F.Y.B.Sc. SEMESTER II
OCTOBER, 2018 [ATKT]
PAPER I: MICROBIOLOGY (1)
QP.CODE 51278
DATE OF EXAM :

ANSWERS

Q I. A. Define the following terms: (5)

1. **Obligate anaerobes**: Organisms which do not tolerate O_2 at all and die in its presence are called obligate anaerobes.
2. **Generation time**: The specific length of time in the exponential phase during which number of a cell population doubles is called generation time.
3. **Capsid**: The protein coat or shell that surrounds a virion's nucleic acid.
4. **Microsporidia:** They are obligate intracellular parasites, also called curious fungi and lack mitochondria, peroxisomes and centrioles.
5. **Parasitism:** It is an association where one organism lives at the expense of the other; one is benefitted and the other is harmed.

Q I B.State whether the following statement is true or false: (5)

1. Phages are viruses of bacteria.- **TRUE**
2. Metabolically active cells have more protein content. **TRUE**
3. Cyanobacteria can fix atmospheric nitrogen. - **TRUE**
4. *Actinomyces* are soil organism.- **TRUE**
5. Influenza virus is an example of enveloped virus .-**TRUE**

Q I C. Give one example for each of the following: (5)

1. A counting chamber for measuring cell number. **Petroff Hausser , Haemocytometer.**
2. An organism which is a Neutrophile : ***Escherichia coli, Euglena , Paramoecium,***
3. Slime mold – ***Dictosylelia discoideum, Physarum spp, Myxogastria.***
4. Zygomycete - ***Rhizopus, Mucor***
5. RNA virus – HIV, common cold, Influenza, Polio, Hepatitis C, Rabies, etc.

QI D. Select the correct alternatives and rewrite the statement. (5)

1. Bacteriophage has **binal** symmetry.
2. Q fever is a disease caused by ***Coxiella***
3. Agar is obtained from **Algae.**
4. The Mycoplasma are distinguished by the presence of **sterol.**
5. A **Plate count** is not used for turbidometric measurements.

QII .Answer briefly any two of the following: (20)

1. Compare and contrast between the lytic and lysogenic cycle of bacteriophage.
   Similarity-i) Both are the stages of life cycle of viruses of bacteria.
   ii)Both ensure the propagation of genetic material to the progeny

Lytic cycle	Lysogenic cycle
Phage is called virulent phage	Temperate phage
Results in lysis of host cell	no lysis of host cell
Results in release of a large number of virions	Does not produce a large number of progeny phages
Phage genome does not replicate along with host DNA	Phage DNA replicates every time the host's DNA replicates
Phage's DNA is not integrated with host	Phage DNA may get integrated with host

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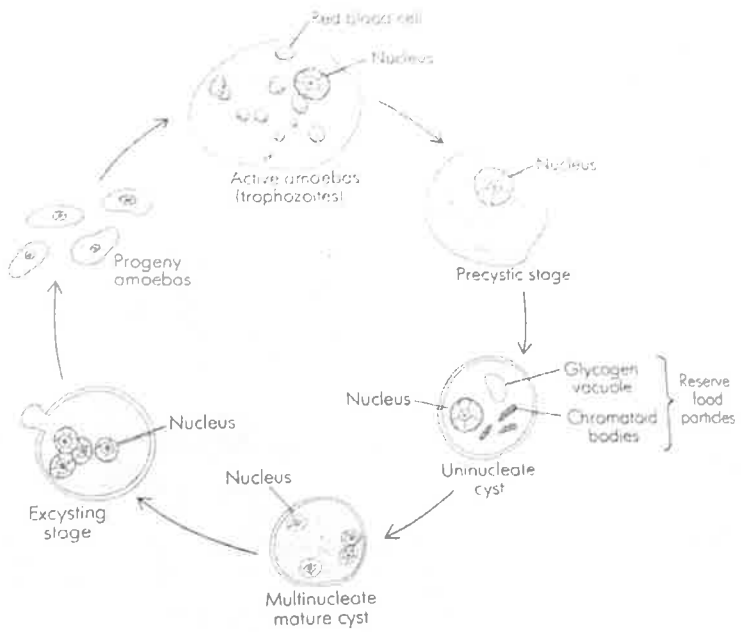
DNA	DNA
There is no phage repressor protein involved	Lysogeny is maintained by the phage repressor protein
eg. T_4 phage	Eg.λ phage of E. coli

2. What is a continuous culture technique? Discuss the types and applications of continuous culture techniques.
   Defn , gen info –4 mks, Chemostat 2 mks, Turbidostat- 2 mks, Appln 2mks.

