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Q.No. 01

Asn

Protozoa

Protozoa are one-celled animals found worldwide in most habitats. Most species are free living, but all higher animals are infected with one or more species of protozoa. Infections range from asymptomatic to life threatening, depending on the species and strain of the parasite and the resistance of the host..

Classification

On the basis of light and electron microscopic morphology, the protozoa are currently classified into six phyla. Most species causing human disease are members of the phyla Sacromastigophora and Apicomplexa.

Life Cycle Stages

The stages of parasitic protozoa that actively feed and multiply are frequently called trophozoites; in some protozoa, other terms are used for these stages. Cysts are stages with a protective membrane or thickened wall. Protozoan cysts that must survive outside the host usually have more resistant walls than cysts that form in tissues.

Reproduction

Binary fission, the most common form of reproduction, is asexual; multiple asexual division occurs in some forms. Both sexual and asexual reproduction occur in the Apicomplexa.

Nutrition

All parasitic protozoa require preformed organic substances—that is, nutrition is holozoic as in higher animals.

Introduction

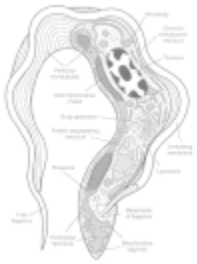
The Protozoa are considered to be a subkingdom of the kingdom Protista, although in the classical system they were placed in the kingdom Animalia. More than 50,000 species have been described, most of which are free-living organisms; protozoa are found in almost every possible habitat. The fossil record in the form of shells in sedimentary rocks shows that protozoa were present in the Pre-cambrian era. Anton van Leeuwenhoek was the first person to see protozoa, using microscopes he constructed with simple lenses. Between 1674 and 1716, he described, in addition to free-living protozoa, several parasitic species from animals, and *Giardia lamblia* from his own stools. Virtually all humans have protozoa living in or on their body at some time, and many persons are infected with one or more species throughout their life. Some species are considered commensals, i.e., normally not harmful, whereas others are pathogens and usually produce disease. Protozoan diseases range from very mild to life-threatening. Individuals whose defenses are able to control but not eliminate a parasitic infection become carriers and constitute a source of infection for others. In geographic areas of high prevalence, well-tolerated infections are often not treated to eradicate the parasite because eradication would lower the individual's immunity to the parasite and result in a high likelihood of reinfection.

Many protozoan infections that are inapparent or mild in normal individuals can be life-threatening in immunosuppressed patients, particularly patients with acquired immune deficiency syndrome (AIDS). Evidence suggests that many healthy persons harbor low numbers of *Pneumocystis carinii* in their lungs. However, this parasite produces a frequently fatal pneumonia in immunosuppressed patients such as those with AIDS. *Toxoplasma gondii,* a very common protozoan parasite, usually causes a rather mild initial illness followed by a long-lasting latent infection. AIDS patients, however, can develop fatal toxoplasmic encephalitis. *Cryptosporidium* was described in the 19th century, but widespread human infection has only recently been recognized. *Cryptosporidium* is another protozoan that can produce serious complications in patients with AIDS. Microsporidiosis in humans was reported in only a few instances prior to the appearance of AIDS. It has now become a more common infection in AIDS patients. As more thorough studies of patients with AIDS are made, it is likely that other rare or unusual protozoan infections will be diagnosed.

Structure

Most parasitic protozoa in humans are less than 50 μm in size. The smallest (mainly intracellular forms) are 1 to 10 μm long, but *Balantidium coli* may measure 150 μm. Protozoa are unicellular eukaryotes. As in all eukaryotes, the nucleus is enclosed in a membrane. In protozoa other than ciliates, the nucleus is vesicular, with scattered chromatin giving a diffuse appearance to the nucleus, all nuclei in the individual organism appear alike. One type of vesicular nucleus contains a more or less central body, called an endosome or karyosome. The endosome lacks DNA in the parasitic amebas and trypanosomes. In the phylum Apicomplexa, on the other hand, the vesicular nucleus has one or more nucleoli that contain DNA. The ciliates have both a micronucleus and macronucleus, which appear quite homogeneous in composition.

The organelles of protozoa have functions similar to the organs of higher animals. The plasma membrane enclosing the cytoplasm also covers the projecting locomotory structures such as pseudopodia, cilia, and flagella. The outer surface layer of some protozoa, termed a pellicle, is sufficiently rigid to maintain a distinctive shape, as in the trypanosomes and *Giardia*. However, these organisms can readily twist and bend when moving through their environment. In most protozoa the cytoplasm is differentiated into ectoplasm (the outer, transparent layer) and endoplasm (the inner layer containing organelles); the structure of the cytoplasm is most easily seen in species with projecting pseudopodia, such as the amebas. Some protozoa have a cytosome or cell "mouth" for ingesting fluids or solid particles. Contractile vacuoles for osmoregulation occur in some, such as *Naegleria* and *Balantidium*. Many protozoa have subpellicular microtubules; in the Apicomplexa, which have no external organelles for locomotion, these provide a means for slow movement. The trichomonads and trypanosomes have a distinctive undulating membrane between the body wall and a flagellum. Many other structures occur in parasitic protozoa, including the Golgi apparatus, mitochondria, lysosomes, food vacuoles, conoids in the Apicomplexa, and other specialized structures. Electron microscopy is essential to visualize the details of protozoal structure. From the point of view of functional and physiologic complexity, a protozoan is more like an animal than like a single cell. shows the structure of the bloodstream form of a trypanosome, as determined by electron microscopy.



