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The respiratory tract microflora and disease

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3.1 INTRODUCTION

The human respiratory tract harbors hundreds of different bacterial spe­
cies. The purpose of the following chapter is to review some of the
bacterial and host factors that contribute to the normal microflora and
the infections that originate in this site. There is generally a peaceful state
of coexistence between humans and the multitude of organisms that
occupy the mucosal surfaces of the upper respiratory tract. Many bacter­
ial species appear to be highly adapted to colonize this site, and in many
cases humans are their only natural host. These are considered to be
commensal organisms because in the absence of underlying mucosal
damage or immunological dysfunction they live in the upper respiratory
tract without causing disease. Several of these species are also common
etiologic agents of disease both within the respiratory tract and at more
distant host sites following hematogenous dissemination. The respiratory
tract is also a common point of entry for many strict pathogens such as
Mycobacterium tuberculosis and Streptococcus pyogenes (group A beta­
hemolytic streptococcus) whose presence usually correlates with disease.
These organisms are not a part of the normal microflora and will not be
discussed in this chapter. Three species, Streptococcus pneumoniae (the
pneumococcus), Haemophilus influenzae and Neisseria meningitidis (the
meningococcus) will be reviewed in detail. These have been selected
because they are members of the normal microflora as well as being
etiologic agents of common respiratory tract and disseminated infections.
Many of the host and bacterial factors involved in the diseases caused by these organisms are understood and will be reviewed.

3.2 ANATOMY OF THE RESPIRATORY TRACT

The respiratory tract begins at the nasopharynx and includes the nose and superior pharyngeal areas. Extending laterally from the nasopharynx are self-contained cavities known as sinuses that are normally aerated but are not involved in the process of air movement; these areas become fully developed during early childhood. Included in the upper respiratory tract is the middle ear, although it, too, does not contribute to respiration. Beyond the nasopharynx inhaled air combines with that from the oropharynx, which joins the nasopharynx at the posterior pharynx. Inferiorly is the trachea, which serves as the marker between the upper and lower respiratory tracts. From there air moves into the mainstem bronchi, which divide into eight to ten segmental bronchi in each lung, and then through smaller branches called bronchioles until it reaches the distal sacs known as alveoli. At this level exchange of gases, primarily oxygen, carbon dioxide and nitrogen, takes place between the bloodstream and moving air. Adjacent to these airways are the pleurae, which enclose the lung.

3.2.2 The normal host state

In the normal state the human is colonized with several bacterial species and strains without the occurrence of disease (Tramont and Hoover, 1995; Table 3.1). These bacteria normally act as symbiotic partners on the mucosal surface, protecting the host from becoming colonized with potentially more pathogenic or antibiotic-resistant organisms.

The presence of particular organisms within specific sites is determined by various mechanical, chemical and immunological host factors that favor as well as hinder specific bacterial adhesion, growth, persistence and spread from host to host. The ready access to the outside environment as well as its moisture and warmth make the nasopharynx the most advantageous place for bacterial growth. However, the aerodynamic environment of the nasopharynx is turbulent because of the presence of nasal hairs as well as the constant movement of air against the nasal turbinates with each inhalation and exhalation, preventing attachment of less adaptable organisms. Large particles in this humid environment become trapped in the mucous secretions and are transported down the mucus stream to the posterior pharynx, where they are swallowed periodically and eliminated by the gastrointestinal system. Transiently increased production of mucus related to local inflammation, as occurs in viral illnesses, induces protective reflexes such as sneezing and coughing, which clear the airways of secretions that contain bacteria.