Model Answer **Paper code: AS-2177**

M.Sc. (Botany) I Semester
Paper – LBC 701/LBT 101
Diversity and Biology of Bacteria, Fungi and Viruses

Section - A

Answer 1.

(i) Arabinose and galactose sugar found in *Nocardia* and *Rhodococcus.* Option "**a"** is correct.

(ii) Microviridae group do not have ds DNA. Option **"c"** is correct.

(iii) HMC (Hydroxymethyl cytosine) do not replaces cytosine from host DNA. Option **"b"** is correct.

(iv) DNA is packed in head of viral particle by Packasome. Option **"d"** is correct.

(v) spores of fungi is not avoid of water. Option **"a"** is correct.

(vi) Powdery mildew of *Vitis vinifera* is caused by *Uncinula nector.* Option "**a"** is correct.

(vii) Secondary zoospore is arises from a sporangium. Option **"c"** is correct.

(viii) *Pilobolus* is a Hat thrower fungi. Option "**a"** is correct.

(ix) The conidia of Erysiphales is hydrated. Option "**d"** is correct.

(x) Muriform conidia found in Moniliales. Option **"a"** is correct.

Section B

Answer 2. The order Ustilaginales includes the plant pathogenic organism commonly known as the smut fungi. The main characteristics are:-

(1) This name refers to the balck, dusty masses of teliospores resembling soot or smut that form in diseased plants.
(2) All these fungi are biotrophic pathogens with shorter or longer saprobic phases.
(3) In nature, the dikaryotic phase of the life cycle of a smut fungus appears to be obligately parasitic on flowering plants.
(4) While various portions of host plants may be infected, including leaves, stems, and in a few cases, even roots, in most hosts it is the flowering parts that are attacked.
(5) Hyphae usually remain confined to certain host tissues, although those of a few smut fungi may become systemic.
(6) In some hosts perennial infections are established in which the pathogen survives the winter in hot tissue.
(7) New growth arising from these tissues in the spring can be infected from the beginning.
(8) Hyphae of smut fungi are slender, septate, and often highly convoluted structure that grow primarily between host cells.
(9) The hyphae of that fungi are binucleated and form teliospore.
(10) Later on teliospore germinate to form basidiospore, those basidiospore undergo plasmogamy and form soredia. Basidiospore is uninucleated structure which soredia is dinucleated.
(11) Soredia develop to form hyphal structure of fungi.

Answer 3: (a) Fungi used in medicine:-

Fungi have been a source of food for numerous generations. Today a huge range of edible fungi (mushrooms) are cultivated in a multimillion dollar industry and savored in many parts of the world. Many food products that we use regularly in our daily lives are processed using fungi. Some common examples include soy sauce processed using *Aspergillus oryzae* and *Saccharomyces rouxii*, blue cheese using *Penicillium roquefortii*, etc. Fungi have also been used in activities such as the control of pests, alcohol and beer production, and making bread. But their importance to humanity is not really appreciated until one studies their usage in drug manufacturing. At the beginning of this century, 10 of the 20 most profitable medicinal products involved fungi. Of the current top-selling prescription medicines, there is the antibiotic *amoxicillin* (a semi synthetic penicillin which is sold in combination with another compound), three anti-cholesterol statins (*pravastatin, simvastatin,* and *lovastatin*), all used to lower plasma lipoprotein levels and an immunosuppressant *cyclosporin A*, each of which has an annual revenues in excess of 1 billion dollars. All of these are fungal products.

Chemicals derived as part of the life process of one organism that can be used to kill or stop the growth of other microorganisms are referred to as antibiotics. Many of us are here only because an antibiotic called 'penicillin' saved our lives, or the life of one of our parents or grandparents. Penicillin's ability to cure people of numerous bacterial infections has saved so many lives that it is has been referred to as a "miracle drug." In the year 1929, Alexander Fleming, a doctor and researcher, published a paper on a chemical he called 'penicillin', which he had isolated from a mold, *Penicillium notatum* and noted that it had prevented the growth of a neighboring colony of germs in the same petri dish. Although Dr. Fleming was never able to purify penicillin, he became the first person to publish penicillin's germ-killing power. In the year 1938, Howard Florey, Ernst Chain, Norman Heatley and others expanded on Fleming's work and developed methods for growing, extracting and purifying enough penicillin to prove its value as a drug. This discovery of penicillin marked the beginning of a new approach to treating human disease and established the importance of fungi. Many once-fatal bacterial diseases became treatable, and new forms of medical intervention were possible. The current top five best-selling antibiotics in the world are produced from fungi. Our life expectancy without them would be much lower.

Statins – another class of medically important products derived from fungi – have been recommended for wide spread use to control heart disease. The soil-borne fungi *Aspergillus terreus* and *Aspergillus griseus* produce these secondary metabolites statins that have been used to reduce or remove low-density lipoproteins from blood vessels in humans. Statins act on an enzyme in the liver that makes cholesterol. By blocking the enzyme, the body removes cholesterol complexes from the inside of blood vessels. This has the effect of reducing or removing blockages in arteries, and thereby reducing the chance of a heart attack, strokes and diabetes.

A powerful immunosuppressant in mammals referred to as *cyclosporin A* is a fungal metabolite, and is derived from various fungi including *Trichoderma polysporum* and *Cylindrocarpon lucidum*. It is widely used during and after bone marrow and organ transplants in humans. *Cyclosporin A* acts by binding to various proteins in a manner that suppresses the proliferation of T-cells (responsible for cell-mediated immunity and delayed hypersensitivity). The inhibition of T-cell proliferation results in the suppression of the activation process associated with invasion by foreign bodies. As a consequence, transplant tissues, which are foreign bodies, are not rejected.

There are numerous other medicinal uses of fungi. Ergot, a common name for a fungal disease of certain grains and grasses, is caused by the Ascomycete *Claviceps*. It produces many alkaloids that have a number of medicinal uses. One of the most widespread uses has been in the treatment of migraines. Griseofulvin, a chemical produced by *Penicillium griseofulvum*) is the only antifungal agent extracted from fungi. It is fungistatic agent that inhibits fungal growth rather than killing, and is used for the treatment of dermatophytes.

In conclusion, it should be stated that only a few of the possible uses of fungi have been mentioned here. One can say that we have barely scratched the surface of fungi as a source of prevention and cure of diseases and there is potentially a vast range of beneficial use of fungi in the field of drugs and medicine.