(1) Classification

In 1985 the Society of Protozoologists published a taxonomic scheme that distributed the Protozoa into six phyla. Two of these phyla—the Sarcomastigophora and the Apicomplexa--contain the most important species causing human disease. This scheme is based on morphology as revealed by light, electron, and scanning microscopy. *Dientamoeba fragilis*, for example, had been thought to be an ameba and placed in the family Entamoebidae. However, internal structures seen by electron microscopy showed that it is properly placed in the order Trichomonadida of flagellate protozoa. In some instances, organisms that appear identical under the microscope have been assigned different species names on the basis of such criteria as geographic distribution and clinical manifestations; a good example is the genus *Leishmania*, for which subspecies names are often used. Biochemical methods have been employed on strains and species to determine isoenzyme patterns or to identify relevant nucleotide sequences in RNA, DNA, or both. Extensive studies have been made on the kinetoplast, a unique mitochondrion found in the hemoflagellates and other members of the order Kinetoplastida. The DNA associated with this organelle is of great interest. Cloning is widely used in taxonomic studies, for example to study differences in virulence or disease manifestations in isolates of a single species obtained from different hosts or geographic regions. Antibodies (particularly monoclonal antibodies) to known species or to specific antigens from a species are being employed to identify unknown isolates. Eventually, molecular taxonomy may prove to be a more

reliable basis than morphology for protozoan taxonomy, but the microscope is still the most practical tool for identifying a protozoan parasite. Table 77-1 lists the medically important protozoa.

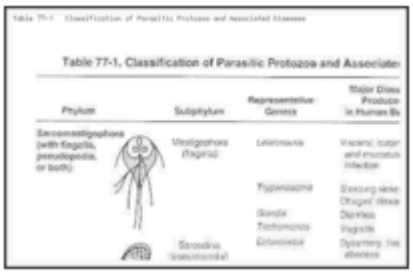


Table 77-1. Classification of Parasitic Protozoa and Associated

Phylum	Subphylum	Representative Genera	Major Diseases Produced in Humans
Sarcomastigophora (with flagella, pseudopodia, or both)	Mastigophora (flagella)	Leishmania	Visceral, cutaneous, and mucosal infection
		Trypanosoma	Sleeping sickness, Chagas' disease
		Giardia, Trichomonas	Diarrhea, Vaginitis
	Sarcodina (pseudopodia)	Entamoeba	Dysentery, liver abscess

(2) Life Cycle Stages

During its life cycle, a protozoan generally passes through several stages that differ in structure and activity. Trophozoite (Greek for "animal that feeds") is a general term for the active, feeding, multiplying stage of most protozoa. In parasitic species this is the stage usually associated with pathogenesis. In the hemoflagellates the terms amastigote, promastigote, epimastigote, and trypomastigote designate trophozoite stages that differ in the absence or presence of a flagellum and in the position of the kinetoplast associated with the flagellum. A variety of terms are employed for stages in the Apicomplexa, such as tachyzoite and bradyzoite for *Toxoplasma gondii*. Other stages in the complex asexual and sexual life cycles seen in this phylum are the merozoite (the form resulting from fission of a multinucleate schizont) and sexual stages such as gametocytes and gametes. Some protozoa form cysts that contain one or more infective forms. Multiplication occurs in the cysts of some species so that excystation releases more than one organism. For example, when the trophozoite of *Entamoeba histolytica* first forms a cyst, it has a single nucleus. As the cyst matures nuclear division produces four nuclei and during excystation four uninucleate metacystic amebas appear. Similarly, a freshly encysted *Giardia lamblia* has the same number of internal structures (organelles) as the trophozoite. However, as the cyst matures the organelles double and two trophozoites are formed. Cysts passed in stools have a protective wall, enabling the parasite to survive in the outside environment for a period ranging from days to a year, depending on the species and environmental conditions. Cysts formed in tissues do not usually have a heavy protective wall and rely upon carnivorism for transmission. Oocysts are stages resulting from sexual reproduction in the Apicomplexa. Some apicomplexan oocysts are passed in the feces of the host, but the oocysts of *Plasmodium*, the agent of malaria, develop in the body cavity of the mosquito vector.

(3) Reproduction

Reproduction in the Protozoa may be asexual, as in the amebas and flagellates that infect humans, or both asexual and sexual, as in the Apicomplexa of medical importance. The most common type of asexual multiplication is binary fission, in which the organelles are duplicated and the protozoan then divides into two complete organisms. Division is longitudinal in the flagellates and transverse in the ciliates; amebas have no apparent anterior-posterior axis. Endodyogeny is a form of asexual division seen in *Toxoplasma* and some related organisms. Two daughter cells form within the parent cell, which then ruptures, releasing the smaller progeny which grow to full size before repeating the process. In schizogony, a common form of asexual division in the Apicomplexa, the nucleus divides a number of times, and then the

cytoplasm divides into smaller uninucleate merozoites. In *Plasmodium, Toxoplasma*, and other apicomplexans, the sexual cycle involves the production of gametes (gamogony), fertilization to form the zygote, encystation of the zygote to form an oocyst, and the formation of infective sporozoites (sporogony) within the oocyst.

