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Streptococcus pneumoniae: From Pathogen to Protection

Introduction

Streptococcus pneumoniae is a Gram-positive, encapsulated bacterium responsible for a wide spectrum of infections, including pneumonia, meningitis, otitis media, and bacteremia. It remains one of the leading causes of morbidity and mortality worldwide, particularly affecting young children, the elderly, and immunocompromised individuals.

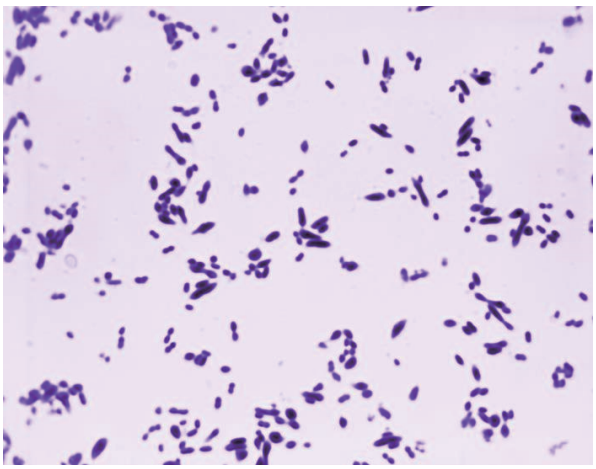

Fig. 1 Gram stain of *Streptococcus pneumoniae*
Under a magnification of 1700X, this Gram-stained pure culture specimen, revealed numerous, Gram-positive, lancet-shaped, Streptococcus pneumoniae diplococcal bacteria.

The virulence of S. *pneumoniae* is primarily attributed to its polysaccharide capsule, which serves as a protective barrier against host immune defenses. More than 90 distinct serotypes have been identified, each defined by unique structural variations in their capsular polysaccharides (CPS). Given the extensive serotype diversity and the increasing prevalence of antibiotic resistance, vaccination has emerged as the most effective and sustainable strategy for preventing pneumococcal disease.

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The Power of Vaccination

Pneumococcal vaccines can be broadly classified into whole-cell and subunit vaccines. Whole-cell vaccines include live attenuated and inactivated forms, while subunit vaccines encompass polysaccharide, conjugate, and protein-based formulations. All commercially available pneumococcal vaccines belong to the subunit category, including the 23-valent polysaccharide vaccine (PPV23) and the 13-valent conjugate vaccine (PCV13).

The introduction of PCV13 has significantly reduced the incidence of pneumococcal disease in children. However, serotype replacement—where non-vaccine serotypes emerge as dominant pathogens, has limited the overall impact of existing vaccines. As a result, novel vaccine candidates capable of providing broader and more durable protection are currently under active investigation and clinical evaluation.

Whole cell vaccine

Live attenuated vaccine: An attenuated or weakened form of the pathogen is used as a vaccine. Currently available live vaccines are the most cost-effective. In rare cases, the live attenuated vaccine strain can revert to its virulent wild type, causing severe disease. However, whole cell vaccines are superior in providing protection against various pneumococcal serotypes, as demonstrated by live attenuated mucosal vaccine.

Inactivated vaccine: The inactivated vaccine is made by treating pathogens with chemicals or physical processes. Compared to live attenuated vaccines, inactivated vaccines are safer. Inactivated whole cell vaccine can confer effective protection against lethal pneumococcal challenge, as demonstrated by reduced colonization or higher survival rate.

Subunit vaccine

Polysaccharide vaccine: The polysaccharide capsule from encapsulated bacteria is a major virulence factor and can be used as an antigen. However, the polysaccharide antigen interacts with B cells and directly induces antibody production without a T cell response. Infants have a particularly immature B cell response, and so vaccines that do not also induce a T cell response cannot provide adequate protection against pneumococcal infection. The pneumococcal polysaccharide vaccine (PPV23; Pneumovax 23) comprises polysaccharide from 23 serotypes (1, 2, 3, 4, 5, 6B, 7F, 8, 9N, 9V, 10A, 11A, 12F, 14, 15B, 17F, 18C, 19F, 19A, 20, 22F, 23F, and 33F), which are responsible for 85-90% of invasive pneumococcal infections in the world. PPV23 is effective against invasive pneumococcal disease (IPD), and is recommended to individuals aged ≥50 and children aged ≥2. However, PPV23 does not prevent the incidence of pneumonia or morbidity, since it elicits serum IgG but not secretory IgA in the nasopharynx. Although no strong evidence on PPV23-induced CAP prevention is available, PPV23 seems to alleviate CAP severity.

