UNIT - I

CHAPTER - 1

CHARACTERIZATION OF MICROBES

INTRODUCTION

- Microbiology is an integral part of 'biological sciences', and hence essentially encompasses the three cardinal objectives, namely: characterization, classification, and identification.
- The entire 'microbial world' enjoys the reputation for being an extremely complex and extraordinarily diversified domain with respect to their morphological, physiological, and genetical characteristic features. In the light of the said glaring facts, it became almost necessary to afford a broad and critical classification as a means of bringing order to the puzzling diversity as well as variety of organisms in nature.
- Therefore, once the characteristic features of the various microbes existing in this universe have been duly established, one may compare it with other organisms quite conveniently in order to draw a line amongst their similarities and dissimilarities in particular.
- It would be a lot easier task to segregate the microbes having the same features and subsequently group them together under a specific classified head or group known as 'classification'.
- Based upon the enormous volume of researches made in the study of microorganisms, one has to know their characteristics prior to their legitimate identification and classification.
- Because of the extremely minute and microscopical size of the microorganism, it may not be quite feasible to carry out an elaborated study of the characteristics of a single microorganism. In order to circumvent the above difficulties, one may conveniently study the characteristics of a culture i.e., a population of microorganisms or the propogation of microorganisms.

- Therefore, the meticulous investigation of the characteristics of a culture comprising a host of microorganisms,* it is as good as exploring the characteristics of a single organism.
- **Pure Culture** [Axenic Culture] : It refers to a 'culture' that essentially be composed of a single type of microorganism, irrespective of the number of individuals, in a surrounding absolutely free of other living microbes (organisms). Summarily, the process of establishing the 'characteristics' of microorganisms is not only a cardinal prerequisite for classification but also play a variety of vital, indeed essential, roles in nature.

CHARACTERIZATION

The microorganisms may be broadly characterized into the following categories, namely:

(i) Morphological characteristics (ii) Chemical characteristics (iii) Cultural characteristics (iv) Metabolic characteristics (v) Antigenic characteristics (vi) Genetic characteristics (vii) Pathogenicity, and (viii) Ecological characteristics.

The aforesaid categories of characteristics shall now be treated individually in the sections that follow :

(i) Morphological characteristics: Morphology refers to the science of structure and form of organisms without any regard to their function. The morphological determinations invariably require the intensive studies of the individual cells of a pure culture. The microorganisms being of very small size are usually expressed in micrometers (μm)*.

(ii) Chemical characteristics: Interestingly, one may observe a broad spectrum of organic compounds critically located in the microbial cells. These cells upon undergoing disintegration (broken apart) give rise to several different chemical entities that are methodically subjected to vigorous chemical analysis. Thus, each type of microorganism is observed to possess altogether specific and characteristic chemical composition. The presence of distinct qualitative and quantitative differences in composition does occur amongst the various prevailing microbial species. Examples: (a) Gram-positive Microorganisms—they essentially possess in their cell walls an organic acid known as 'teichoic acids', and such compounds are not be seen in Gram-negative microorganisms. (b) Gram-negative Microorganisms—they invariably contain 'lipolysaccharide' in their cell walls, and this is distinctly absent in Gram-positive bacteria.

(iii) Cultural characteristics: It has been amply established that each and every type of microorganism possesses specific as well as definitive growth-requirements. Salient Features. The salient features of the important and vital cultural characteristics are as stated under: (1) A plethora of microbes may be grown either on or in a cultural medium*. (2) A few microorganisms could be cultivated (grown) in a medium comprising specifically organic chemical entities**, whereas some others require solely inorganic chemical entities. (3) Certain microbes do require complex natural materials*** only for their normal growth. (4) Importantly, there are certain critical microbes that may be carefully and meticulously propogated only in a living host or living cells, and cannot be grown in an usual artificial laboratory medium. Example: Rickettsias**** prominently require a definitive host in which they may grow conveniently and generously, for instance: (a) an arthroped*****; (b) a chick embryo (i.e., a fertilizedchicken egg); and (c) a culture of mammalian tissue cells. In reality, the host being employed as an extremely complex specified and articulated 'medium' essentially required for such nutritionally demanding microorganisms.