Some protozoa have complex life cycles requiring two different host species; others require only a single host to complete the life cycle. A single infective protozoan entering a susceptible host has the potential to produce an immense population. However, reproduction is limited by events such as death of the host or by the host's defense mechanisms, which may either eliminate the parasite or balance parasite reproduction to yield a chronic infection. For example, malaria can result when only a few sporozoites of *Plasmodium falciparum*—perhaps ten or fewer in rare instances—are introduced by a feeding *Anopheles* mosquito into a person with no immunity. Repeated cycles of schizogony in the bloodstream can result in the infection of 10 percent or more of the erythrocytes—about 400 million parasites per milliliter of blood.

(4) Nutrition

The nutrition of all protozoa is holozoic; that is, they require organic materials, which may be particulate or in solution. Amebas engulf particulate food or droplets through a sort of temporary mouth, perform digestion and absorption in a food vacuole, and eject the waste substances. Many protozoa have a permanent mouth, the cytosome or micropore, through which ingested food passes to become enclosed in food vacuoles. Pinocytosis is a method of ingesting nutrient materials whereby fluid is drawn through small, temporary openings in the body wall. The ingested material becomes enclosed within a membrane to form a food vacuole.

Protozoa have metabolic pathways similar to those of higher animals and require the same types of organic and inorganic compounds. In recent years, significant advances have been made in devising chemically defined media for the in vitro cultivation of parasitic protozoa. The resulting organisms are free of various substances that are present in organisms grown in complex media or isolated from a host and which can interfere with immunologic or biochemical studies. Research on the metabolism of parasites is of immediate interest because pathways that are essential for the parasite but not the host are potential targets for antiprotozoal compounds that would block that pathway but be safe for humans. Many antiprotozoal drugs were used empirically long before their mechanism of action was known. The sulfa drugs, which block folate synthesis in malaria parasites, are one example.

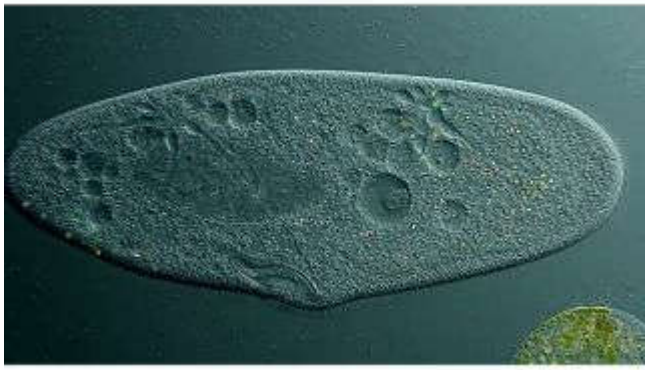
The rapid multiplication rate of many parasites increases the chances for mutation; hence, changes in virulence, drug susceptibility, and other characteristics may take place. Chloroquine resistance in *Plasmodium falciparum* and arsenic resistance in *Trypanosoma rhodesiense* are two examples.

Competition for nutrients is not usually an important factor in pathogenesis because the amounts utilized by parasitic protozoa are relatively small. Some parasites that inhabit the small intestine can significantly interfere with digestion and absorption and affect the nutritional status of the host; *Giardia* and *Cryptosporidium* are examples. The destruction of the host's cells and tissues as a result of the parasites' metabolic activities increases the host's nutritional needs. This may be a major factor in the outcome of an infection in a malnourished individual. Finally, extracellular

Q.No. 02:

Ans : 02

Paramecium?



Paramecium, showing contractile vacuole and ciliary motion. Paramecium lives in fresh water. The excess water it takes in via osmosis is collected into two contractile vacuoles, one at each end, which swell and expel water through an opening in the cell membrane. The sweeping motion of the hair-like cilia helps the single-celled organism move. [See the video.] Differential interference contrast, 350x-1000x. Tenth Prize, 2013 Olympus BioScapes Digital Imaging Competition®. www.OlympusBioScapes.com

(Image: © Ralph Grimm, Jimboomba Queensland, Australia.)

Paramecia are single-celled protists that are naturally found in aquatic habitats. They are typically oblong or slipper-shaped and are covered with short hairy structures called cilia. Certain paramecia are also easily cultured in labs and serve as useful model organisms.

Characteristics

Appearance

Paramecia cells are characteristically elongated. Historically, based on cell shape, these organisms were divided into two groups: aurelia and bursaria, according to the "The Biology of Paramecium, 2nd Ed." (Springer, 1986). The aurelia morphological type is oblong, or "cigar" shaped, with a somewhat tapered posterior end. Bursaria, on the other hand, represents cells that are "slipper" shaped. They tend to be shorter, and their posterior end is rounded.

Paramecia are a part of a group of organisms known as ciliates. As the name suggests, their bodies are covered in cilia, or short hairy protrusions. Cilia are essential for movement of paramecia. As these structures whip back and forth in an aquatic environment, they propel the organism through its surroundings. Paramecia can move forward at rates up to 2 millimeters per second, as José de Ondarza, an associate professor in the Department of Biological Sciences at SUNY Plattsburgh notes on his research website. Sometimes the organism will perform

"avoidance reactions" by reversing the direction in which the cilia beat. This results in stopping, spinning or turning, after which point the paramecium resumes swimming forward. If multiple avoidance reactions follow one another, it is possible for a paramecium to swim backward, though not as smoothly as swimming forward.