- Microbial populations can be maintained in a state of exponential growth over a long period of time by using a system of continuous culture
- The growth chamber is connected to a reservoir of sterile medium.
- Once growth has been initiated, fresh medium is continuously supplied from the reservoir.
- Continuous culture systems can be operated as *chemostats* or as turbidostats.
- In a chemostat the flow rate is set at a particular value and the rate of growth of the culture adjusts to this flow rate.
- In a turbidostat the system includes an optical sensing device which measures the absorbancy of the culture (culture density) in the growth vessel; the electrical signal from this device regulates the flow rate. Thus, the absorbancy of the culture controls the flow rate and the rate of growth of the culture adjusts to this flow rate.
- Appln: constant source of cells in an exponential phase, allow cultures to grow continuously at extremely low concentration of substrate, regulation of synthesis or catabolism of the limiting substrate, selection of various classes of mutants, ecological studies.

(Page 193, 194 Stanier 5th edition.)

3. Write a short note on characteristics and life cycle of *Entamoeba histolytica.*
   Characteristics (4M), life cycle (6M)
   Entamoeba histolytica causes amoebic dysentery, 2 forms -trophic and cystic.
   If Food or water contaminated with infective mature cyst is ingested excystation occurs, releasing progeny amoebas, which become active amoebas called trophozoites in the intestine. Penetration of intestinal mucosa by trophozoites, may result in infection of liver and other organs. Continued multiplication by binary fission and tissue destruction



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combine to result in abscesses.
Thus the accompanying diarrhoea is often tinged with blood. Cysts are passed in blood and can infect humans.

QIII. A. Answer briefly <u>any three</u> of the following: **(18)**

1. **Write a note on *Chlamydia*, their morphology, metabolism and the diseases caused by them.**

Chlamydia and diseases: [Pelczar 805] obligate intracellular parasite, cause several infections, *C. trachomatis*, cause of psittacosis , isolation done in egg yolk or tissue culture. Unable to grow in lab media When infected cells stained by Giemsa, characteristic intracellular inclusions obsd. Tetracyclines, sulfonamides and erthyromycin are effective antimicrobial agents. Vaccines not available.

2. **Differentiate between *Mycoplasma* and Rickettsia.**

Mycoplasma	Rickettsia
Cell wall absent	Cell wall present
Pleomorphic	Tiny ,non motile cells
Can be cultivated on nutrient rich artificial media	Cannot be cultivated on artificial bacteriological media
Parasites and pathogens	Obligate intracellular parasites
Do not require insect vectors for disease transmission	Require an insect vector for transmission
Are able to carry out some metabolic activities	Are dependent on host for provision of energy
Eg of disease- pneumonia	Eg of disease- typhus fever

3. **Discuss the general properties of viruses.**

Viruses are a unique group of infectious agents whose distinctiveness resides in their simple, acellular organization & pattern of reproduction. A complete virus particle or **virion** consists of one or more molecules of DNA or RNA enclosed in a coat of protein. Some viruses have additional layers that can be very complex and contain carbohydrates, lipids, and additional proteins. Viruses can exist in two phases: extracellular and intracellular.
Virions, the extracellular phase, possess few if any enzymes and cannot reproduce independent of living cells. In the intracellular phase, viruses exist primarily as replicating nucleic acids that induce host metabolism to synthesize virion components; eventually complete virus particles or virions are released. Viruses differ from living cells in at least three ways: (1) their simple, acellular organization; (2) the presence of either DNA or RNA, but not both, in almost all virions; and (3) their inability to reproduce independent of cells and carry out cell division as procaryotes and eucaryotes do.

