hepatitis A (infectious hepatitis) is caused by the hepatitis A virus and spreads through fecal contamination of food,

clothing, toys, and shared utensils (fecal-oral route). It typically affects children and young adults, presenting with symptoms such as anorexia, malaise, nausea, diarrhea, fever, and chills. Jaundice eventually develops, with most individuals recovering within 4-6 weeks. The hepatitis A virus possesses a single-stranded RNA genome and a non-enveloped capsid.

2. Hepatitis B (serum hepatitis) is caused by the hepatitis B virus (HBV), a 42 nm enveloped virus containing a partially double-stranded circular DNA genome. HBV transmission primarily occurs through sexual contact, contaminated syringes, transfusion equipment, and possibly saliva and tears. Chronic HBV infection can lead to cirrhosis and liver cancer. Individuals harboring active HBV are at risk of cirrhosis and may become carriers. Recombinant DNA technology has facilitated the development of vaccines (e.g., Recomb Ivax HB) to prevent hepatitis B infection, representing second-generation vaccines.
3. Hepatitis C (non-A, non-B hepatitis) is caused by the hepatitis C virus (HCV), clinically resembling hepatitis B and often transmitted through blood transfusions. HCV infection can lead to cirrhosis and liver cancer. The virus is enveloped and possesses single-stranded RNA.
4. Hepatitis D (delta hepatitis) is caused by the hepatitis D virus, which also has single-stranded RNA. Transmission is similar to hepatitis B, with co-infection with HBV necessary for hepatitis D contraction. Hepatitis D induces severe liver damage and carries a higher fatality rate compared to individuals infected with hepatitis B virus alone.
5. Hepatitis E (infectious non-A, non-B hepatitis) is induced by the hepatitis E virus, spreading similarly to hepatitis A. While it typically doesn't result in chronic liver disease, the hepatitis E virus carries a significantly high mortality rate, particularly among pregnant women. HEV possesses single-stranded RNA.

Virus	Genome	Mode of Transmission
HAV	ssRNA	Faeco-oral
HBV	dsDNA	Blood, sexual contact
HCV	ssRNA	Blood, sexual contact
HDV	ssRNA	Blood, sexual contact
HEV	ssRNA	Faeco-oral

C. Diseases Caused by Protozoans

(i) Malaria

Pathogen: Malaria is caused by Plasmodium, a minuscule protozoan. Human-targeting species of Plasmodium include P. vivax, P. malariae, P. ovale, and P. falciparum.

Mode of Transmission:

The malarial parasite, Plasmodium, undergoes a lifecycle requiring two hosts:

(i) Humans

(ii) Mosquitoes

specifically female Anopheles, which serve as the vector or transmitting agent. Plasmodium enters the human bloodstream as sporozoites, the infectious form, through the bite of an infected female Anopheles mosquito.

Life History: Upon biting a human to extract blood, an infected female Anopheles mosquito also injects malarial parasites into the human bloodstream through its saliva. Sporozoites, minute sickle-shaped forms of Plasmodium, are introduced in large numbers into the human blood. Within about thirty minutes, sporozoites move from the bloodstream into the liver's parenchymal cells to evade phagocytic white blood cells and multiply.

Schizogony: Each sporozoite enlarges within a liver cell, forming a large, rounded schizont that undergoes division to yield approximately 1,000 small, spindle-shaped merozoites. This multiple fission process is termed schizogony. Upon schizont rupture, merozoites are released into liver venous passages (sinusoids). This phase of reproduction constitutes the pre-erythrocytic phase. Merozoites in this phase are also known as crypto zoites, possessing immunity to medicines and host resistance.
Crypto zoites (merozoites) infiltrate new liver cells, developing into schizonts that further divide to generate merozoites. These second-generation merozoites are termed metacryptozoites, and their formation characterizes the exo-erythrocytic phase. Exo-erythrocytic cycling may persist in additional liver cells to establish a parasite reservoir, or some merozoites, after multiple liver cycles, may re-enter the bloodstream. Merozoites reaching the bloodstream target healthy erythrocytes, termed phanerozoites or metacryptomerozoites.

Incubation Period: The duration from initial sporozoite infection to the onset of malarial symptoms is termed the incubation period. It spans approximately 14 days in P. vivax, 30 days in P. malariae, 14 days in P. ovale, and 12 days in P. falciparum.