Cilia also aid in feeding by pushing food into a rudimentary mouth opening known as the oral groove. Paramecia feed primarily on bacteria, but are known to eat yeast, unicellular algae and even some non-living substances such as milk powder, starch and powdered charcoal, according to "Biology of Paramecium."

Cell structure

Paramecia are eukaryotes. In contrast to prokaryotic organisms, such as bacteria and archaea, eukaryotes have well-organized cells. The defining features of eukaryotic cells are the presence of specialized membrane-bound cellular machinery called organelles and the nucleus, which is a compartment that holds DNA. Paramecia have many organelles characteristic of all eukaryotes, such as the energy-generating mitochondria. However, the organism also contains some unique organelles.

Under an external covering called the pellicle is a layer of somewhat firm cytoplasm called the ectoplasm. This region consists of spindle-shaped organelles known as trichocysts. When they discharge their contents, they become long, thin and spiky, according to "Biology of Paramecium." The exact function of trichocysts is not quite clear, though a popular theory is that they are important for defense against predators. This has been tested over the years and has held true for certain *Paramecium* species against particular predators. For example, a 2013 article published in the journal Zoological Science found that trichocysts of *Paramecium tetraurelia* were effective against two of the three predators that were tested: the *Cephalodella* species of rotifers and the *Eucypris* species of arthropods.

Below the ectoplasm lies a more fluid type of cytoplasm: the endoplasm. This region contains the majority of cell components and organelles, including vacuoles. These are membrane-enclosed pockets within a cell. According to a 2013 paper published in the journal Bioarchitecture, the name "vacuole" describes the fact that they appear transparent, and empty. In actuality, these organelles tend to be filled with fluid and other materials. Vacuoles take on specific functions with a paramecium cell. Food vacuoles encapsulate food consumed by the paramecium. They then fuse with organelles called lysosomes, whose enzymes break apart food molecules and conduct a form of digestion. Contractile vacuoles are responsible for osmoregulation, or the discharge of excess water from the cell, according to the authors of "Advanced Biology, 1st Ed." (Nelson, 2000). Depending on the species, water is fed into the contractile vacuoles via canals, or by smaller water-carrying vacuoles. When the contractile vacuole collapses, this excess water leaves the paramecium body through a pore in the pellicle ("Biology of Paramecium").Perhaps the most unusual characteristic of paramecia is their nuclei. "*Paramecium* along with the other ciliates have this rather unique feature," said James Forney, a professor of biochemistry at Purdue University. "They have two types of nuclei, which differ in their shape, their content and function."The two types of nuclei are the micronucleus and

macronucleus. The micronucleus is diploid; that is, it contains two copies of each paramecium chromosome. Forney notes that the micronucleus contains all of the DNA that is present in the organism. "It's the DNA that is passed from one generation to the another during sexual reproduction," he said. On the other hand, the macronucleus contains a subset of DNA from the micronucleus, according to Forney. "It is the transcriptionally active nucleus," he added. "So it's the nucleus that is transcribed to make mRNAs and proteins from those mRNAs." The macronucleus is polyploid, or contains multiple copies of each chromosome, sometimes up to 800 copies.

Classification, Structure, Function and Characteristics

Paramecium is a unicellular organism with a shape resembling the sole of a shoe. It ranges from 50 to 300um in size which varies from species to species. It is mostly found in a freshwater environment.

It is a single-celled eukaryote belonging to kingdom Protista and is a well-known genus of ciliate protozoa.

As well, it belongs to the phylum Ciliophora. Its whole body is covered with small hair-like filaments called the cilia which helps in locomotion. There is also a deep oral groove containing not so clear oral cilia. The main function of this cilia is to help both in locomotion as well as dragging the food to its oral cavity.

Q.No: 03

Ans: 03

parasite

an organism that lives on or in an organism of another species, known as the host, from the body of which it obtains nutriment.

a person who receives support, advantage, or the like, from another or others without giving any useful or proper return, as one who lives on the hospitality of others.

(in ancient Greece) a person who received free meals in return for amusing or impudent conversation, flattering remarks, etc.A plant or an animal organism that lives in or on another and takes its nourishment from that other organism. Parasitic diseases include infections that are due to protozoa, helminths, or arthropods. For example, malaria is caused by Plasmodium, a parasitic protozoa.

A parasite is an organism living in or on, and metabolically depending on, another organism. **Endoparasites** live inside an organism, and **ectoparasites** live on the surface of the host. Answer

Ectoparasites:

These are the parasites which live on the outside of host. For example, human body lice.

Endoparasites: These are the parasites which live in the digestive tract, body cavities, various organs, or blood or other tissues of the host. For example, *Plasmodium.*

Many parasites have evolved to be host specific in such a way that both host and parasite tends to coevolve i.e. if the host evolves special mechanism for rejecting or resisting the parasite, the parasite has to evolve the mechanism to counteract and neutralise them, in order to be successful to the same host species. In accordance with the their lifestyle, parasites evolved special adaptations such as:
(a) Loss of unnecessary sense organs.
(b) Presence of adhesive organs or suckers to cling on to the host.
(c) Loss of digestive system.
(d) High reproductive capacity.

