

Streptococcus

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A large genus of spherical or ovoid bacteria that are characteristically arranged in pairs or in chains resembling strings of beads. Many members of the genus *Streptococcus* (streptococci) that constitute part of the normal flora of the mouth, throat, intestine, and skin are harmless commensal forms; other streptococci are highly pathogenic. The cells are gram-positive and can grow either anaerobically or aerobically, although they cannot utilize oxygen for metabolic reactions. Glucose and other carbohydrates serve as the sources of carbon and energy for growth. All members of the genus lack the enzyme catalase. Streptococci can be isolated from humans and other animals. *See also:* BACTERIA; BACTERIOLOGY; MEDICAL BACTERIOLOGY; MICROBIOTA (HUMAN); PATHOGEN.

Classification

Classification of the streptococci can be based on hemolytic, serologic, or physiologic reactions or on genetic similarities (see table).

Hemolytic reactions. The action of streptococci on blood cells that have been incorporated into solid, agar-containing media was one of the first characteristics used to classify streptococci. Some strains cause beta hemolysis, that is, lysis of blood cells, visualized as clear zones surrounding colonies on blood agar. Other streptococci are alpha-hemolytic, causing a greenish discoloration of blood-containing media. The term gamma hemolysis actually describes the inactivity of streptococci on blood cells. These strains are also known as nonhemolytic. *See also:* BLOOD; LYTIC REACTION.

Serologic reactions. In the 1930s, Rebecca C. Lancefield began her serological studies of streptococci and proposed a scheme for classifying these bacteria into groups on the basis of antigens present in their cell walls. The antigen (known as Lancefield group antigen) is extracted chemically from the cells of a given strain and then is reacted with a series of antisera, each containing antibodies specific for a single Lancefield group antigen. *See also:* ANTIBODY; ANTIGEN; SEROLOGY.

The different groups are denoted by letters of the alphabet. A streptococcus containing an antigen reacting with an antiserum specific for group A, but not with other antisera, is classified as a group A streptococcus. Positive reactions are denoted by the formation of a precipitate of antigen-antibody complexes (the precipitin reaction) or by the agglutination of antiserum-coated latex beads in the presence of antigen. According to Lancefield's classification scheme, all strains with the same group antigen are considered to be closely related, usually

Characteristics of <i>Streptococcus</i> species and related bacteria				
Species or division	Hemolytic reactions	Serologic reactions	Diseases	Comments
<i>S. pyogenes</i>	Beta	Lancefield group A	Pharyngitis, impetigo, scarlet fever	Causes <i>S. pyogenes</i> throat infection, which may be followed by rheumatic fever or glomerulonephritis
<i>S. agalactiae</i>	Beta, gamma (rare)	Lancefield group B	Neonatal infections (septicemia and meningitis), urinary tract infections	Causes overwhelming infection in newborns, which is transmitted from the mother during birth
Group C and G streptococci	Beta	Lancefield group C or G	Pharyngitis, skin and soft tissue infections	Have different Lancefield antigens, but are physiologically and genetically very similar
<i>S. bovis</i>	Gamma, alpha	Lancefield group D	Endocarditis	Presence in the bloodstream often associated with cancer of the colon
<i>S. pneumoniae</i>	Alpha	Various capsular antigens	Respiratory, ear, and eye infections	Antigens in the cell's capsule (an outer polysaccharide layer) are used to classify <i>S. pneumoniae</i> bacteria into serologic types
Viridans streptococci	Alpha, gamma, beta	No Lancefield antigen or group A, C, F, or G	Endocarditis, abscesses	Include a number of species, such as <i>S. mutans</i> (an agent of dental caries) and <i>S. milleri</i> (a cause of abscesses)
Nutritionally variant streptococci	Alpha	Unique type of antigens	Endocarditis	Require vitamin B ₆ for growth
Enterococci	Gamma, alpha, beta	Lancefield group D	Urinary tract infections, septicemia, endocarditis	Formerly considered to be streptococci, but now classified in the genus <i>Enterococcus</i>
Lactococci	Gamma, alpha	Lancefield group N	Rarely isolated from clinical specimens (endocarditis)	Formerly considered to be streptococci, but now classified in the genus <i>Lactococcus</i>

members of the same species. Streptococci of some groups can be subdivided on the basis of type antigens, such as the M-protein type antigens present in group A streptococci. *See also:* ANTIGEN-ANTIBODY REACTION.

Lancefield's classification system is still in use for identifying many beta-hemolytic streptococci of medical importance. Rapid tests for identifying group A streptococci causing strep throat (streptococcal pharyngitis) are based on the detection of the group A Lancefield antigen in streptococci removed from the throat on a swab. Lancefield serology is not useful for identifying most alpha-hemolytic and nonhemolytic strains because possession of a given Lancefield group antigen does not usually correlate with the species identity of strains of these streptococci.

Physiologic reactions. Physiologic activities, including the ability to metabolize certain carbohydrates, to produce various enzymes, or to grow in the presence of different inhibitory compounds, are also used to classify streptococci to the species level. These reactions are most useful for identifying non-beta-hemolytic strains that cannot be easily classified by Lancefield serology.