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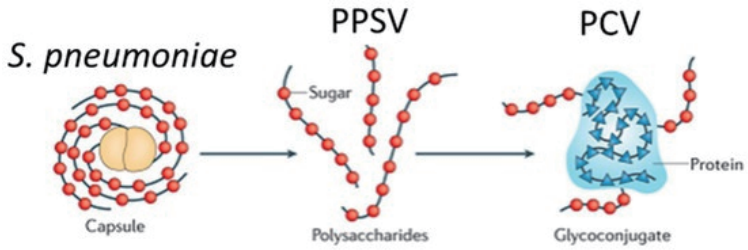

Fig. 2 Vaccines for pneumococcal disease derived from polysaccharide content of S. pneumoniae to generate either pneumococcal polysaccharide vaccine (PPSV) or pneumococcal conjugate vaccine (PCV) clinical options.

Conjugate vaccine: This vaccine uses polysaccharide antigens conjugated with carrier proteins. In contrast to polysaccharide vaccines, the conjugate vaccine can elicit T cell response, resulting in superior immunogenicity and immunity that lasts longer. Pneumococcal conjugate vaccine with 7 valent capsular polysaccharides (PCV7; Prevnar®) includes serotypes 4, 6B, 9V, 14, 18C, 19F and 23F, and PCV10 (Synflorix®) comprises serotypes 1, 4, 5, 6B, 7F, 9V, 14, 18C, 19F and 23F. Serotypes 3, 6A, and 19A are added to PCV13 (Prevnar 13®). PCV7 has been shown to induce protective effects against IPD, pneumonia, and otitis media. Moreover, PCV7 can protect HIV-infected adults from pneumococcal infection. PCV13 has been shown to markedly decrease pneumococcal pneumonia incidence in children, because pneumococcal serotypes 19A and 3 are responsible for half of childhood pneumococcal pneumonia cases. PCV13 vaccination is recommended for infants, children, and adults.

Protein-based vaccine (Recombinant protein vaccine): These vaccines consist of purified protein antigens that have been produced in bacteria. The protein antigen elicits antibodies in a vaccinated person, thus protecting them from disease. Various recombinant protein vaccines have been developed to elicit a sufficient protective immune response.infants, children, and adults.

Capsular Polysaccharides: The Core of Protection

The CPS of *S. pneumoniae* functions as both the bacterium's principal surface antigen and a major virulence determinant. As the outermost layer enveloping the cell wall, the capsule interferes with host immunity by preventing complement deposition, blocking opsonophagocytic uptake, and concealing underlying antigenic proteins. Each pneumococcal serotype is defined by its unique CPS composition: repeating oligosaccharide units of distinct monosaccharides, glycosidic linkages, branching patterns, and modifications (e.g., acetylation, pyruvylation). This structural diversity translates into antigenic uniqueness, meaning that protective immunity against *S. pneumoniae* is largely serotype-specific. Different serotypes exhibit characteristic biological and epidemiological profiles:

- Serotype 1, frequently linked to epidemic outbreaks of pneumonia.
- Serotype 3 produces an exceptionally thick capsule associated with high virulence.
- Serotypes 6A/6B, commonly found in pediatric infections.
- Serotypes 19A and 19F, notable for antibiotic resistance.
- Serotype 23F, historically prevalent in invasive pneumococcal disease.