Erythrocytic Schizogony

Following the liver phase, another round of schizogony, termed the erythrocytic phase, occurs within the red blood cells. Upon entry into the erythrocyte, merozoites initiate feeding on the cell. Subsequently, a vacuole emerges within the merozoite, displacing its nucleus to one side, marking the onset of the ring-shaped trophozoite stage. This trophozoite is approximately 1/3 to 1/2 the size of an erythrocyte. As the trophozoite progresses, it assumes a more rounded and amoeboid shape, further enlarging at the expense of the red blood cell to form a mature schizont. The schizont contains yellowish-brown pigment granules of haemozoin, derived from the iron of hemoglobin within the red blood cell. Concurrently, the red blood cell undergoes significant enlargement and develops granules known as Schuffner's dots.
The schizont undergoes multiple divisions, giving rise to approximately 12 to 24 merozoites. Some residual cytoplasm, along with haemozoin granules, remains unshared. This process of asexual multiplication is termed erythrocytic schizogony. The newly formed merozoites rupture the compromised red blood cell, releasing into the blood plasma. The haemozoin released from the bursting red blood cells is a toxin of Plasmodium, contributing to symptoms such as shivering and fever. These merozoites, also known as schizocoels, are short, thick spindles that invade new red blood cells, initiating another cycle of erythrocytic schizogony, occurring approximately every 48 hours and repeating for several generations. Alternatively, they may migrate to liver cells to undergo post-erythrocytic schizogony.
Upon red blood cell rupture, toxins are released into the bloodstream, disseminating to various body parts and accumulating in the spleen, liver, and under the skin. The buildup of toxins leads to benign tertiary malaria fever, characterized by a yellowish-pale skin coloration, high temperature recurring every 48 hours with accompanying chills and shivering, followed by profuse sweating.
Following numerous generations of schizogony, some merozoites develop into large cells within the blood corpuscles. These merozoites give rise to two types of cells termed gamonts or gametocytes: male and female gametocytes. Female gametocytes, or mega gametocytes, are round with cytoplasm rich in nutrients and a small eccentric nucleus. Male gametocytes, or microgametocytes, exhibit clear cytoplasm and a large central nucleus. Both types of gametocytes contain significant amounts of haemozoin.

Note: Gametocytes persist in the bloodstream for several weeks but are incapable of progressing further within the human host due to the elevated body temperature. Thus, it is essential for them to be ingested by an Anopheles mosquito, where a suitable temperature prevails. As mosquitoes are cold-

blooded creatures, this transfer is crucial for the survival of the gametocytes. If this transfer fails to occur, gametocytes deteriorate and perish.

When gametocytes are ingested by an Anopheles mosquito along with a blood meal, they enter the mosquito's stomach. While red blood cells are dissolved, gametocytes remain intact. Upon transitioning from the warm human blood to the mosquito's body, a remarkable transformation occurs in the microgametocytes, known as Ex flagellation. The nucleus of the microgametocyte divides into 6 to 8 nuclei, around which cytoplasm gathers to form elongated, flagellated structures called microgametes. These microgametes detach from the pigmented residual cytoplasm and begin to grow and swim within the mosquito's gut.

In contrast, mega gametocytes undergo minimal changes. Their nucleus divides into two, with one nucleus and some cytoplasm moving outward to form a mature mega gamete, while a polar body protrudes. Subsequently, the mature mega gamete extends a small conical projection known as the cone of fertilization. Since the gametes are dissimilar, they are termed anisogametes.

One microgamete adheres to the cone of fertilization of the mega gamete, and the two fuse to produce a spherical zygote (Anisogamous syngamy). The completion of the sexual cycle occurs in any mosquito species that feeds on human blood. However, further development of the malarial parasite is contingent upon the parasite being ingested with blood by an appropriate species and variety of mosquito, specifically certain types of Anopheles mosquitoes.

Following syngamy, the spherical zygote may reside between the cells of the mosquito's stomach. Subsequently, the zygote elongates and transforms into a worm-like motile organism termed an ookinete.

Penetration and Encasement

After traversing the stomach wall of the female Anopheles mosquito, the ookinete undergoes a transition. It becomes motionless, reassumes its spherical shape, and initiates the process of encasement. The encysted form of the zygote is termed an oocyst. Remarkably, within just one- or two-days following fertilization, numerous oocysts emerge on the surface of the stomach of an infected female Anopheles mosquito, manifesting as small protrusions.

The cyst wall surrounding the oocyst is formed partially by the zygote itself and partially by the mosquito's stomach. Within each oocyst, the encysted zygote is now referred to as a sporont.

The oocyst's nucleus, now termed sporont, initially undergoes division through meiosis followed by mitosis, resulting in the formation of numerous small haploid nuclei. Concurrently, the cytoplasm undergoes development, forming large vacuoles. These tiny nuclei and cytoplasmic masses coalesce to create elongated, spindle-shaped structures known as sporozoites.