Genetic similarities. Studies of genetic (nucleic acid) similarities among streptococci have revealed that two major groups of organisms that were previously thought to be streptococci really belong in separate genera. One of these groups, the enterococci, possesses Lancefield group D antigen, but enterococci are different from group D streptococci by virtue of their physiologic properties [they are able to grow in the presence of bile and high salt concentrations, and at both 45°C (113°F) and 10°C (50°F)]. Genetic studies have shown that these organisms belong in a separate genus, *Enterococcus*. Another group of organisms previously considered to be streptococci with Lancefield group N antigen have been reclassified in the genus *Lactococcus*. These bacteria are found on plants and in foods, and they are important in the dairy industry.

Pathogenicity

Streptococcus pyogenes (group A) [see **illustration**] is well known for its participation in many serious infections. It is a common cause of throat infection (strep throat), which may be followed by more serious complications such as rheumatic fever, glomerulonephritis, and scarlet fever. Following the mid-1980s, an increase in the incidence of rheumatic fever and severe group A streptococcal infection, sometimes associated with a toxic shock-like syndrome, was noted. This rise in serious group A streptococcal infections is probably associated with increased virulence properties in some strains of these streptococci. Other beta-hemolytic streptococci with Lancefield group C and G antigens participate in similar types of infection, but they are usually not associated with rheumatic fever and glomerulonephritis. Group B streptococci, which are usually beta-hemolytic, cause serious infections in newborns (such as meningitis) and adults. *See also:* HEART DISORDERS; KIDNEY DISORDERS; MENINGITIS; RHEUMATIC FEVER; SCARLET FEVER; TOXIC SHOCK SYNDROME; VIRULENCE.

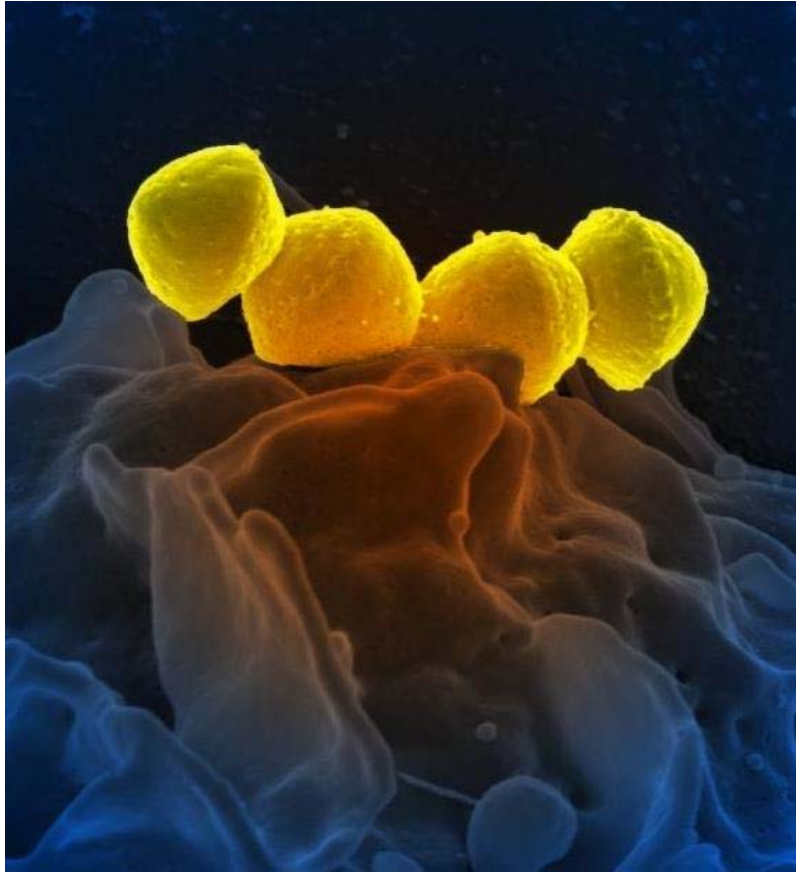
Among the alpha-hemolytic and nonhemolytic streptococci, *S. pneumoniae* is an important cause of pneumonia and other respiratory infections. Vaccines that protect against infection by the most prevalent capsular serotypes are available. The viridans streptococci comprise a number of species commonly isolated from the mouth and throat. Although normally of low virulence, these streptococci are capable of causing serious infections (endocarditis and abscesses). *See also:* PNEUMONIA; *STREPTOCOCCUS PNEUMONIAE* (PNEUMOCOCCUS).

The enterococci, formerly considered to be group D streptococci, have been reclassified into a separate genus, *Enterococcus*. These organisms are normally harmless inhabitants of the intestine, but they can cause urinary tract infections, septicemia (blood poisoning), and endocarditis. Enterococci are generally more resistant to antibiotics than are streptococci. *See also:* ANTIBIOTIC; DRUG RESISTANCE.

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Keywords

bacteria; Lancefield group antigen; *Streptococcus*; *Streptococcus pneumoniae*; *Streptococcus pyogenes*



A scanning electron micrograph of *Streptococcus pyogenes* bacteria (yellow) bound to a human neutrophil (blue). (Photo courtesy of the National Institute of Allergy and Infectious Diseases, National Institutes of Health, Bethesda, MD)

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Additional Readings

Centers for Disease Control and Prevention: Group A Streptococcal (GAS) Disease

New York State Department of Health: Streptococcal Infections

Mayo Clinic: Strep Throat