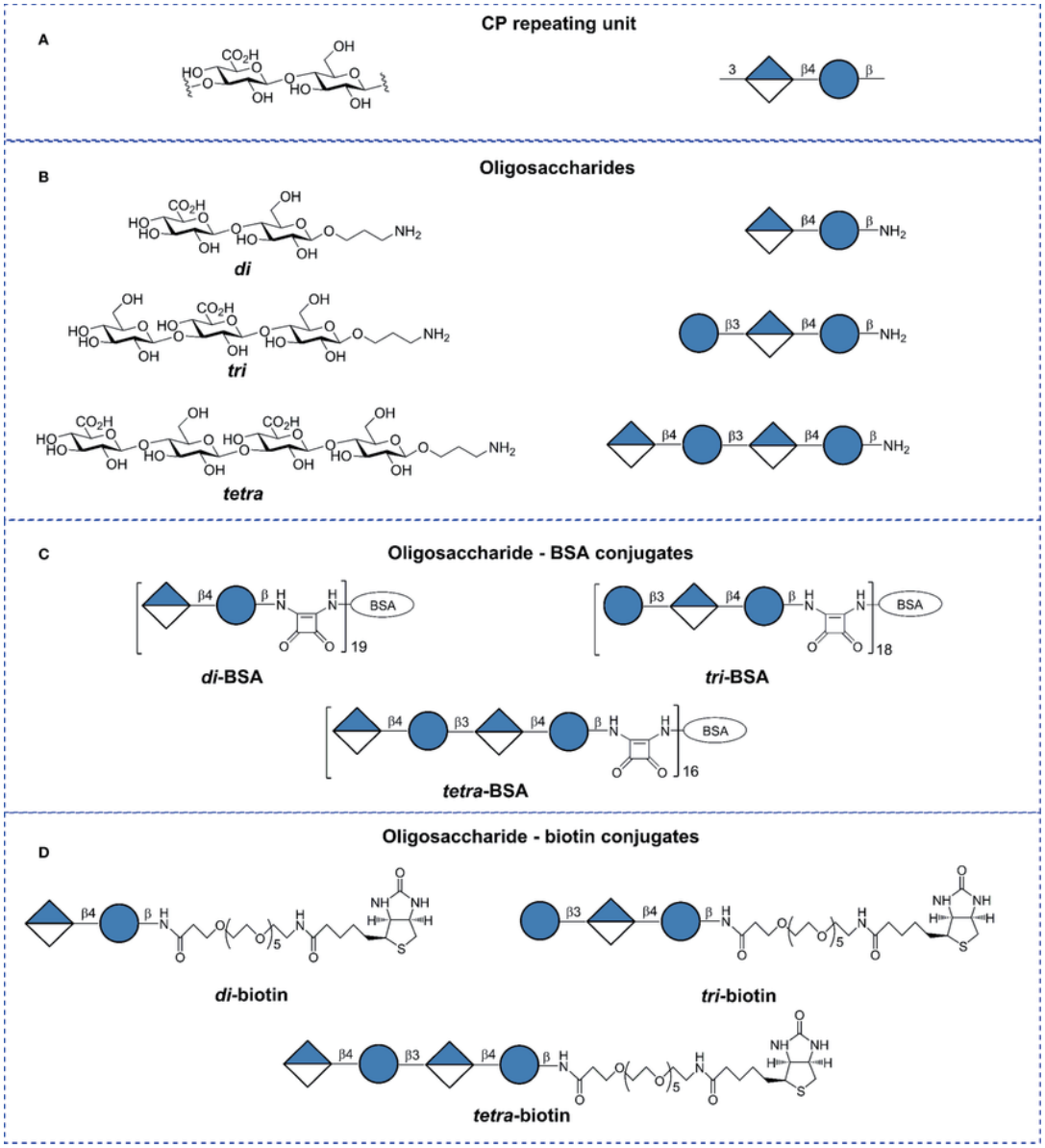

Fig. 3 Structures of the Streptococcus pneumoniae type 3 capsular polysaccharide (CP), synthetic oligosaccharides (OSs), and glycoconjugates.

(A) Repeating unit of the S. pneumoniae type 3 CP. (B) Synthetic spacer-armed OSs representing the CP-fragments. (C) BSA conjugates of synthetic OSs. (D) Biotin conjugates of synthetic OSs. Structural and symbolic representations are assigned according to symbol carbohydrate nomenclature for the carbohydrate sequences.

As CPS defines both the pneumococcal serotype and the immune target of existing vaccines, it is fundamental to vaccine development and manufacturing control. Both polysaccharide and conjugate vaccines derive their antigenic components from CPS or CPS-based oligosaccharides covalently linked to carrier proteins. Precise structural characterization (e.g., via NMR spectroscopy, HPAEC, and immunoassays) and quantification of CPS antigens are critical for vaccine potency, consistency, and regulatory compliance. Moreover, serotype-specific CPS reference materials and monoclonal antibodies are indispensable in both pre-clinical immunogenicity assessment and batch-release testing. The ability to monitor CPS integrity and serotype-specific immune responses ensures that vaccines meet their protective promise and adapt to emerging serotype dynamics.