Types of Endoparasites:

There are three main types of parasites.**Protozoa**: Examples include the single-celled organism known as Plasmodium. A protozoa can only multiply, or divide, within the host.

Helminths: These are worm parasites. Schistosomiasis is caused by a helminth. Other examples include roundworm, pinworm, trichina spiralis, tapeworm, and fluke.

Ectoparasites: These live on, rather than in their hosts. They include lice and fleas.

SymptomsThere are many types of parasite, and symptoms can vary widely. Sometimes these may resemble the symptoms of other conditions, such as a hormone deficiency, pneumonia, or food poisoning.

Some parasite-related problems, such as giardiasis and amebic dysentery, can cause abdominal pain.Symptoms that might occur include:However, parasites can pass on a wide variety of conditions, so symptoms are hard to predict.Often there are no symptoms, or symptoms appear long after infection, but the parasite can still be transmitted to another person, who may develop symptoms.

Human parasites Many types of parasites can affect humans. Here are some examples of parasites and the diseases they can cause.

AcanthamoebiasisThis tiny ameba can affect the eye, the skin, and the brain. It exists all over the world in water and soil. Individuals can become infected if they clean contact lenses with tap water.

BabesiosisThis disease that comes from parasites that are spread by ticks. It affects the red blood cells. The risk is highest in summer in the Northeast and upper Midwest of the United States.

BalantidiasisThis is passed on by *Balatidium coli*, a single-cell parasite that usually infects pigs but can, in rare cases, cause intestinal infection in humans. It can be spread through direct contact with pigs or by drinking contaminated water, usually in tropical regions.

Blastocystosis

This affects the intestines. The blastocystis enters humans through the fecal-oral route. A person can get it by eating food or drink contaminated with human or animal feces where the parasite is present.

CoccidiosisThis affects the intestines. Coccidia is passed on through the fecal-oral route. It is found around the world. It can also affect dogs and cats, but these are different kinds. Dogs, cats, and humans cannot normally infect each other.

Amoebiasis

This is caused by the parasite *Entamoeba histolytica*. It affects the intestines. It is more likely in tropical regions and in areas with high population density and poor sanitation. It is transmitted through the fecal-oral route.

GiardiasisGiardia, or "beaver fever" affects the lumen of the small intestine. If humans ingest food or water contaminated with feces, dormant cysts may infect the body.

Isosporiasis or cystosporiasis

This disease is caused by the *Cystoisospora belli*, previously known as *Isospora belli*. It affects the epithelial cells of the small intestine. It exists worldwide and is both treatable and preventable. It is passed on through the fecal-oral route.

LeishmaniasisThis is a disease that is passed on by parasites of the Leishmania family. It can affect the skin, the viscera, or the mucous membranes of the nose, mouth, and throat. It can be fatal. The parasite is transmitted by types of sandflies.

Primary amoebic meningoencephalitis (PAM)

This is passed on through a free-living ameba known as *Naegleria fowleri*. It affects the brain and the nervous system, and it is nearly always fatal within 1 to 18 days. It is transmitted through breathing in contaminated soil, swimming pools, and contaminated water, but not from drinking water.

Malaria

Different types of plasmodium affect the red blood cells. It exists in tropical regions and is transmitted by the Anopheles mosquito.

Rhinosporidiosis

This is caused by *Rhinosporidium seeberi*. It mainly affects the mucous of the nose, conjunctiva, and urethra. It is more common in India and Sri Lanka but can occur elsewhere. Polyps result in nasal masses that need to be removed through surgery. Bathing in common ponds can expose the nasal mucous to the parasite.

Toxoplasmosis

This is a parasitic pneumonia caused by the parasite *Toxoplasma gondii*. It affects the liver, heart, eyes and brain. It occurs worldwide. People can become infected after ingesting raw or undercooked pork, lamb, goat, or milk, or though contact with food or soil that is contaminated with cat feces.

A person with a healthy immune system will not usually have symptoms, but it can pose a risk during pregnancy and for those with a weakened immune system.

Trichomoniasis

Also known as "trich" this is a sexually transmitted infection (STI) caused by the parasite *Trichomonas vaginalis*. It affects the female urogenital tract. It can exist in males, but usually without symptoms.

Trypanomiasis (Sleeping sickness)

This is passed on when the tetse fly transmits a parasite of the Trypanosoma family. It affects the central nervous system, blood, and lymph. It leads to changes in sleep behavior, among other symptoms, and it is considered fatal without treatment. It can cross the placenta and infect a fetus during pregnancy.

Chagas disease

This affects the blood, muscle, nerves, heart, esophagus and colon. It is transmitted through an insect bite. Over 300,000 people in the U.S. have the parasite that can lead to this disease.

Anisakiasis: This is caused by worms that can invade the intestines or the stomach wall. The worms are passed on through contaminated fresh or undercooked fish and squid.

Roundworms can be passed on by raccoons.