Answer 3: (b) Plant disease causing fungi

Canker - There are some fungal infections that affect the roots and barks of the plants. One such fungi is canker fungi. It is found on woody trees and is notorious for causing localized damage to the barks of trees.

Downy Mildew - This disease is specifically caused by Peronosporaceae which affects a number of plants. It can be identified when discolored blotches appear on the leaves; a mold-like growth also develops on the plants. It affects the growth and strength of the plant.

Damping Off - This is a disease that infects the seedling of the plant, caused by different fungi -- *Pythium* and *Phytophthora* being some of them. It infects the seed and decays it, thus affecting the growth and vigor of the whole plant.

Anthracnose- It is a disease caused by *Colletotrichum* or *Gloeosporium* fungi which occur in warm and humid areas. In this, shrunken kind of spots of different colors are observed on the fruits, flowers, stems, and leaves. These spots gradually expand and cause the plant to die.

Decay - Decomposition of leaves and wood that is caused by fungi is called decay. It attacks living plant tissue and kills the plants. Decay is caused by many species of fungi -- *Pythium, Aphanomyces* and *Phytophthora* being some of them.

Club Root - This infection is found in cabbages, turnips, and radishes which is caused by the *Plasmodiophora brassicae* fungus. The color of the leaves changes to bluish-green, and the roots if pulled out appear clubbed and are easily broken.

Black Spot - *Diplocarpon rosae* is the fungus that causes the black spot disease on a rose plant. Blackish spots that appear on the leaves gradually spread upwards and weaken the plant. It is mostly observed in humid climate.

Crown Wart - Like canker attacks on the barks of woody trees, this fungus (*Physoderma* species) attacks the stem of the alfalfa plants. It forms white protrusions at the base of the stem of the plant.

Potato Wart - Caused by *Synchytrium endobioticum*, it is a fungal disease that causes dark, warty, spongy excrescences in the eyes of potato tubers, similar to the crown wart in alfalfa plants.

Rhizoctonia Disease - *Rhizoctonia solani* is the fungus that infects potato plants, underground stems, and tubers as well. It generally occurs in the lesion form, or as sclerotia on tubers. This infection can kill the plant as it does not allow the plant to grow further.

Early Blight - *Alternaria solani* is the fungal pathogen that causes early blight disease in potatoes and tomatoes. It destroys the fruit of the plant and affects the life as well. The leaves and fruits turn yellow or brown and then drop off from the plant.

Late Blight - Late blight or blight is caused by *Phytophthora infestans*, which again attacks potatoes and tomatoes. Gray spots start appearing on the leaves; white-colored mold also appears on the leaves as well as the fruits, eventually killing the whole plant.

Plant Wilting - This fungal disease gets its name because it causes the plant (it infects) to wilt. The fungal invasion starts in the roots and then slowly makes its way into the stem and plugs of the vascular system of the plant. Fusarium wilt (caused by *Fusarium oxysporum*) and Verticillium wilt (caused by *Verticillium longisporum*) are the types of plant wilting that affect many plants, like cotton, potato, tomatoes, tobacco, and so on.

Leaf Curl - It is a disease caused by *Taphrina deformans* in which the leaves appear distorted, crumpled, and thickened. It reduces the production of leaves and fruits.

Powdery Mildew - The characteristic of this fungal infection is that it is often specific to the host that it invades. It is normally seen on roses, lilac, English oak, zinnias, etc.

Apple Scab - An air-borne fungus, *Venturia inaequalis* causes the apple scab disease. Olive green-colored patches appear on the leaves, black- or gray-colored patches develop on the fruits eventually destroying it.

Rust - This disease affects the stems, leaves, seeds, and fruits of the plant. It can be identified if spots of brown, yellow, red, or orange colors are seen. It may reduce the vigor of the plant. It is caused by pathogenic fungi.

Smut - Ustilago maydis is a fungus that affects corn and sugarcane plants. Blisters develop on the affected parts of the plant and it gets discolored as well. The kernels become huge, they swell up, and the whole plant and fruit are slowly destroyed.

Sclerotium Rot - It is a result of *Sclerotium rolfsii* which is a soil-inhabiting fungus affecting the seed of the plant. This seed-borne disease infects the seed and it turns into blue and black patches.

Answer 3: (c) Edible fungi

Edible Fungal species are difficult to cultivate; others (particularly mycorrhizal species) have not yet been successfully cultivated. Some of these species are harvested from the wild, and can be found in markets. When in season they can be purchased fresh, and many species are sold dried as well. The following species are commonly harvested from the wild:

1. *Boletus edulis* or edible Boletus, native to Europe, known in Italian as Fungo Porcino (plural 'porcini') (Pig mushroom), in German as Steinpilz (Stone mushroom), in Russian as "white mushroom", in Albanian as (Wolf mushroom) and in French the *cèpe*. It also known as the king bolete, and is renowned for its delicious flavor. It is sought after worldwide, and can be found in a variety of culinary dishes.
2. *Cantharellus cibarius* (The chanterelle), The yellow chanterelle is one of the best and most easily recognizable mushrooms, and can be found in Asia, Europe, North America and Australia. There are poisonous mushrooms which resemble it, though these can be confidently distinguished if one is familiar with the chanterelle's identifying features.
3. *Cantharellus tubaeformis*, the tube chanterelle or yellow-leg
4. *Clitocybe nuda* - Blewit (or Blewitt)
5. *Cortinarius caperatus* the Gypsy mushroom (recently moved from genus *Rozites*)
6. *Craterellus cornucopioides* - Trompette de la Mort or Horn of Plenty

7. *Grifola frondosa*, known in Japan as *maitake* (also "hen of the woods" or "sheep’s head"); a large, hearty mushroom commonly found on or near stumps and bases of oak trees, and believed to have *Macrolepiota procera* properties.
8. *Gyromitra esculenta* this "False morel" is prized by the Finns. This mushroom is deadly poisonous if eaten raw, but highly regarded when parboiled (see below).
9. *Hericium erinaceus*, a tooth fungus; also called "lion's mane mushroom."
10. *Hydnum repandum* Sweet tooth fungus, hedgehog mushroom, urchin of the woods

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Answer 4: Asexual reproduction in fungi

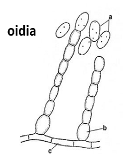
The kind of reproduction which does not involve meiosis and fusion of nuclei is called asexual reproduction. It occurs by the following methods-

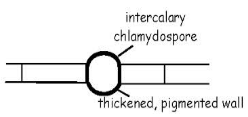
(1) Oidia: The hypha breaks up into its component cells or small pieces which behave like spores. These are called oidia. The oidia are generally thin walled and do not store reserve food material. They germinate immedietly after liberation and cannot survive under unfavourable conditions.