Reliable Tools for Vaccine Development and Quality Control

As global demand for pneumococcal vaccines grows, the need for precise, standardized analytical tools has never been greater. Reliable antigens and antibodies are indispensable across all stages of vaccine development—from preclinical research and process optimization to batch release and post-market surveillance. Key applications include:

- Serological assays (e.g., ELISA, multiplex immunoassays) to quantify antibody responses.
- Functional assays, such as opsonophagocytic activity (OPA), to evaluate vaccine-induced protection.
- Quality control tests ensuring antigen identity, purity, and potency.
- Lot-to-lot consistency testing, confirming reproducibility of production processes.

Our Product Portfolio

We provide a comprehensive panel of *S. pneumoniae* antigens and monoclonal antibodies tailored for vaccine research and quality control applications. Our product line includes high-purity capsular polysaccharides and well-characterized monoclonal antibodies covering the major vaccine serotypes: 1, 2, 3, 4, 5, 6A, 6B, 7F, 8, 9N, 9V, 11A, 14, 17F, 18C, 19A, 19F, 20, 23F, and 33F. Key features of our pneumococcal antibody portfolio include:

- High specificity and affinity, ensuring accurate serotype discrimination with minimal cross-reactivity.
- Validated for multiple applications, including ELISA, WB, and Immunoturbidimetry.
- Available in multiple conjugations, such as FITC, HRP, and biotin, for flexibility in assay design.
- Batch-to-batch consistency, essential for reproducible QC testing and regulatory compliance.

Our CPS antigens are purified under stringent quality standards to maintain their structural integrity and immunological reactivity. They are ideal for use as coating antigens, reference standards, or vaccine development controls.

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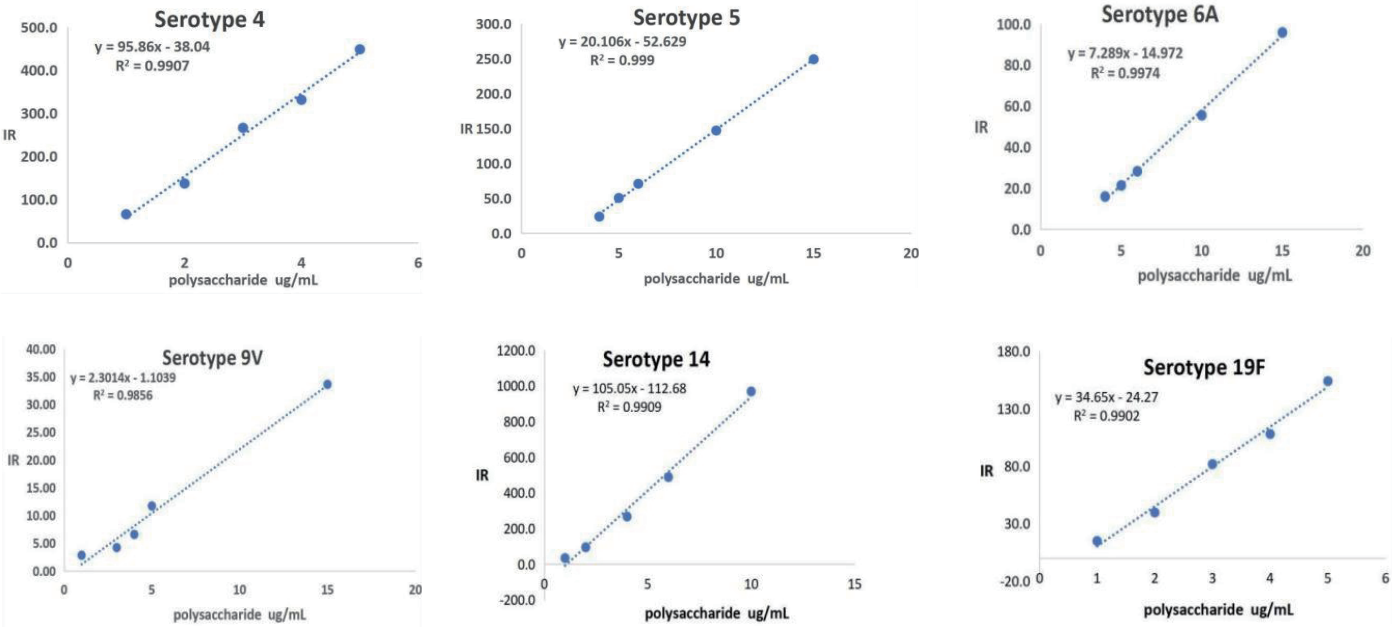
Immunoturbidimetry Data