Q.No: 04

Ans: 04

Microorganisms are tiny organisms which cannot be seen by our naked eyes. There are several groups of microorganisms. Bacteria and fungi are significant among them. Most bacteria and fungi are beneficial while a small percentage causes diseases and other harmful effects. Fungi play various crucial roles in the environment. They the dominant decomposers of organic wastes and are involved in recycling of nutrients in all terrestrial habitats. Fungi are able to break down complex material such as cellulose and lignin and help other organisms to absorb nutrients. Actinomycetes are a group of bacteria which are gram positive and behave like fungi. They are beneficial in agriculture and soil systems. Actinomycetes grow as colonies which resemble mycelia of fungi. The key difference between actinomycetes and fungi is that **Actinomycetes are prokaryotic organisms while fungi are eukaryotic organisms.**

Actinomycetes

Actinomycetes are a phylum of gram positive bacteria. They are prokaryotic organisms with a primitive unicellular organization. Actinomycetes are anaerobic microorganisms. They show filamentous and branching growth pattern on solid substrates resembling fungi mycelia. Their colonies are extensive like mycelium. Aerial hyphae are found in many genera of actinomycetes. Some actinomycetes genera are motile and have flagella. Actinomycetes are responsible for the musty odor (the smell of freshly ploughed soils) which comes after rain.

Figure 01: Actinomycetes

Actinomycetes are found in terrestrial and aquatic environments. The common genera of actinomycetes are *Streptomyces*, *Nocardia,* and *Micromonospora*. Many actinomycetes species can be observed in the soil. Soil bacteria are harmless to animals and plants. They act as good decomposers. Hence they are important in increasing the availability of nutrients for plants. Actinomycetes produce a wide variety of useful secondary metabolites which have potent biological activities, including commercially important antibiotics and immunosuppressive compounds. Some of them are used for manufacturing of commodity chemical, health products, and agrochemicals.

Fungi

Fungi are a group of microorganisms which includes yeast, moulds, mushrooms and filamentous fungi. Fungi can be single celled or multi-celled. They show eukaryotic cellular organization. Fungi are found in almost all habitats. But most of them are found in lands, mainly in soil or on plant material. Fungi are heterotrophs, and they obtain foods by absorbing molecules which were digested using their digestive enzymes. One characteristic feature of fungi is the presence of chitin in their cell walls. Chitin is unique to fungi.

Show of Pic

Fungi cause a number of plant and animal diseases. In humans, several diseases such as athlete's foot ringworm, thrush, and other diseases are caused by fungi. Plant fungal diseases include rusts, smuts, leaf, stem and root rots.

Difference Between Actinomycetes and Fungi

Actinomycetes vs Fungi	
Actinomycetes are non-motile filamentous gram positive bacteria belonging to the genus of the Actinobacteria class of bacteria.	Fungi are a group of microorganism which includes single cell and complex multicellular organisms such as yeast, mushrooms, moulds, etc.
Cellular Organization	
Actinomycetes are prokaryotic organisms.	Fungi are eukaryotic organisms.
Cell Wall Composition	
Actinomycetes contain peptidoglycan in their cell walls.	Fungi contain chitin in their cell walls
Cell Size under Microscope	
Actinomycetes filaments are smaller.	Fungal filaments are bigger.
GC Content in DNA	
GC content in actinomycetes DNA is less than fungi.	Fungi have more GC bases in DNA.

Actinomycetes vs Fungi

Actinomycetes are a group of gram positive bacteria. They grow well under anaerobic conditions. The morphology of actinomycetes resembles fungi. They grow as extensive colonies or mycelia. Hence they are referred to as filamentous bacteria. Fungi are a phylum which includes yeasts, moulds and mushrooms. Actinomycetes and fungi are beneficial economically and ecologically. Actinomycetes are unicellular prokaryotic organisms while fungi are unicellular or multicellular eukaryotic organisms. This is the main difference between actinomycetes and fungi.

Q.No.05

Ans: 05

1. Virions

The illustration at left depicts a virion – the infectious particle that is designed for transmission of the nucleic acid genome among hosts or host cells. A virion is not the same as a virus. I define virus as a distinct biological entity with five different characteristics. Others believe that the virus is actually the infected host cell.The idea that virus and virion are distinct was first proposed by Bandea in 1983. He suggested that a virus is an organism without a cohesive morphological structure, with subsystems that are not in structural continuity:Viruses are presented as organisms which pass in their ontogenetic cycle through two distinctive phenotypic phases: (1) the vegetative phase and (2) the phase of viral particle or nucleic acid. In the vegetative phase, considered herein to be the ontogenetically mature phase of viruses, their component molecules are dispersed within the host cell. In this phase the virus shows the major physiological properties of other organisms: metabolism, growth, and reproduction.According to Bandea's hypothesis, the infected cell is the virus, while the virus particles are 'spores' or reproductive forms. His theory was largely ignored until the discovery of the giant mimivirus, which replicates its DNA genome and produces new virions in the cytoplasm within complex viral 'factories'. Claverie suggested that the viral factory corresponds to the organism, whereas the virion is used to spread from cell to cell. He wrote that "to confuse the virion with the virus would be the same as to confuse a sperm cell with a human being".If we accept that the virus is the infected cell, then it becomes clear that most virologists have confused the virion and the virus. This is probably a consequence of the fact that modern virology is rooted in the study of bacteriophages that began in the 1940s. These viruses do not induce cellular factories, and disappear (the eclipse phase) early after cell entry. Contemporary examples of such confusion include the production by structural virologists of virus crystals, and the observation that viruses are the most abundant entities in the seas. In both cases it is the virion that is being