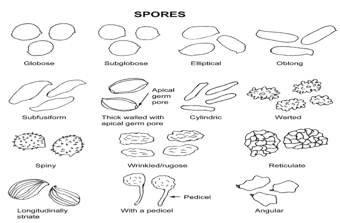
(2) Chalmydospores: These are thick walled resting cells produced in the same manner as oidia. They store reserve food material and are capable of withstanding long unfavourable conditions.

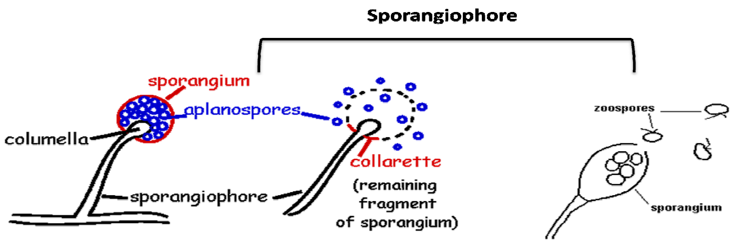
(3) Spores: These are minute propagating units which serve in the production of new individuals. They vary in shape, size and colour in different individuals and sometimes serve as basis in the classification of certain groups of fungi. The asexual spores are of two types- **(i) Sporangiophores:** These spores are produced inside the sac-like structure, called **sporangia**. Sometimes these spores are also termed as endospore. If the sporangiospores are non-motile, they are called **Apalnospores** (e.g., *Mucor*, *Rhizopus*). If the sporangiospores are motile, they are called **zoospores**. The zoospores may be uniflagellate or biflagellate.

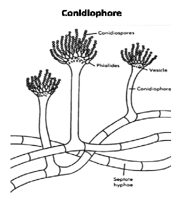
(ii) Conodia: These are non-motle sproes produed singly or in chains by constrictions at the tip or lateral side of special branches, called **conidiophores**. They are produced exogenously (not enclosed within sporangia). The conidia germinate directly by giving out germ tubes. Sometimes the conidia behave like sporangia and called **conidiosporangia**.







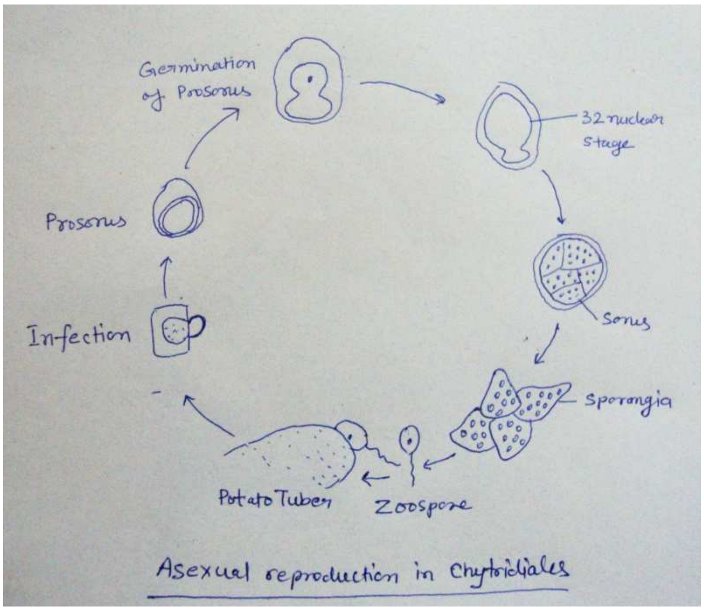




Asexual reproduction in chytridiales

In chytridiales asexual reproduction is occurred by zoospore production. The zoospore is produced in sporangia which are developed by sorus. The sorus structure is formed by penetraction of zoospore in host tissue. In host tissue only cytoplasm of zoospore enters the flagella remain outside.

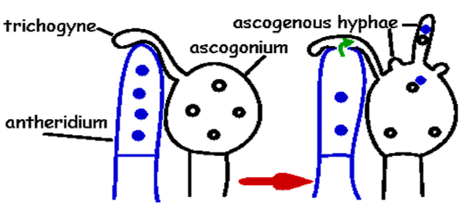
The asexual reproduction in chytridiales started from infection of host tissue. The host tissue is infected by zoospore (resting spore) which is act as prosporangium on germination. They form the prosorus (walled structure). It later on develops the vesicle and undergo in nuclear division without cytoplasmic division. It produces sporangial sorus and develop the zoospore.

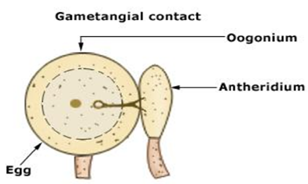


Answer 5: (a) Sexual reproduction in pernosporales:- sexual reproduction is **oogamous** type and mode of sexual fusion is **gametangial contact** type. The sex organs are antheridia (male) and oogonia (female). The fungus reproduces sexually by the end of growing season of host plant. The sex organs develop in the fungal branches present in the intercellular spaces of deeper tissues of pith and cortex of stem, petioles and flowers. Externally presence of sex organs is indicated byh twisting, distortion and hyhpertrophy of host plant parts.

Development of sex organs

The sex organs develop at the tips of irregular hyphal branches present in the intercellular spaces of host tissues. Both antheridia and oogonia develop in close vicinity of each other. Development of sex organs is fundamentally similar in all the genus of Pernosporales.