Conclusion

As pneumococcal serotype dynamics continue to evolve, the demand for high-quality analytical reagents and validated reference standards has become ever more critical. By providing scientifically robust, serotype-specific antibodies and polysaccharide materials, we help ensure that pneumococcal vaccines achieve their protective potential with precision, safety, and reliability.

Reference

1. Kim G L, *et al*. Pneumonia and *Streptococcus pneumoniae* vaccine[J]. *Archives of pharmacal research*, 2017, 40(8): 885-893.

2. Paton J C, *et al*. *Streptococcus pneumoniae* capsular polysaccharide[J]. *Microbiology spectrum*, 2019, 7(2): 10.1128/microbiolspec. gpp3-0019-2018.

3. Mandal P K. Bacterial surface capsular polysaccharides from *Streptococcus pneumoniae*: A systematic review on structures, syntheses, and glycoconjugate vaccines[J]. *Carbohydrate Research*, 2021, 502: 108277.

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Product List

Antigens

Cat. No.	Product name	Application
DAGC700	Native S. pneumoniae 1 Antigen	Immunogen, WB, ELISA
DAGC701	Native S. pneumoniae 2 Antigen	Immunogen, WB, ELISA
DAGC702	Native S. pneumoniae 3 Antigen	Immunogen, WB, ELISA
DAGC703	Native S. pneumoniae 4 Antigen	Immunogen, WB, ELISA
DAGC704	Native S. pneumoniae 5 Antigen	Immunogen, WB, ELISA
DAGC705	Native S. pneumoniae 6B Antigen	Immunogen, WB, ELISA
DAGC706	Native S. pneumoniae 7F Antigen	Immunogen, WB, ELISA
DAGC707	Native S. pneumoniae 8 Antigen	Immunogen, WB, ELISA
DAGC708	Native S. pneumoniae 9N Antigen	Immunogen, WB, ELISA
DAGC709	Native S. pneumoniae 9V Antigen	Immunogen, WB, ELISA
DAGC710	Native S. pneumoniae 10A Antigen	Immunogen, WB, ELISA
DAGC711	Native S. pneumoniae 11A Antigen	Immunogen, WB, ELISA
DAGC712	Native S. pneumoniae 12F Antigen	Immunogen, WB, ELISA
DAGC713	Native S. pneumoniae 14 Antigen	Immunogen, WB, ELISA
DAGC714	Native S. pneumoniae 15B Antigen	Immunogen, WB, ELISA
DAGC715	Native S. pneumoniae 17F Antigen	Immunogen, WB, ELISA
DAGC716	Native S. pneumoniae 18C Antigen	Immunogen, WB, ELISA
DAGC717	Native S. pneumoniae 19A Antigen	Immunogen, WB, ELISA
DAGC718	Native S. pneumoniae 19F Antigen	Immunogen, WB, ELISA
DAGC719	Native S. pneumoniae 20 Antigen	Immunogen, WB, ELISA
DAGC720	Native S. pneumoniae 22F Antigen	Immunogen, WB, ELISA
DAGC721	Native S. pneumoniae 23F Antigen	Immunogen, WB, ELISA
DAGC722	Native S. pneumoniae 33F Antigen	Immunogen, WB, ELISA
DAG2685	S. pneumoniae CWPS Antigen	ELISA