Upon the rupture of mature oocysts, the sporozoites are released into the hemocoel, the body cavity filled with hemolymph, of the mosquito. Exhibiting motility, the sporozoites traverse various organs within the mosquito's body cavity, with many of them eventually penetrating the salivary glands. At this stage, the mosquito becomes infectious. Subsequently, when such an infected female Anopheles mosquito feeds on a healthy individual, the sporozoites are injected into their bloodstream along with the mosquito's saliva. These sporozoites then initiate the cycle anew within the human host's body.

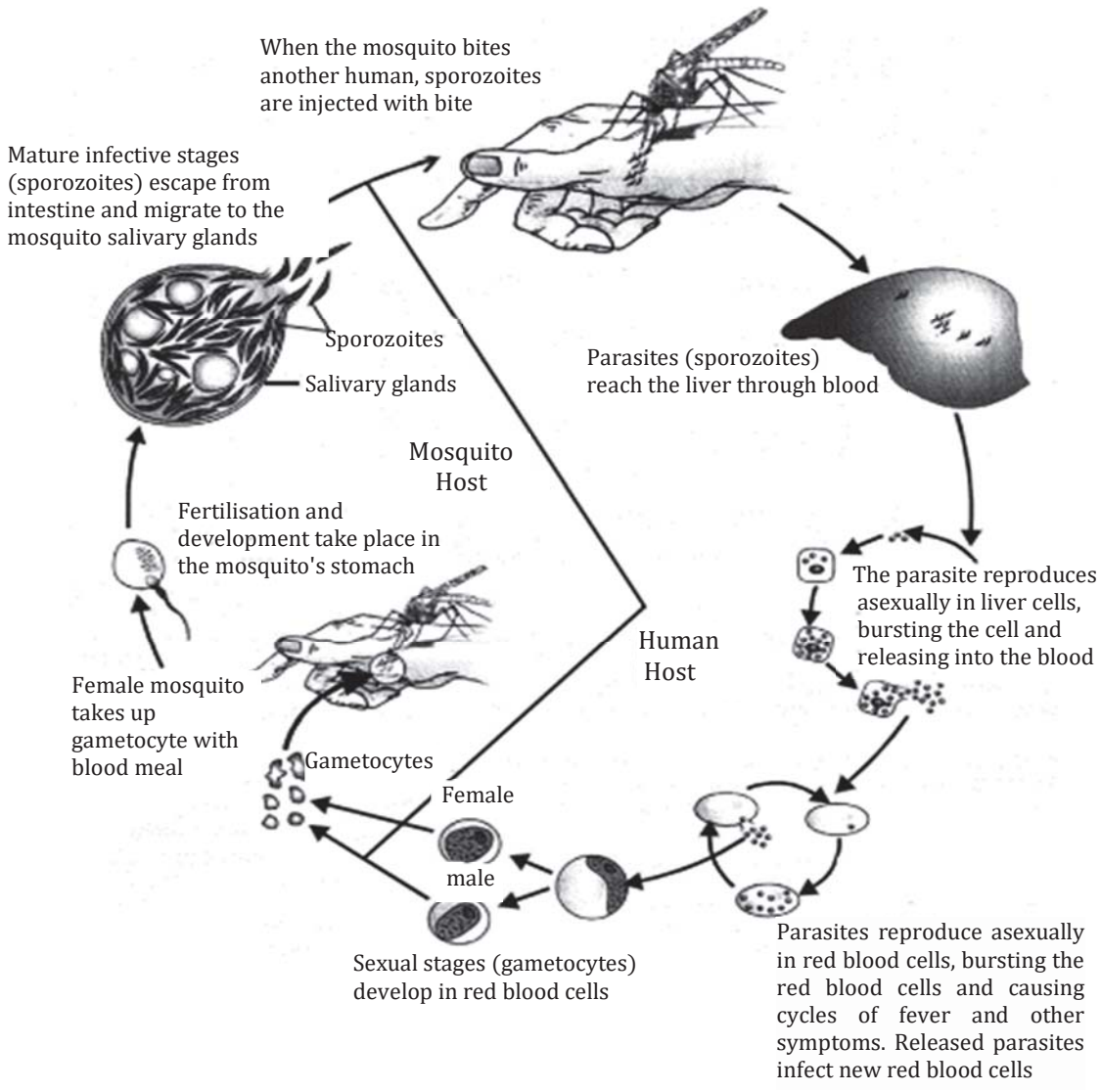

Fig.: Stages in the life cycle of Plasmodium

(ii) Amoebiasis/Amoebic dysentery

Pathogen: Entamoeba histolytica, a protozoan parasite, is the causative agent of this infection, predominantly found in the large intestine of humans.