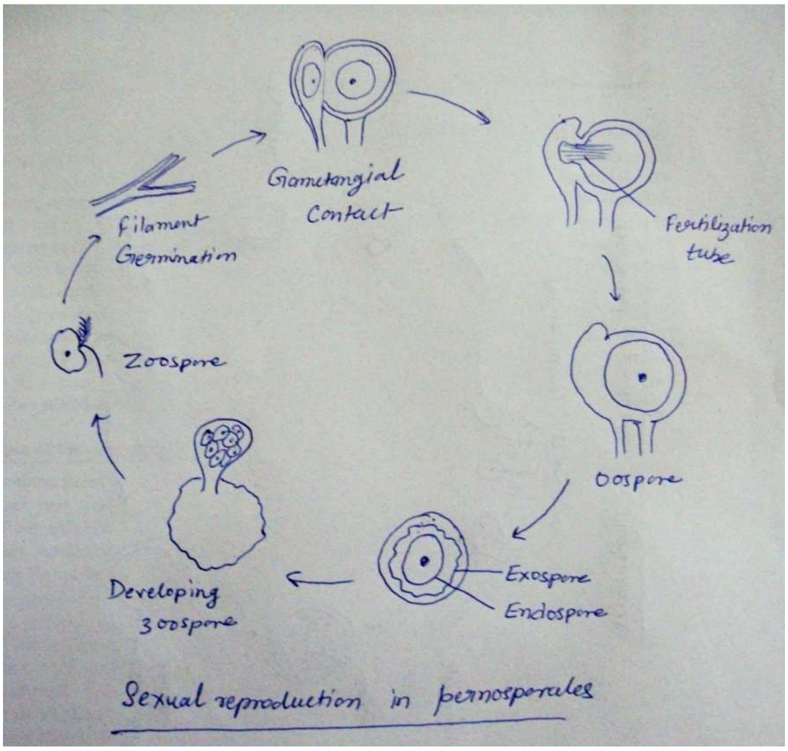
Gametangial contact

Development of oospore

The male branch develp antheridium and female branch develop oogonium. Later they mature to differ in their cytoplasm. There is fertilization tube formation and nuclear material of both sex organ fertilize. This stage called **plasmogamy** and later on the nucleus divide and **karyogamy** occurs. The resultant structure **Oospore** formed.

Germination of oospore

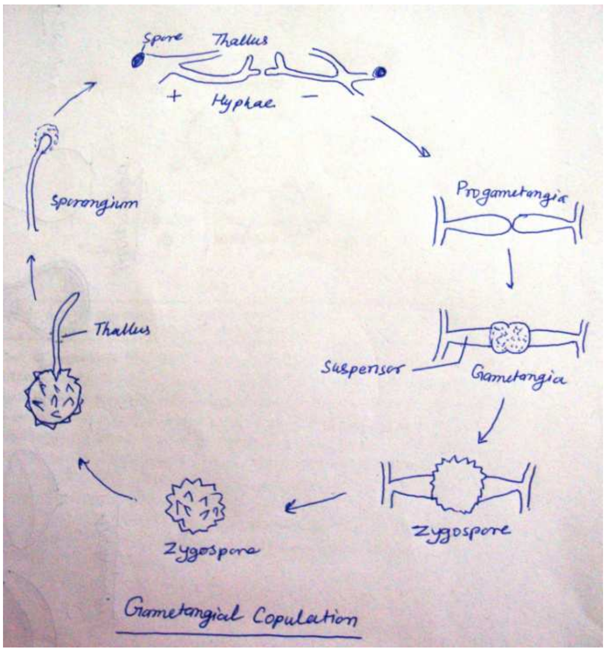
The oospore differentiated into exospores and endospore and later on develop multinucleated body which form zoosporangium. This liberate biflagellated zoospore.



Answer 5: (b) Gametangial copulation

In this mode of reproduction, the two gametangia fuse with each other and lose their identity in the sexual reproduction. Examples, *Rhizopus, Mucor.* Two different strain hyphae of fungus approaches for gametangial copulation. The different strain hyphae form **progametangia.** The two progametangia adhere together by their tips. Soon the cytoplasm along with nuclei flows towards the tips of progmetangia. The tips of progametangia enlarge in size. Finally a transverse septum is laid down in each progametangium which separates terminal **gametangia** from rest of the branch. The rest of the branch is now called **suspensor.** The size of gametangia and suspensor are almost equal. At this stage the two gametangia of opposite strains are in close contact with each other. Each one of them possesses densely granular multinucleate protoplasm, which differentiates into single aplanogamete. It is also called **coenogamete** due to presence of a large number of nuclei. The suspensor has vacuolated cytoplasm with lesser number of nuclei. In most of the species, the two gametangia of the pair are equal in size bu in some cases they are unequal. Thus they produce **zygospre,** which under go in resting stage.

The diploid nuclei of zygospre divide by meiosis before enters into resting stage. They give rise to haploid thallus of fungi.



Answer 6: Mode of nutrition in fungi

The fungal members lack chlorophyll and exhibit heterotrophic mode of nutrition. They either live on dead decaying organic matter or on living organisms. A few forms live in symbiotic association with other plants or as mycorrhiza. Thus, according to their mode of nutrition they are classified into two broad categories.

1. Saprophytes : the term is derived from greek word sapros meaning rotten. It includes all those fungi which obtain their food from dead decaying organic matter. The saprophytes are further sub divided into-

(a). Obligate saprophytes : It includes fungi which get their food from dead decaying organic matter and cannot grow on living host, i.e., they are true saprophytes. Example, Peziza, Morchella, Agaricus etc.

(b) Facultative parasites : They are ordinarily saprophytes and grow on dead and decaying organic matter, but under certain conditions they may become parasites. Example, Pythium.

2. Parasite : The term is derived from greek word parasites meaning eating beside another. A parasite may be defined as and organism or virus existing in an intimate association with another living organism from which it derives an essential part of the materials for its existence. Thus these organisms grow on other living organisms and obtain their food from them. The parasites are further sub divided into-

(a) Obligate parasites: they are the true parasites and restricted only to living hot tissues. They fail to grow on artificial media.

(i) Biotrophs : The parasites which obtain their food from the living tissues on which they complete their life cycles.

(ii) Hemibiotrophs : They attack living tissues in the same way as biotrophs but continue to develop and sporulate after the tissue is dead.