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Antibodies

Cat. No.	Product name	Application
CABT-CS118	Anti-S. pneumoniae CPS 1 Mab, clone 1227	ELISA, Immunoturbidimetry
DMAB-CLS25373	Anti-S. pneumoniae CPS 1 Mab, clone 1117	Immunoturbidimetric
DMAB-CLS25370	Anti-S. pneumoniae CPS 1 Mab, clone 1342	ELISA
DMAB-CLS25374	Anti-S. pneumoniae CPS 2 Mab, clone 1125	Immunoturbidimetric
CABT-CS119	Anti-S. pneumoniae CPS 3 Mab, clone 1216	ELISA, Immunoturbidimetry
DMAB-CLS25375	Anti-S. pneumoniae CPS 3 Mab, clone 1119	Immunoturbidimetric
CABT-CS120	Anti-S. pneumoniae CPS 4 Mab, clone 1220	ELISA, Immunoturbidimetry
DMAB-CLS25376	Anti-S. pneumoniae CPS 4 Mab, clone 1113	Immunoturbidimetric
CABT-CS121	Anti-S. pneumoniae CPS 5 Mab, clone 1221	ELISA, Immunoturbidimetry
DMAB-CLS25377	Anti-S. pneumoniae CPS 5 Mab, clone 1121	Immunoturbidimetric
CABT-CS122	Anti-S. pneumoniae CPS 6A Mab, clone 1217	ELISA, Immunoturbidimetry
DMAB-CLS25378	Anti-S. pneumoniae CPS 6A Mab, clone 1110	Immunoturbidimetric
CABT-CS123	Anti-S. pneumoniae CPS 6B Mab, clone 1231	ELISA, Immunoturbidimetry
CABT-CS124	Anti-S. pneumoniae CPS 7F Mab, clone 1245	ELISA, Immunoturbidimetry
DMAB-CLS25379	Anti-S. pneumoniae CPS 7F Mab, clone 1123	Immunoturbidimetric
CABT-CS125	Anti-S. pneumoniae CPS 8 Mab, clone 1233	ELISA, Immunoturbidimetry
DMAB-CLS25380	Anti-S. pneumoniae CPS 8 Mab, clone 1122	Immunoturbidimetric
CABT-CS126	Anti-S. pneumoniae CPS 9N Mab, clone 1230	ELISA, Immunoturbidimetry
CABT-CS127	Anti-S. pneumoniae CPS 9V Mab, clone 1225	ELISA, Immunoturbidimetry
DMAB-CLS25381	Anti-S. pneumoniae CPS 9V Mab, clone 1118	Immunoturbidimetric
DMAB-CLS25371	Anti-S. pneumoniae CPS 9V Mab, clone 1343	ELISA
CABT-CS128	Anti-S. pneumoniae CPS 11A Mab, clone 1234	ELISA, Immunoturbidimetry
CABT-CS129	Anti-S. pneumoniae CPS 14 Mab, clone 1229	ELISA, Immunoturbidimetry
DMAB-CLS25382	Anti-S. pneumoniae CPS 14 Mab, clone 1124	Immunoturbidimetric

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Cat. No.	Product name	Application
DMAB-CLS25384	Anti-S. pneumoniae CPS 18C Mab, clone 1115	Immunoturbidimetric
CABT-CS132	Anti-S. pneumoniae CPS 19A Mab, clone 1219	ELISA, Immunoturbidimetry
DMAB-CLS25385	Anti-S. pneumoniae CPS 19A Mab, clone 1114	Immunoturbidimetric
CABT-CS133	Anti-S. pneumoniae CPS 19F Mab, clone 1215	ELISA, Immunoturbidimetry
DMAB-CLS25386	Anti-S. pneumoniae CPS 19F Mab, clone 1112	Immunoturbidimetric
CABT-CS134	Anti-S. pneumoniae CPS 20 Mab, clone 1262	ELISA, Immunoturbidimetry
CABT-CS135	Anti-S. pneumoniae CPS 23F Mab, clone 1263	ELISA, Immunoturbidimetry
CABT-CS136	Anti-S. pneumoniae CPS 33F Mab, clone 1264	ELISA, Immunoturbidimetry
DMAB-CLS25372	Anti-S. pneumoniae CPS 33F Mab, clone 1354	ELISA
CABT-B8726	Anti-S. pneumoniae CWPS Mab	ELISA (cap), IF, LFIA
CABT-B8727	Anti-S. pneumoniae CWPS Mab	ELISA (det), IF, LFIA
CABT-B8728	Anti-S. pneumoniae CWPS Mab, clone C2400N	ELISA, IF
CABT-CS130	Anti-S. pneumoniae CPS 17F Mab, clone 1235	ELISA, Immunoturbidimetry
DMAB-CLS25383	Anti-S. pneumoniae CPS 17F Mab, clone 1116	Immunoturbidimetric
CABT-CS131	Anti-S. pneumoniae CPS 18 Mab, clone 1224	ELISA, Immunoturbidimetry