4. **Explain the use of chick embryo for cultivation of viruses.**

Because they are unable to reproduce independent of living cells, viruses cannot be cultured in the same way as procaryotic and eukaryotic microorganisms. For many years researchers have cultivated animal viruses by inoculating suitable host animals or embryonated eggs—fertilized chicken eggs incubated about 6 to 8 days after laying. To prepare the egg for cultivation of viruses, the shell surface is first disinfected with iodine and penetrated with a small sterile drill. After inoculation, the drill hole is sealed with gelatin and the egg incubated. Some viruses reproduce only in certain parts of the embryo; consequently they must be injected into the proper region. For example, the myxoma virus grows well on the chorioallantoic membrane, whereas the mumps. virus grows best in the allantoic cavity. The infection may produce a local tissue lesion known as a pock, whose appearance is often the characteristic of the virus. **(Prescott, page 418)**

5. Discuss the morphology (3M) and commercial importance (3M) of ~~Actinolmycetes.~~ Streptomyces.

Morphology: *Streptomyces* is a large genus; there are around 150 species. Members of the genus are strict aerobes, have cell wall type I, and form chains of nonmotile spores. The three to many spores in each chain are often pigmented and can be smooth, hairy, or spiny in texture. *Streptomyces* species are determined by means of a mixture of morphological and physiological characteristics, including the following: the color of the aerial and substrate mycelia, spore arrangement, surface features of individual spores, carbohydrate use, antibiotic production, melanin synthesis, nitrate reduction, and the hydrolysis of urea and hippuric acid. Streptomycetes are very important, both ecologically and medically.

Importance 1)*Streptomycetes* play a major role in mineralization. They are flexible nutritionally and can aerobically degrade resistant substances such as pectin, lignin, chitin, keratin, latex, agar, and aromatic compounds.

2) Streptomycetes are best known for their synthesis of a vast array of antibiotics. Stanley Waksman's discovery that *S. griseus* produces streptomycin was an enormously important contribution to science and public health. Streptomycin was the first drug to effectively combat tuberculosis. In addition, this discovery set off a massive search resulting in the isolation of new *Streptomyces* species that produce other compounds of medicinal importance.

3) In fact, since that time, the streptomycetes have been found to produce over 10,000 bioactive compounds. Hundreds of these natural products are now used in medicine and industry; about two-thirds of the antimicrobial agents used in human and veterinary medicine are derived from the streptomycetes. Examples include amphotericin B, chloramphenicol, erythromycin, neomycin, nystatin, and tetracycline.

4) Some *Streptomyces* species produce more than one antibiotic. Antibiotic- producing bacteria have genes that encode proteins that make them resistant to such compounds.

5) The genome of *Streptomyces coelicolor,* which produces four antibiotics and serves as a model species for research, has been sequenced. At 8.67 Mbp, it is one of the largest procaryotic genomes. Its large number of genes (7,825) no doubt reflects the number of proteins required to undergo a complex life cycle. Many genes are devoted to regulation, with an astonishing 65 predicted RNA polymerase sigma subunits and over 50 two-component regulatory systems. The ability to exploit a variety of soil nutrients is also demonstrated by the presence of a large number of ABC transporters, the Sec protein translocation system, and secreted degradative enzymes. Finally, genes were discovered that are thought to encode an additional 18 secondary metabolites

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6. Discuss the ecology and adaptations of archea

Ecology

- The types of environments where archaea have most often been found include areas with either very high or low temperatures or pH, concentrated salts, or completely anoxic.
- These are generally referred to as "extreme environments." However, terms such as extreme and hypersaline reflect a human perspective, meaning that they are situations where humans could not survive. On the contrary, most of the Earth (the oceans) is an "extreme environment" where it is very cold (about 4°C), dark, and under high pressure.
- Many archaea are well adapted to these environments, where they can grow to high numbers. For instance, archaea constitute at least 34% of the procaryotic biomass in at least some Antarctic coastal waters. In some hypersaline environments, their populations become so dense that the brine is red with archaeal pigments. Some archaea are symbionts in the digestive tracts of animals. Archaeal gene sequences have been found in soil and temperate and Tropical Ocean surface waters.

