



PROTEUS AND PROVIDENCIA

25.1 INTRODUCTION

The genera *Proteus* and *Providencia* belong to the tribe *Proteae* of the family *Enterobacteriaceae*. The members of both these genera are gram negative, motile bacilli, aerobes and facultative anaerobes and can grow on basic media.

A characteristic feature which distinguishes tribe *Proteae* from other members of *Enterobacteriaceae* is the presence of the enzyme phenylalanine-deaminase which converts phenylalanine to phenylpyruvic acid (PPA reaction). They also produce a powerful urease enzyme which rapidly hydrolyses urea to ammonia.



OBJECTIVES

After reading this lesson, you will be able to:

- define the tribe *Proteae* and distinguish it from the other members of *Enterobacteriaceae*.
- differentiate among the various members of this tribe with the help of various biochemical reactions.
- discuss the pathogenicity, laboratory diagnosis and treatment of *Proteus* and *Providencia*.

25.2 GENUS PROTEUS

They are gram-negative bacilli, 1-3 μm long and 0.6 μm wide. They are non-capsulated and are actively motile by peritrichous flagella. The name 'Proteus' refers to their pleomorphism, after the Greek God Proteus who could assume any shape. Four species: *Proteus mirabilis*, *P vulgaris*, *P penneri* and *P*

myxofaciens are recognized. *Proteus mirabilis*, *P. vulgaris* are widely recognised as human pathogens.

25.3 CULTURE CHARACTERISTICS

These can grow on ordinary media like nutrient agar with a characteristic fishy or seminal odour. On MacConkey and Teepol lactose agar, lactose non-fermenting pale colonies, around 2-3 mm in size are formed. On non-inhibitory solid media such as blood and nutrient agar *Proteus mirabilis* and *P vulgaris* show characteristic swarming growth in the form of a uniform film, which spreads over the whole surface of the plate. In young swarming cultures, many of the bacteria are long, curved and filamentous, sometimes reaching upto 80 μm in length. When two different strains of swarming proteus mirabilis encounter one another on an agar plate, swarming ceases and a visible line of demarcation forms. This is known as the Dienes phenomenon.

Swarming inhibitory methods: Swarming of *Proteus* can be prevented by

- Increasing the concentration of agar from 1-2% to 6%.
- Incorporation of sodium azide, boric acid, or chloral hydrate.
- Introducing growth inhibitors like sulphonamides.
- On Teepol Lactose agar by Teepol(surface active agent)
- On MacConkey agar or DCA by presence of bile salts.
- On CLED agar by the absence of electrolytes.

In liquid medium (peptone water, nutrient broth), *Proteus* produces uniform turbidity with a slight powdery deposit and an ammonical odour.



Fig. 25. 1: Swarming of Proteus





Fig. 25. 2: Dienes phenomenon

25.4 BIOCHEMICAL REACTIONS

Like all other members of the family Enterobacteriaceae, all the species of genus *Proteus* are catalase positive, oxidase negative, reduce nitrates to nitrites and show fermentative reaction on Hugh Leifson’s of media. All members of the tribe *Proteeae* are PPA positive and, hydrolyse urea to ammonia which differentiates them from other *Enterobacteriaceae*.

Table 25.1: Biochemical Reactions of Tribe *Proteeae*

Biochemical reaction	<i>Proteus mirabilis</i>	<i>Proteus vulgaris</i>	<i>Providencia stuartii</i>	<i>Providencia rettgeri</i>	<i>Providencia alcalifaciens</i>
Indole -	+	+	+	+	
Methyl red	+	+	+	+	+
Voges Proskauer	-	-	-	-	-
Citrate+/-	-	+	+	+	
Urease+	+	+/-	+	-	
H ₂ S production	+	+	-	-	-
Gas from glucose	+	+	-	-	+

25.5 ANTIGENIC STRUCTURE

The bacilli possess thermostable ‘O’ antigen (somatic) and thermolabile ‘H’ (flagellar) antigen. Weil and Felix observed that certain non-motile strains of *P vulgaris*, called the ‘X’ strains, were agglutinated by sera from patients with typhus fever. This heterophile agglutination due to the sharing of carbohydrate antigen by certain strains of *Proteus* and *Rickettsia* forms the basis of the Weil Felix reaction and is used for diagnosing rickettsial infections. Three non-motile *Proteus* strains OX-2 and OX-19 of *P vulgaris* and OX-K of *P mirabilis* are used in the agglutination test.