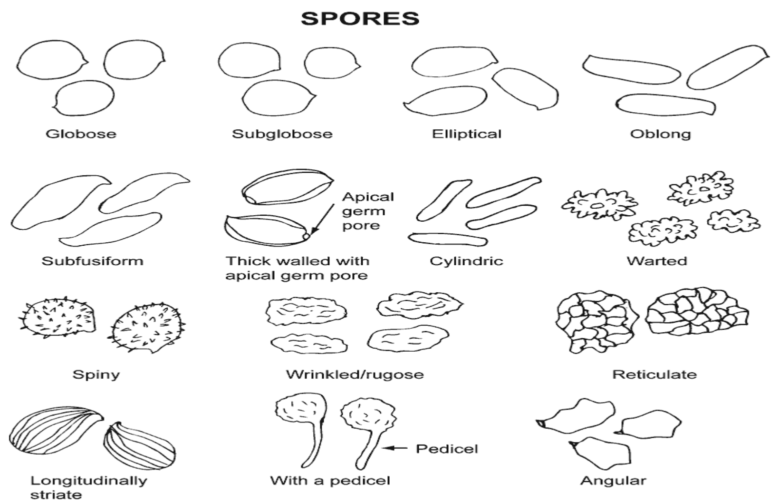
(iii). Perthotrophs : They kill the host tissue in advance and then get their nourishment saprophytically.

(b) Facultative saprophytes : It includes fungi which live as parasite and pass most of the life cycle in association with the living host. However, under certain circumstances they can also grow as saprophytes.

Spore are the most common method of asexual reproduction in fungi. The term spore is used for any small propagative, reproductive or survival unit, which separates from a hypha or a sporogenous cell and give rise to a new individual. On the basis of structure they can be divided in to many form.

i. Chlamydospre, ii. Basidiospre, iii. Uredospre, iv. Telutospre, v. amerospore, vi. Didymospre, vii. Phramospre, viii. Dictyospore, ix. Helicospre, x. Staurospre.

Structures of spores



Answer 7: (a) Genetic recombination

(i) Conjugation. Conjugation is the closest analogue in bacteria to eukaryotic sex.

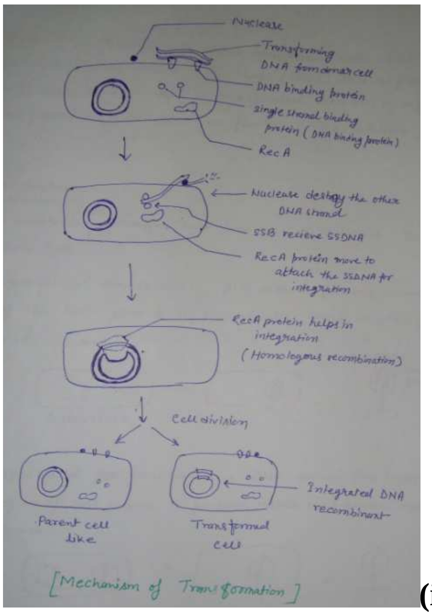
- The ability to conjugate is conferred by the F plasmid. A plasmid is a small circle of DNA that replicates independently of the chromosome. Bacterial cells that contain an F plasmid are called "F+". Bacteria that don't have an F plasmid are called "F-".
- F+ cells grow special tubes called "sex pilli" from their bodies. When an F+ cell bumps into an F- cell, the sex pilli hold them together, and a copy of the F plasmid is transferred from the F+ to the F-. Now both cells are F+.

(ii). Transformation. The essence of recombinant DNA technology is to remove DNA from cells, manipulate it in the test tube, then put it back into living cells. In most cases this is done by transformation.

- In the case of E. coli, cells are made "competent" to be transformed by treatment with calcium ions and heat shock. E. coli cells in this condition readily pick up DNA from their surroundings and incorporate it into their genomes.

(iii). Transduction.

- Transduction is the process of moving bacterial DNA from one cell to another using a bacteriophage.
- Bacteriophage or just "phage" are bacterial viruses. They consist of a small piece of DNA inside a protein coat. The protein coat binds to the bacterial surface, then injects the phage DNA. The phage DNA then takes over the cell's machinery and replicates many virus particles.
- Two forms of transduction:
- 1. generalized: any piece of the bacterial genome can be transferred
- 2. specialized: only specific pieces of the chromosome can be transferred.

(i)


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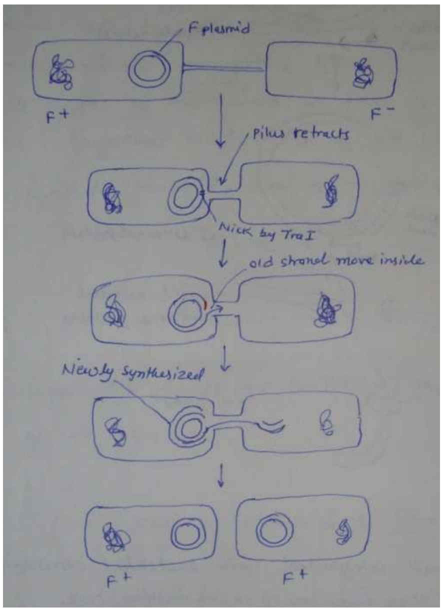
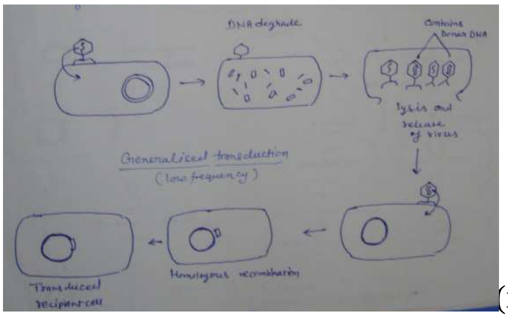


(iii) 1.


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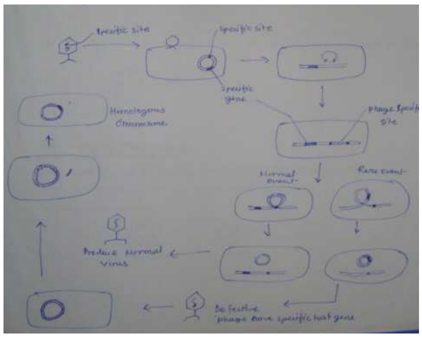
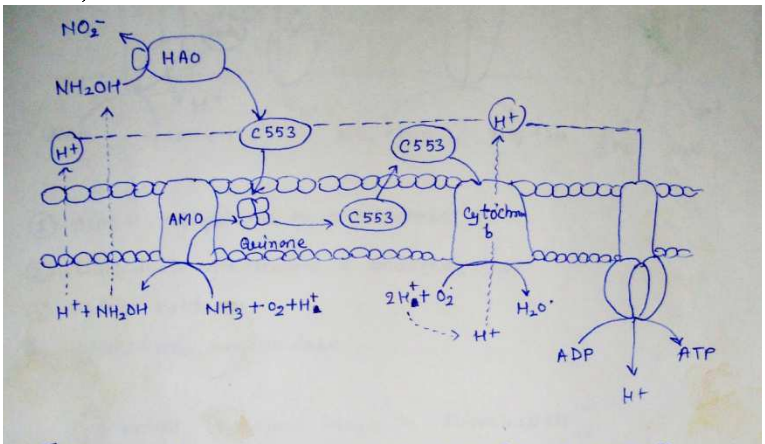


Answer 7: (b) Chemosynthetic bacteria

bacteria that synthesize organic compounds, using energy derived from the oxidation of organic or inorganic materials without the aid of light.