Mode of transmission: The common housefly serves as a mechanical carrier, facilitating the transmission of the parasite from the feces of an infected individual to food and food products. Consequently, contamination occurs, primarily affecting those who consume contaminated food and water.

Symptoms: The disease manifests through symptoms such as constipation, abdominal pain, cramps, and the presence of mucus and blood clots in stools.

D. Diseases Caused by Helminths

(i) Ascariasis

Pathogen

Ascariasis is caused by the common roundworm, Ascaris lumbricoides, which inhabits the small intestine of humans.

Transmission:

Individuals contract this infection through the ingestion of contaminated water, vegetables, fruits, and similar sources.

Symptoms:

Ascariasis manifests with symptoms including internal bleeding, muscular pain, fever, anemia, and blockage of the intestinal passage. The eggs of the parasite are excreted in the feces of infected individuals, contaminating soil, water, and plants.

(ii) Filariasis

Pathogen

Washeteria (specifically W. bancrofti and W. malayi), filarial worms, are the causative agents behind this illness.

Mode of transmission: Healthy individuals contract the pathogens through the bite of infected female Culex mosquitoes.

Symptoms

The presence of filarial worms induces a slowly progressing chronic infection and inflammation within the affected organs, a condition that persists for numerous years. Typically targeting the lymphatic vessels, this disease manifests through notable symptoms such as swelling in the legs, scrotum, and various other body parts, a condition commonly referred to as Elephantiasis due to its similarity to the enlarged leg of an elephant. Additionally, the genital organs often bear the brunt of the infection, resulting in significant deformities.

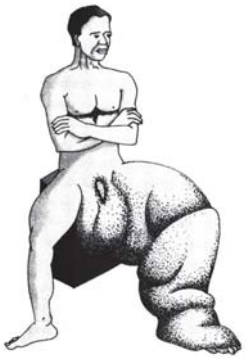

Fig.: Diagram showing inflammation in one of the lower limbs due to elephantiasis / filariasis

E. Fungal Diseases

- Ringworm: one of the most prevalent infectious diseases in humans, is caused by various fungi from the genera Microsporum, Trichophyton, and Epidermophyton.
- Transmission: Typically, ringworm is transmitted through contact with contaminated soil or by sharing items such as towels, clothing, or combs with infected individuals.
- Symptoms: The disease manifests with the appearance of dry, scaly lesions on different parts of the body, including the skin, nails, and scalp. These lesions are often accompanied by intense itching. Fungi thrive in warm, moist environments, leading to their growth in areas with skin folds, such as the groins or between the toes (commonly known as athlete's foot). Other manifestations include tinea cruris, affecting the groin and perineum, and tinea barbae, affecting the beard areas of the face and neck. Additionally, tinea pedis, or athlete's foot, targets the feet.

Fig.: Diagram showing ringworm affected area of the skin

Preventive Measures and Disease Control

Ensuring personal and public hygiene is paramount for preventing and controlling various infectious diseases:

(i) Personal hygiene involves maintaining cleanliness of the body and consuming uncontaminated drinking water, food, vegetables, and fruits.

(ii) Public hygiene encompasses proper disposal of waste and excreta, periodic cleaning, and disinfection of water reservoirs, pools, and tanks. These measures are crucial, especially where diseases are transmitted through contaminated food and water, such as typhoid, amoebiasis, and ascariasis.

(iii) For airborne diseases like pneumonia and the common cold, it's important to avoid close contact with infected persons or their belongings.

(iv) Diseases transmitted through insect vectors, such as malaria and filariasis, require controlling or eliminating the vectors and their breeding grounds. This can be achieved by preventing water stagnation, cleaning household coolers regularly, using mosquito nets, introducing larvivores fish like Gambusia in ponds, and spraying insecticides in areas prone to breeding, among other measures. Additionally, doors and windows should be equipped with wire mesh to prevent mosquito entry. Such precautions have become crucial, particularly due to recent widespread incidences of vector-borne diseases like Dengue and Chikungunya in various parts of India.

(v) The use of vaccines and immunization programs has led to the eradication of deadly diseases like smallpox. Many other infectious diseases such as polio, diphtheria, pneumonia, and tetanus have been significantly controlled through vaccination. The availability of newer and safer vaccines synthesized using biotechnology further enhances disease prevention efforts.

(vi) The discovery of antibiotics and other drugs has revolutionized the treatment of infectious diseases, enabling effective management and control.