studied. But virologists are not the only ones at fault – the media writes about the AIDS virus while showing an illustration of the virion.Those who consider the virus to be the infected cell also believe that viruses are alive.one can conclude that infected eukaryotic cells in which viral factories have taken control of the cellular machinery became viruses themselves, the viral factory being in that case the equivalent of the nucleus. By adopting this viewpoint, one should finally consider viruses as cellular organisms. They are of course a particular form of cellular organism, since they do not encode their own ribosomes and cell membranes, but borrow those from the cells in which they live.This argument leads to the assumption that viruses are living, according to the classical definition of living organisms as cellular organisms. Raoult and Forterre have therefore proposed that the living world should be divided into two major groups of organisms, those that encode ribosome's (archaea, bacteria and eukarya), and capsid-encoding organisms (the viruses).

2. Viroids

are small, single-stranded, circular RNAs that, despite their lack of protein-coding capacity, can infect higher plants and, in many cases, induce specific diseases. Based upon differences in their structural and functional properties, viroid species are assigned to one of two taxonomic families: the *Pospiviroidae*, whose 25 members adopt a rod-like secondary structure with five domains and several conserved motifs; and the *Avsunviroidae*, whose four members are catalytic RNAs that undergo self-cleavage through hammerhead ribozymes during replication. Type members of the families *Pospiviroidae* and *Avsunviroidae* replicate in the nucleus and the chloroplast, respectively, using alternative versions of an RNA-based rolling-circle mechanism. To establish a systemic infection, viroids must then move intracellularly, next intercellularly through plasmodesmata, and finally through the phloem to distal parts of the plant following the typical source-to-sink pattern of photoassimilate transport. This movement process most likely requires interaction with host proteins. Viroids also trigger a defensive RNA-silencing response in their hosts, a phenomenon that may mediate pathogenesis and other important biological properties. The host range and pathogenicity determinants of several viroids have been mapped to specific regions of their secondary or tertiary structure. Viroids are regarded as 'living fossils' of a primitive RNA world, a view that is strongly supported by the presence of ribozymes in members of the *Avsunviroidae*.

3. Prions

This post is part of a series introducing the basics of prion disease. Read the full series here.

The term **prion** was coined to mean *proteinaceous infectious particle* [Prusiner 1982]. It's usually pronounced PREE-on in the U.S. and PRY-on in the U.K. Prions are bits of misfolded protein that have the ability to spread by making other proteins misfold.

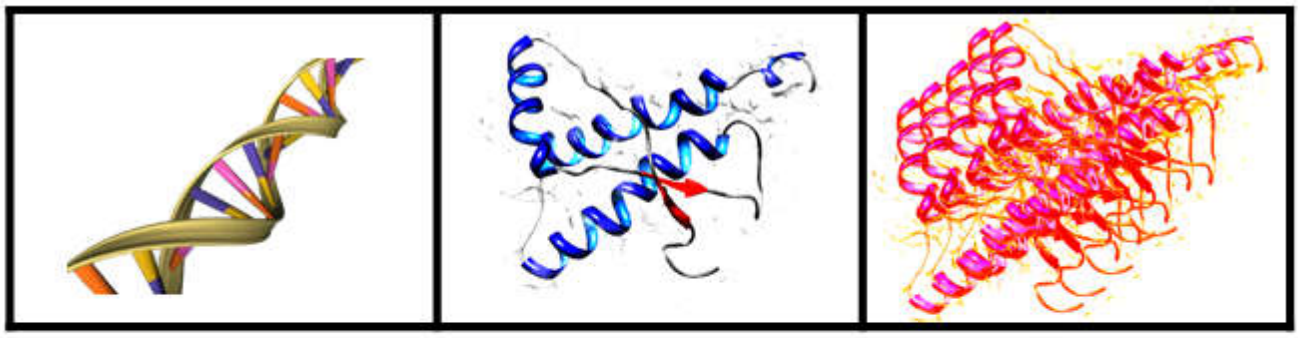
The concept and the nomenclature surrounding it are easier to understand with a bit of historical background.

A couple of centuries ago, people started taking note of a unique disease afflicting sheep, which they called **scrapie** because the sheep became deranged and, among other things, started scraping their hindquarters raw. Scrapie was an unusual disease: it seemed to spread like a virus but in other ways it looked like a genetic disease [Parry 1962]. Most peculiar of all, the infectious agent – whatever it was – seemed nearly indestructible. Viruses can usually be inactivated by heat and then used in vaccines, but scrapie survives high temperatures. In one notable incident, a herd of sheep were vaccinated against louping-ill virus with a heat-treated sample from other sheep [Gordon 1946]. The sample turned out to contain scrapie, and many of the inoculated sheep became ill with scrapie as a result.

People studied scrapie for about 150 years without much insight as to the true nature of the disease. A breakthrough came in the mid-20th century when scientists started studying **kuru**, a neurological disease epidemic in the highlands of Papua New Guinea. Carleton Gajdusek won the 1976 Nobel Prize for demonstrating that kuru could be transmitted to chimpanzees [Gajdusek 1966], as could Creutzfeldt-Jakob disease (CJD), another condition which wreaked havoc on people's brains. The damage from CJD looked a lot like that of kuru and scrapie under the microscope.