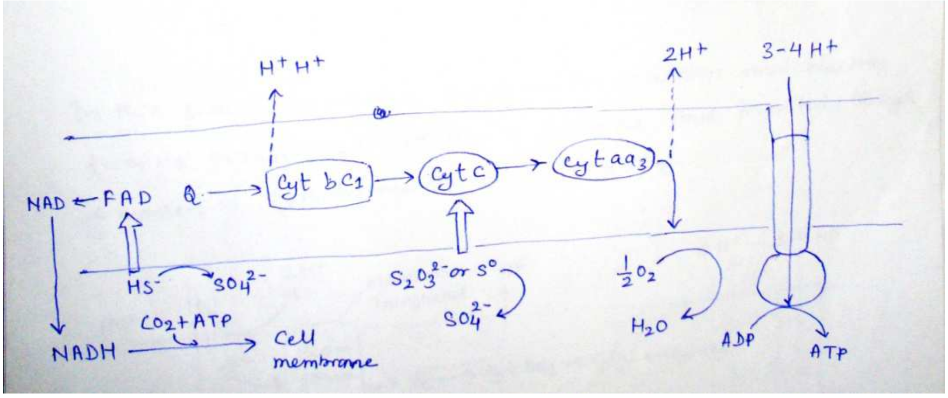
Examples

1. **Nitrifying bacteria: Nitrifying bacteria** are chemoautotrophic or chemolithotrophs depending on the genera (*Nitrosomonas*, *Nitrosococcus*, *Nitrobacter*, *Nitrococcus*) bacteria that grow by consuming inorganic nitrogen compounds. Many species of nitrifying bacteria have complex internal membrane systems that are the location for key enzymes in nitrification: ammonia monooxygenase which oxidizes ammonia to hydroxylamine, and nitrite oxidoreductase, which oxidizes nitrite to nitrate.

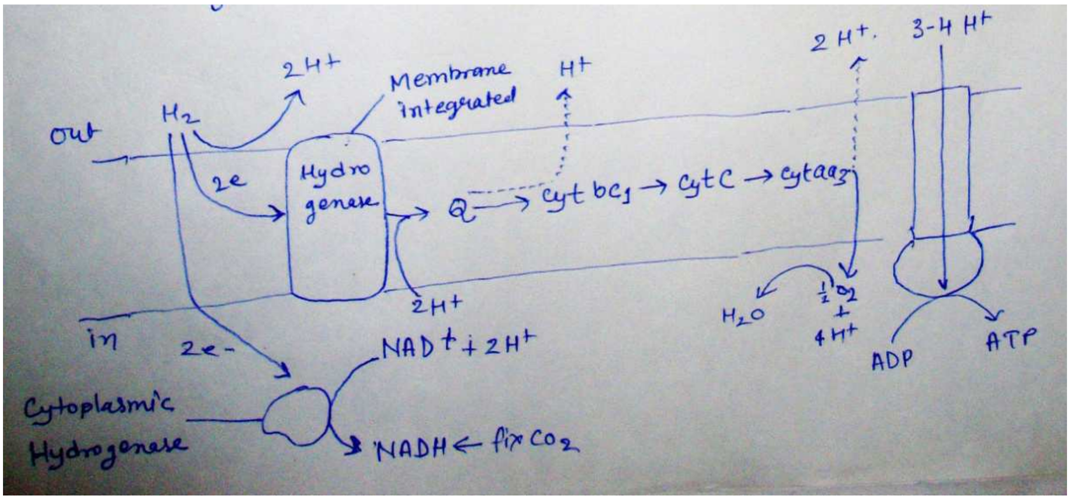


[Electron transport system in Nitrifying bacteria]

2. **Sulphur oxidizer:** Sulfide may be oxidized to elemental sulfur aerobically by species of **Thiothrix** and **Beggiatoa** (morphologically conspicuous sulfur oxidizers), and anaerobically by the purple sulfur bacteria. Both of these groups are primarily aquatic microbes. In soil, the predominant microbes involved in the oxidation of sulfide to elemental sulfur belong to the genus **Thiobacillus**. However, many thiobacilli are aquatic as well, especially in acidic mine waters. For the following two "generic" reactions, the first is typical of oxidation of sulfide to sulfur, and the second of oxidation of sulfide to sulfate.



3. **Hydrogen bacteria: Hydrogen oxidizing bacteria**, or sometimes ***Knallgas*-bacteria**, are bacteria which oxidize hydrogen. See microbial metabolism (hydrogen oxidation). These bacteria include *Hydrogenobacter thermophilus*, *Hydrogenovibrio marinus*, and *Helicobacter pylori*. There are both Gram positive and Gram negative knallgas bacteria. Most grow best under microaerophilic conditions. They do this because the hydrogenase enzyme used in hydrogen oxidation is inhibited by the presence of oxygen, but oxygen is still needed as a terminal electron acceptor.



(c) Prions: A **prion** is an infectious agent composed of protein in a misfolded form. This is the central idea of the Prion Hypothesis, which remains debated. This would be in contrast to all other known infectious agents (virus/bacteria/fungus/parasite) which must contain nucleic acids (either DNA, RNA, or both). The word *prion*, coined in 1982 by Stanley B. Prusiner, is derived from the words *protein* and *infection*. Prions are responsible for the transmissible spongiform encephalopathies in a variety of mammals, including bovine spongiform encephalopathy (BSE, also known as "mad cow disease") in cattle. In humans, prions cause Creutzfeldt-Jakob Disease (CJD), variant Creutzfeldt-Jakob Disease (vCJD), Gerstmann–Sträussler–Scheinker syndrome, Fatal Familial Insomnia and kuru. All known prion diseases affect the structure of the brain or other neural tissue and all are currently untreatable and universally fatal. In 2013, a study revealed that 1 in 2,000 people in the United Kingdom might harbour the infectious prion protein that causes vCJD.