25.6 TYPING METHODS

- Serotyping
- Phage typing

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- Dienes typing
- Bacteriocin(proticin) typing

Dienes phenomenon: This method forms the basis of typing swarming strains of *Proteus* for local epidemiological studies. Different cultures are inoculated as discrete spots on the same plate and allowed to swarm towards one another. A line of complete or partially inhibited growth is formed where cultures of different strains meet; no line is formed between culture of the same strain.

25.7 PATHOGENECITY

Proteus species are saprophytic and widely distributed in nature. They also occur as commensals in the intestine. They are opportunistic pathogens and may cause many types of infections such as:

- Urinary tract infections (UTI) with predilection for upper UTI. It produces urease which liberates ammonia from urea. The alkaline conditions lead to the precipitation of phosphates and the formation of calculi in the urinary tract.
- Pyogenic lesions
- Wound infections
- Bed sores
- Otitis media
- Meningitis
- Septicaemia
- Osteomyelitis

25.8 LABORATORY DIAGNOSIS

- (i) Specimen:
- UTI- midstream urine
 - Wound/ abscesses, osteomyelitis, otitis media: pus
 - Meningitis: CSF
 - Septicaemia – blood culture
- (ii) Culture: Clinical specimens should be cultured on MacConkey agar/ Teepol lactose agar, 6% blood agar and in case of urine on CLED (Cysteine lactose electrolyte deficient agar). Culture media are incubated at 37°C for 18-24 hours. Pale coloured Non-Lactase Fermenting (NLF) colonies are seen on MacConkey agar. Identification is done by standard biochemical reactions mentioned above.

MODULE

Microbiology



Notes



Notes

(iii) Antibiotic susceptibility: *Proteus* are resistant to many of the common antibiotics, except *P mirabilis* which is sensitive to ampicillin and cephalosporins but nitrofurantoin is not effective.

25.9 GENUS PROVIDENCIA

Like *Proteus*, strains of *Providencia* are Non-lactase fermenting (NLF), methyl red and PPA positive bacilli which are motile by peritrichous flagella. However, they do not swarm on solid media. They can often be recognized by their ‘fruity’ smell. Three important pathogenic species include *Prov alcalifaciens*, *Prov rettgeri* and *Prov stuartii*. It has been suggested that *Prov alcalifaciens* causes diarrhea, *Prov rettgeri* and *Prov stuartii* have been associated with hospital-acquired urinary-tract, wound and other infections. *Providencia* are very resistant to antibiotics, particularly *Prov stuartii* which is also resistant to disinfectants, making it a major pathogen in burn units.



INTEXT QUESTIONS 25.1

1. Proteus are Gram bacilli
2. Name proteus refers to
3. Proteus are catalase and oxidase
4. phenomenon is the basis of typing swarming strains of proteins.



WHAT YOU HAVE LEARNT

- This unit summarizes for you the features of tribe *Proteae* which include the genera *Proteus* and *Providencia*. All the members of the tribe *Proteae* are gram negative, non-capsulated, lactose non-fermenting, motile bacilli with a characteristic swarming growth of genus *Proteus* on blood and nutrient agar. The distinguishing test for the tribe is PPA. They are mainly saprophytes, but may lead to various infections, particularly UTI with predilection to the upper urinary tract and the risk of formation of phosphate stones.



TERMINAL QUESTIONS

1. What are the swarming inhibitory factors?
2. Discuss the Weil-Felix reaction.
3. What is dienes phenomenon?
4. What are the biochemical reactions of Proteus



Notes



ANSWERS TO INTEXT QUESTIONS

25.1

1. Negative
2. Pleomorphism
3. Positive, Negative
4. Dienes