Adaptations

One of the most distinctive archaeal features is their membrane lipids, the *Archaea* differ from both

- *Bacteria* and *Eucarya* in having branched chain hydrocarbons attached to glycerol by ether (rather than ester) linkages.
- Thermophilic archaea sometimes link two glycerol groups to form long tetraethers. Diether side chains are usually 20 carbons long, and tetraether chains contain 40 carbon atoms. However, cells can adjust chain lengths by cyclizing the chains to form pentacyclic rings. Such pentacyclic rings are used by thermophilic archaea to help maintain the delicate liquid crystalline balance of the membrane at high temperatures.
- Polar phospholipids, sulfolipids, and glycolipids are also found in archaeal membranes

Q III B. Do as directed any two of the following:

(2)

1. **Methanogen**.:*Methanobacterium* ..*Methanococcus Methanomicrobium*
2. **Hyperthermophilic archaea**: *Desulfurococcus. Pyrodictium* .*Pyrococcus* . *Sulfolobus* . *Thermococcus* *Thermoproteus*
3. **Function of bacteriorhodopsin**: **Bacteriorhodopsin** that can trap light energy without the presence of chlorophyll, it functions as a light-driven proton pump. Used for ATP production.
4. **Term to describe *Mycoplasma* colonies**: Fried egg appearance

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1. Justify the commercial and ecological significance of Fungi.
(Prescott – 630-631)
   - Important to humans in both beneficial and harmful ways
   - Acts as decomposers of organic matter into simple organic and inorganic form and C, N and P are released.
   - Cause disease in animal, plants and humans. Give examples.
   - Important to industrial process Production of- bread, wine, beer, cheese, soy sauce and Sufu
   - Production of Organic acids- citric and gallc acids
   - Production of Drugs -ergometrine and cortisone
   - Production of antibiotics – peniciilin and griseofulvin
   - Production of cyclosporine
   - Research tool for cytologists, geneticists, biochemists, microbiologists.

2. **Write a short note on Algal pigments.**
(Pelczar -371-374)

Algae have 3 types of pigments
   - Chlorophylls- 5 cholorophylls – a,b,c,d and e. Chlorophyll a is found in all algae, lipid soluble
   - Carotenoids : lipid soluble, Carotenes (linear,unsaturated hydrocarbons) and Xanthophylls (oxygenated derivatives)
   - Phycobilins – water soluble, 2 types-phycocyanin and phycoerythrin