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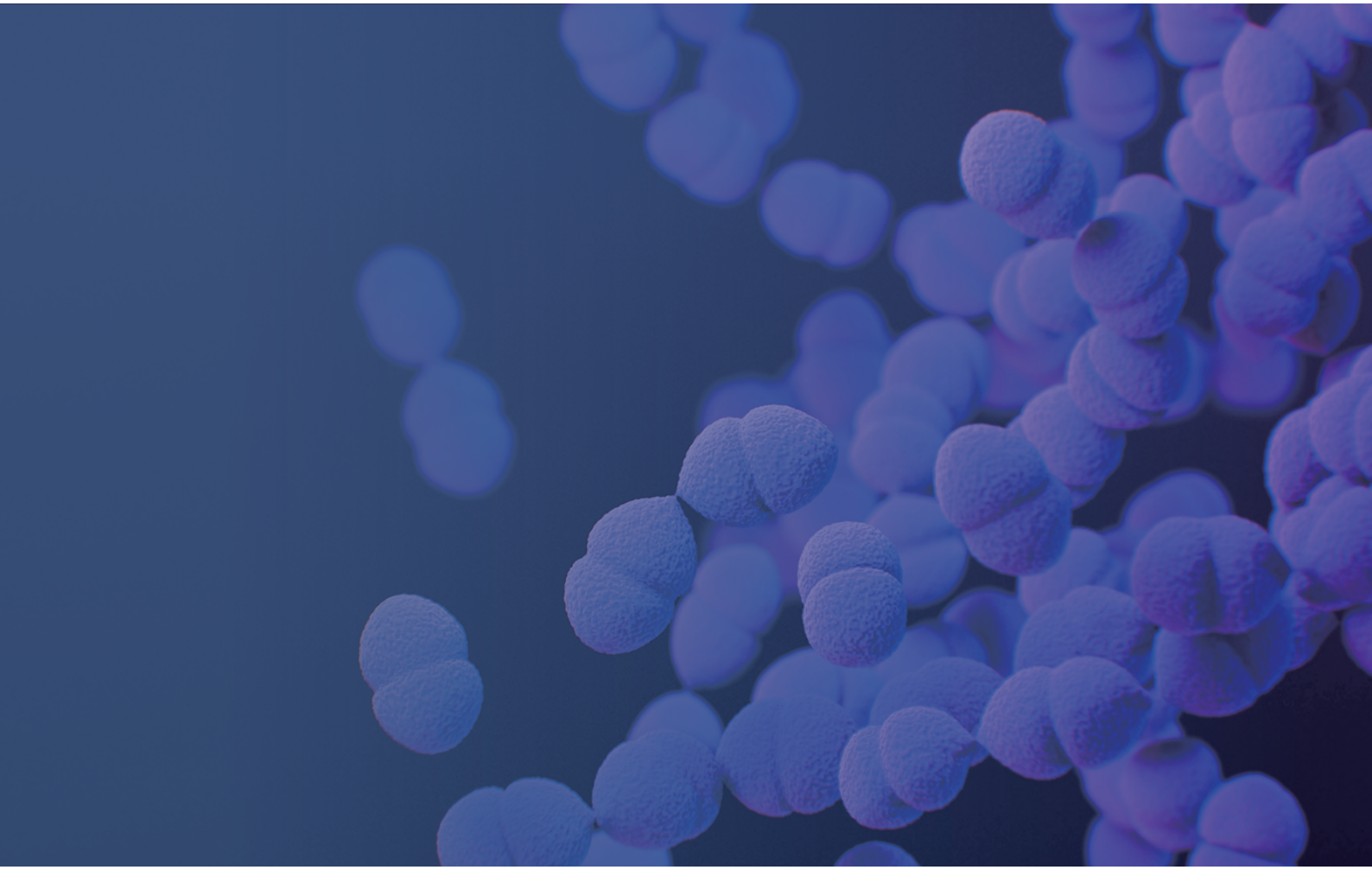

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