(iv) Metabolic characteristics: Metabolism refers to the sum of all physical and chemical changes that take place within an organism; all energy and material transformations that occur within living cells. It includes essentially the material changes (i.e., changes undergone by substances during all periods of life, for instance: growth, maturity, and senescence), and energy changes (i.e., all transformations of chemical energy of food stuffs to mechanical energy or heat). Metabolism involves two fundamental processes, namely: anabolism (viz., assimilation or building-up processes), and catabolism (viz., disintegration or tearing, down processes). Anabolism is the conversion of ingested substances into the constituents of protoplasm; Catabolism is the breakdown of substances into simpler substances, the end products usually being excreted. The broad spectrum of these reactions gives rise to a plethora of excellent opportunities to characterize and differentiate categories of microorganisms. Examples: (a) Absorption of Light: Certain microbes may derive energy via absorption of light. (b) Oxidation: A few microorganisms may obtain energy through oxidation of a host of inorganic and organic compounds. (c) Redistribution of Atoms: Some organisms engage actively in the redistribution of atoms within certain molecules thereby rendering the resulting molecules less stable. (d) Synthesis of Cell Components: The microorganisms also vary a lot in the manner whereby they invariably synthesize their prevailing cell components in the course of their usual growth. (e) Role of Enzymes.

(v) Antigenic characteristics: There are some chemical entities abundantly found in the microbial cells known as antigens. In fact, antigens refer to a protein or an oligosaccharide marker strategically located upon the surface of cells which critically identifies the cell as self or non-self; identifies the type of cell, e.g., skin, kidney; stimulates the production of antibodies, by B lymphocytes which will neutralize or destroy the cell, if necessary; and stimulates cytotoxic responses by granulocytes, monocytes, and lymphocytes.

(vi) Genetic characteristics: It has been duly established that the double-stranded chromosomal DNA of each individual type of microbe essentially inherits some typical characteristic features which remain not only constant and absolutely specific for that microorganism, but also quite beneficial for its methodical classification as well. However, there are two predominant criteria invariably employed for determining the 'genetic characteristics' of microbes, namely: (a) DNA base composition, and (b) Sequence of nucleotide bases in DNA.

(vii) Pathogenicity: Pathogenicity refers to the particular state of producing or being able to produce pathological changes and diseases. Therefore, the ability to cause pathogenicity of certain microorganisms is definitely an unique noticeable characteristic feature that has virtually given a tremendous boost to the earlier researches carried out with the microbes. It has been observed that comparatively a few microbial variants actually produce disease, some microorganisms prove to be pathogenic for plants and animals, and lastly certain microbes may bring about specific disease in other microbes. Examples: (a) Bdellovibrio: A parasite that invades bacteria by forming a hole in the cell wall. It usually lives and reproduces inside the cell. (b) Bacteriophage: A virus that infects bacteria. Bacteriophages are widely distributed in nature, having been isolated from faeces, sewage, and polluted surface waters. They are regarded as bacterial viruses, the phage particle consisting of a head composed of either RNA or DNA and a tail by which it attaches the host cells.

(viii) Ecological characteristics: Exhaustive and meticulous studies have provided a substantial evidence that the habitat (i.e., a microbe's or an animal's or plant's natural environment) of a microorganism is extremely vital and important in the precise and definitive characterization of that particular organism. Examples: (a) Microbes in Buccal Cavity: The population of the microorganisms present in the buccal cavity (or oral cavity) distinctly differs from that of the gastrointestinal tract (GIT). (b) Marine Microorganisms: Invariably the microorganisms located specifically in the marine environments differ

predominantly from those found in the fresh water and terrestrial environments. (c) Distribution in Nature: Quite often one may observe that certain microorganisms are abundantly and widely distributed in nature, whereas others, may be significantly restricted to a specific environment. Besides, a number of vital factors, such as : life-cycle patterns, the nature of symbiotic** relationships, the capability for causing disease in a specific host, and preferential habitats e.g., pH, O2, temperature, osmotic concentration, do represent other befitting examples of taxonomically important ecological characteristic features.

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