3. **Diagrammatically explain the life cycle of acellular slime mold.**

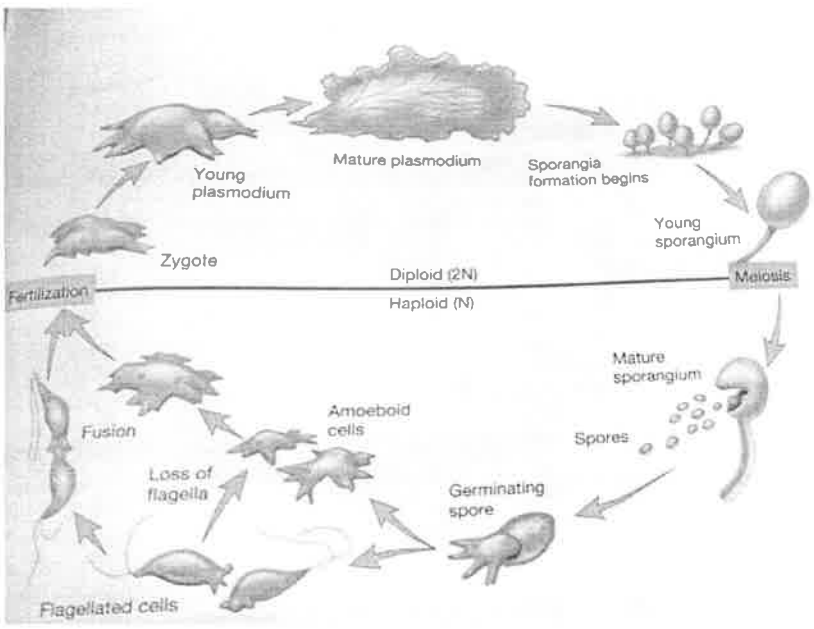

Figure 25.9 Acellular Slime Molds. **(a)** The life cycle of a plasmodial slime mold includes sexual reproduction; when conditions are favorable for growth the adult diploid forms sporangia. Following meiosis, the haploid spores germinate, releasing haploid amoeboid or flagellated cells that fuse. **(b)** Plasmodium of the slime mold *Physarum* sp. (× 175). Sporangia of **(c)** *Physarum polycephalum* **(d)** *Hemitrichia* and **(e)** *Stemonitis*

4. Explain the feeding structures and locomotory structures in Protozoa.
(Pelczar -396-399)
   - Feeding structures - Food gathering structures in protozoa are diverse – ranging from, Pseudopodia in amoeba to tentacular feeding tubes to well developed mouth in ciliates

In ciliates the cytostome is the actual opening through which food is ingested.
Oral groove guides food towards cytosome and acts a concentrating device.
Addition of membralles to oral groove makes its peristome.
   - Locomotory organ- Pseudopodia, flagella, cilia

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5. Write a short note on asexual reproduction in Fungi.
Prescott -632-633)

Asexual reproduction occurs in fungi by – 1) mitosis 2) budding 3) Spore production – Arthrospore, Chlamydospore, Sporangiospore, Conidiospore and Blastospore

6. Differentiate between Algae and Cyanobacteria.

Algae	**Cyanobacteria**
Eukaryote	Prokaryote
unicellular	large form- trichomes
nucleus and mitochondria present	Lacks nucleus and mitochondria
Sexual or asexual reproduction	Reproduce asexually by binary fission, fragmentation and spore production
Not involved in nitrogen fixation	involved in nitrogen fixation
Do not have heterocyst	Have heterocyst
Contain chloroplast	Lack chloroplast
Eg. Chlorella, spirogyra	Nostoc, Anabena

Q IV B. Do as directed <u>any two</u> of the following: (2)

1. example of Basidiomycete- ***Polyporous, Agaricus, Cryptococcus***
2. Name one plant disease caused by Fungi - **Ergot, Smut, Chestnut blight**
3. Explain the role of cyst in protozoa. - **Cysts are dormant, resistant and infectious stage. These cysts are able to survive adverse environmental conditions such as desiccation and low nutrient supply. Once in the intestine, excystation occurs, with trophozoites emerging from the cyst.**
4. Name a product obtained from Algae – **Agar, alginic acid, carrageenan, Diatomaceous earth.**

QV. A. Answer briefly <u>any three</u> of the following: (18)

1. Discuss the effect of salt on microbial growth. (**Pg 118-120 Prescott 6th ed**)

- A selectively permeable plasma membrane separates microorganisms from their environment. Hence they can be affected by changes in the osmotic concentration of their surroundings.

- If a microorganism is placed in a hypotonic solution (one with a lower osmotic concentration), water will enter the cell and cause it to burst unless something is done to prevent the influx. Conversely if it is placed in a hypertonic solution (one with a higher osmotic concentration), water will flow out of the cell. In microbes that have cell walls (i.e., most procaryotes, fungi, and algae), the membrane shrinks away from the cell wall—a process called plasmolysis. Dehydration of the cell in hypertonic environments may damage the cell membrane and cause the cell to become metabolically inactive.

2. **Discuss the advantages and disadvantages of direct cell count methods used for measurement of bacterial growth. Pg. 125-126 Pelczar, TMH ed**

Adv: Rapid, simple, minimum equipment, morphology of cells can be observed.

Disadv: High conc of cells must be present in the suspension.

Dead and live cells counted.