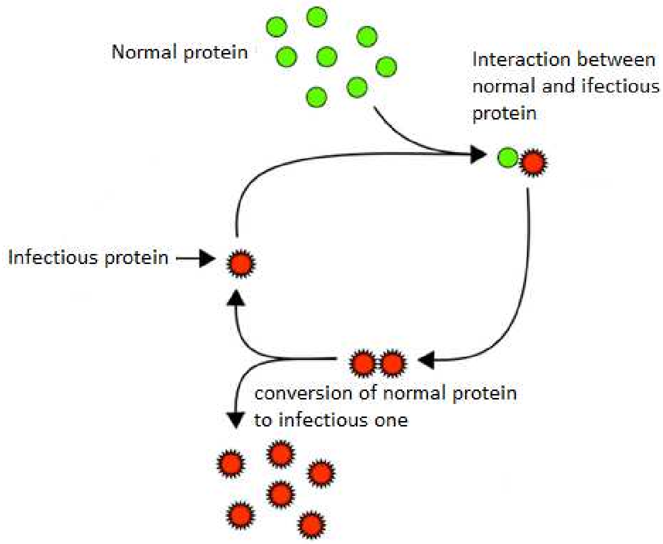
Prions, like viruses, are not actually alive, although both can reproduce by hijacking the functions of living cells.

Prions propagate by transmitting a misfolded protein state. If a prion enters a healthy organism, it induces existing, properly folded proteins to convert into the disease-associated, prion form; the prion acts as a template to guide the misfolding of more proteins into prion form. These newly formed prions can then go on to convert more proteins themselves; this triggers a chain reaction that produces large amounts of the prion form. All known prions induce the formation of an amyloid fold, in which the protein polymerises into an aggregate consisting of tightly packed beta sheets. Amyloid aggregates are fibrils, growing at their ends, and replicating when breakage causes two growing ends to become four growing ends. The incubation period of prion diseases is determined by the exponential growth rate associated with prion replication, which is a balance between the linear growth and the breakage of aggregates. (Note that the propagation of the prion depends on the presence of normally folded protein in which the prion can induce misfolding; animals which do not express the normal form of the prion protein cannot develop nor transmit the disease.)

This altered structure is extremely stable and accumulates in infected tissue, causing tissue damage and cell death. This structural stability means that prions are resistant to denaturation by chemical and physical agents, making disposal and containment of these particles difficult. Prions come in different strains, each with a slightly different structure, and most of the time, strains breed true. Prion replication is nevertheless subject to occasional epimutation and then natural selection just like other forms of replication.

All known mammalian prion diseases are caused by the so-called prion protein, PrP. The endogenous, properly folded, form is denoted PrP^C (for ***C****ommon* or ***C****ellular*) while the disease-linked, misfolded form is denoted PrP^{Sc} (for ***Scrapie***, after one of the diseases first linked to prions and neurodegeneration.) The precise structure of the prion is not known, though they can be formed by combining PrP^{C}, polyadenylic acid, and lipids in a Protein Misfolding Cyclic Amplification (PMCA) reaction.

Proteins showing prion-type behavior are also found in some fungi, which has been useful in helping to understand mammalian prions. Fungal prions do not appear to cause disease in their hosts.



Answer 8: (a) Cyanophage- A **cyanophage** is a virus that infects cyanobacteria. The name is constructed from the term phage, for a virus that targets bacteria, and cyanobacteria for the specific type of bacteria this virus uses for replication. Because of the important role of cyanobacteria as primary producers in the world's oceans, the study of their phage ecology is important toward understanding global carbon cycling. First time isolation of a virus reported by Safferman and Morris (1963). The virus have been previously named as phycoviruses, algophages and blue-green algal viruses.

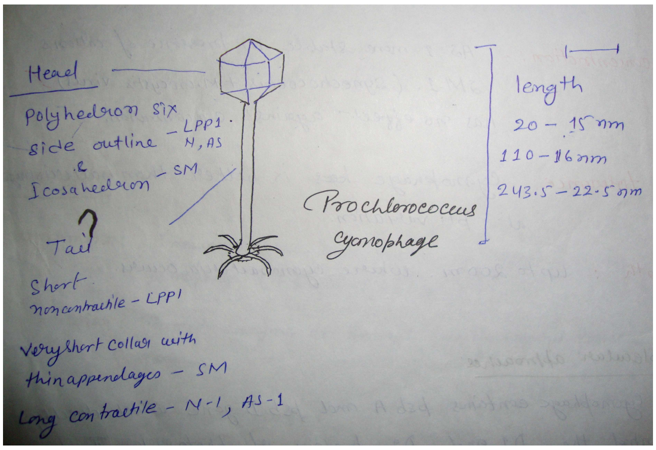
Types of cyanophage

1. Cyanomyovirus: Belongs to Myoviridae, are abundantly found in the marine water and less frequent in the fresh water.
2. Cyanopodoviruses: also known as podoviridae have been isolated from both fresh water and marine water. LPP-1 is a cyanopodovirus that infects three different genera of non heterocystous filamentous cyanobacteria, *Lyngbya, Phormidium and Plectonem*.
3. Cyanostyloviruses: The virus affect Synechococcus also known as S-1. It has an isometric head and a rigid tail (140 nm).

The other group

1. LPP- which infect *Lyngbya, Plectonema, Phormidium*
2. A, AN, N & NP- which infect *Anabaena, Nostoc, Plectonema*.
3. AS, SM- which infect *Anacystis, Synechococcus* and *Microcystis*.