Soon the nature of the infectious agent became clear. The "scrapie agent," as it used to be called, was a protein [Prusiner 1982]. Unlike bacteria and viruses, it has no DNA or RNA. This was a new thing in all of biology, and Stanley Prusiner won the 1997 Nobel Prize for demonstrating this [Prusiner 1998].

So first there was the "scrapie agent", and then this was shown to be an infectious protein which Prusiner dubbed a "prion". Then when Prusiner discovered the protein of which prions were made, he called it "prion protein" (PrP for short) [Prusiner 1983]. Next it turned out that PrP was a protein that everyone – even people who aren't sick – have in their bodies, and that there's a gene in your DNA, on chromosome 20, that contains instructions telling each cell how to make PrP [Oesch 1985]. This gene was eventually called the *PRNP* (prion protein) gene.



PRNP is a gene in your DNA which encodes for prion protein

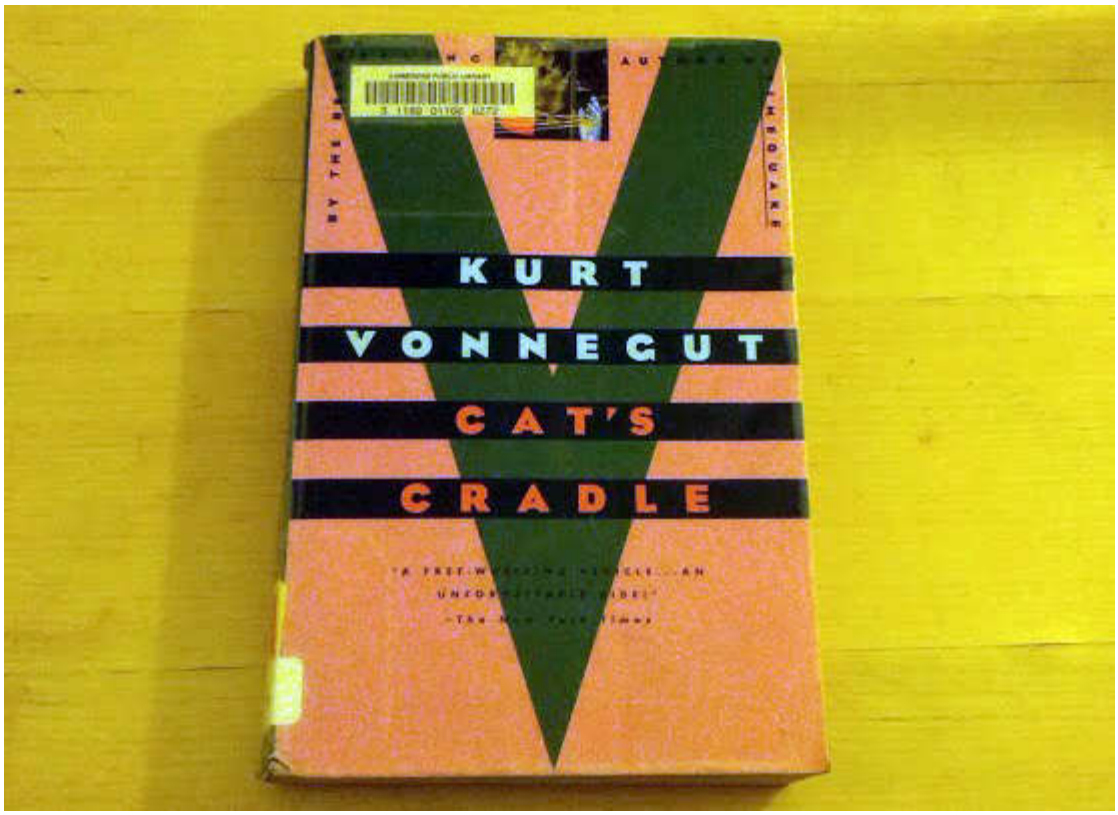
Prion protein or PrP is a protein on the surface of your cells

A prion is an infectious particle made up of misfolded prion proteins

Artist's rendering; protein images adapted from Ilc et al 2010 http://goo.gl/WWlBR7

If everyone has prion protein, then why do most people never get sick with a prion disease? It turns out that PrP normally exists in a healthy state called "cellular prion protein" or PrP^{C}. But it's capable of misfolding into a "scrapie prion protein" or PrP^{Sc}. One particle of PrP^{Sc} can cause other PrP^{C} to convert into PrP^{Sc}.

In the novel Cat's Cradle by Kurt Vonnegut, there's a sort of doomsday weapon called *ice-nine.* Ice-nine is a fictional water crystal that has a higher melting point than ordinary ice – it's solid at room temperature. One crystal of ice-nine causes other water molecules to become ice-nine and so it can freeze an entire ocean. PrP^{Sc} is like ice-nine: it "teaches" the other prion proteins how to fold up into a disease state [Kocisko 1994].



When Stanley Prusiner coined the term prion, there weren't many known prion diseases – just kuru, scrapie, and Creutzfeldt-Jakob disease, all of which turned out to be caused by the same protein, PrP. We now know that several other diseases – mad cow or bovine spongiform encephalopathy in cows, chronic wasting disease in deer, and fatal familial insomnia and Gerstmann-Straussler-Scheinker syndrome (just call it GSS!) in humans are all prion diseases, also caused by PrP.

The End