Coulter counter – the suspending liquid should be free of inanimate particles like dust, sophisticated equipment needed.

3. **Discuss the techniques used to obtain a synchronous culture. Pg 190-191 Stanier 5th edn.**

Synchronous cultures are cultures composed of cells that are all at the same stage of the cell cycle.

- Synchrony can be *induced* by manipulations of environmental conditions, usually cyclic.
  - By repetitive shifts of temperature or by furnishing fresh nutrients to cultures that have just entered the stationary phase. (1 mark)

A synchronous population can be *selected* from a random population by physical separation of cells that are at the same stage of the cell cycle.

- by differential filtration or by centrifugation. (2 marks)
- Helmstetter-Cummings technique-- certain bacteria stick tightly to cellulose nitrate (membrane) filters. The technique involves filtering an unsynchronized culture of bacteria through a (membrane) filter, then inverting the filter and allowing fresh medium to flow through it. After loosely associated bacteria have been washed from the filter, the only bacterial cells in the effluent stream of medium are those that arise through division. Hence, all cells in the effluent are newly formed and are therefore at the same stage of the cell cycle(.2 marks) Diag pg 191 (1mark)

4. Draw neat labelled diagram of a typical bacterial growth curve. Discuss the lag phase and exponential phase of the curve. **Diag : pg 120 Pelczar 6th edn**

The Lag Phase

- Period of adjustment of a culture in a fresh medium is called the *lag phase.*
- It is extremely variable in duration; its length is directly related to the duration of the preceding stationary phase.
- The individual cells increase in size beyond their normal dimensions.
- Physiologically the cells are very active.
- New enzymes to adjust to the new environment may be synthesized.
- Organisms are metabolizing but there is a lag in cell division.

The exponential phase

- The cells divide steadily at a constant rate.
- The log of cells plotted against time results in a straight line.
- The population is nearly uniform in terms of chemical composition of cells, metabolic activity and other physiological characteristics.
- Cells are clearly defined than in any other phase
- Cells in this phase are used for studies of microbial metabolism.

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5. **How are microorganisms classified based on their temperature ranges for growth? Briefly discuss each class.**

Microbial growth has a characteristic temperature dependence with distinct cardinal temperatures—minimum, optimum, and maximum growth temperatures

a. Psychrophiles grow well at 0°C and have an optimum growth temperature of 15°C or lower; the maximum is around 10°C. eg. *Pseudomonas, Vibrio, Alcaligenes, Bacillus, Arthrobacter.*
b. Many species can grow at 0 to 7°C even though they have optima between 20 and 30°C, and maxima at about 35°C. These are called psychrotrophs or facultative psychrophiles.
c. Mesophiles are microorganisms with growth optima around 20 to 45°C; they often have a temperature minimum of 15 to 20°C. Their maximum is about 45°C or lower. Human pathogens are mesophiles --37°C.
d. Thermophiles: they can grow at temperatures of 55°C or higher. Their growth minimum is usually around 45°C and they often have optima between 55 and 65°C. They have more heat-stable enzymes and protein synthesis systems, which function properly at high temperatures.
e. A few thermophiles can grow at 90°C or above and some have maxima above 100°C. Procaryotes that have growth optima between 80°C and about 113°C are called hyperthermophiles. They usually do not grow well below 55°C. *Pyrococcus abyssi* and *Pyrodictium occultum*-- examples of marine hyperthermophiles.

Pg 122-124 Prescott 6th edn

6. Briefly describe quorum sensing and VBNC

Pg 129-130 Prescott 6th edn

Q V B. Do as directed any two of the following: (2)

1. Bacterium which survives large doses of ionising radiations. ***Deinococcus radiodurans***
2. Example of an acidophile. ***Sulfolobus acidocaldarius, Ferroplasma acidarmanus and Picrophilus oshimae***
3. Barophile. **Organisms that grow rapidly at very high pressures (600 to 1,100 atm) are called barophiles**
4. **Microaerophiles are organisms that are damaged by the normal atmospheric level of O_2 (20%) and require O_2 levels below the range of 2 to 10% for growth.**

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