Structure of cyanophage

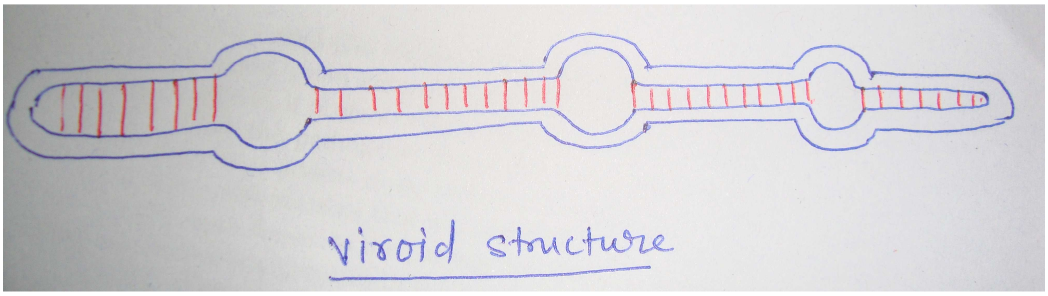


Answer 8: (b) Viroids

Viroids are infectious RNA molecules that differ from viruses in lacking a capsid, Despite this lackm they have a reasonably stable extracellular form that travels from one host cell to another. Viroids are small, circular, single-stranded RNA molecules that are the smallest known pathogens. They range in size from 246 to 399 nucleotides and show a considerable degree of sequence homology to each other, suggesting that they have common evolutionary root. Viroids cause a number of important plant diseases and can have a severe agricultural impact. A few well studied viroids include coconut cadang-cadang viroid (246 nucleotides), citrus exocortis viroid (375 nucleotides), and potato spindle tuber viroid (359 nucleotides). No viroids are known that infect animals or prokaryotes.

Structure and function

The extracellular form of the viroid is naked RNA; there is no protein capsid of any kind. Although the viroid RNA is a single stranded, covalently closed circle, there is so much secondary structure that it resembles a short double-stranded molecule with closed ends. This apparently makes the viroid sufficiently stable to exist outside the host cell. Because it lacks a capsid, the viroid enters a plant cell through a wound, as from insect or other mechanical damage. Once inside, viroids move from cell to cell via the plasmodesmata, which are the thin strands of cytoplasm that link plant cells.



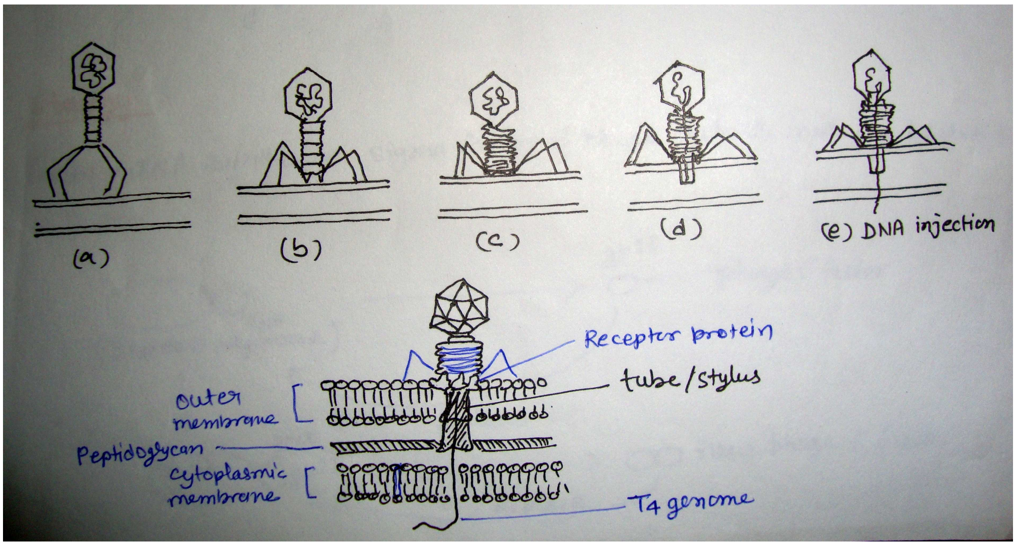
Answer 8: (c) T4 phage

T4 affect E. coli. It is ds DNA. The head (icosahedral) composed of several protein while tail composed of 20 different protein hence known as complex virus. T4 bacteriphage (family Myoviridae) serve as example of a virulent ds DNA phage. T4 capable only of the lytic cycle, that is their infection of host always ends with cell lysis.

T4 Life cycle **(Lytic cycle)**

Steps (i) infection of host cell (ii) Viral multiplication (iii) Maturation of viral particle and release

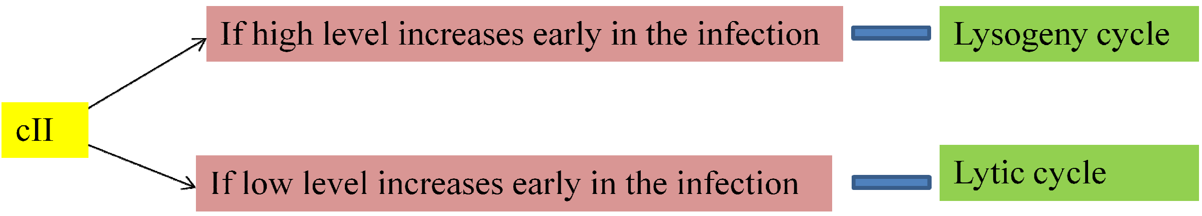
(i) Infection of host cell (a) Landing with the help of tail fibre (b) Attachment (c) Tail contract 24 ring become 12 ring (d) Penetration and unplugging (gp5 act as lysozyme) (e) DNA injection



Answer 8: (d) regulation of lysis and lysogeny in λ Phage

Most genes are clustered according to their function, with separate groups involved in head, tail synthesis, lysogeny, DNA replication and cell lysis.

- The events leading to either lysogeny or the lytic cycle serves as a model for complex regulatory process.
- It involves the action of several regulatory proteins that function as repressor or activators or both, protein that regulate transcription termination and antisense RNA molecules.
- The protein cII is an activator protein that plays a pivotal role in determining if λ will establish lysogeny or follow a lytic pathway



- Transcription of the λ **genome** catalysed by the host cell's DNA dependent RNA polymerase, and the cII protein is synthesized relatively early in the infection.
- If the cII protein levels are high enough, it will increase transcription of the **int** gene, which encodes the enzyme integrase.
- Integrase catalyzes the integration of the λ **genome** into the host cell's chromosome, thus establish lysogeny.
- The cII protein also increases transcription of the cI gene. This gene encodes a regulatory protein that is often called the λ **repressor** because it represses the transcription of all genes (except its own).
- This repression maintains the lysogenic state. As just noted, the cI protein (λ **repressor**) allows transcription of its own gene. This is because cI function as an activator protein when it binds to the Prm promoter from which the cI gene can be transscribed.