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REFERENCE STRAINS FOR THE SEROLOGIC
GROUPS OF MENINGOCOCCUS
(Neisseria meningitidis)

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Many variations in designation of serological groups of Neisseria meningitidis have appeared in the literature since the existence of such differences were first pointed out by Dopter in 1909. Confusion has resulted from inexact use of the terms "type" and "group", and from uncertainty as to the relation of these to each other, as well as from differences in terminology. The need for uniformity led to the organization of the Subcommittee on the Family Neisseriaceae of the International Committee on Bacteriological Nomenclature. This Subcommittee prepared a classification of N. meningitidis which conforms to the International Bacteriological Code of Nomenclature (1948). The preliminary report of the Subcommittee was given at the Fifth International Congress for Microbiology, Rio de Janeiro, Brazil, in 1950; a more complete report was presented at the Sixth International Congress for Microbiology in Rome, Italy, 1953. Both of these reports were published in the International Bulletin of Bacteriological Nomenclature and Taxonomy, 1954.

In the recommended classification the 4 main serological groups of the meningococcus are designated as A, B, C, and D. The relationship of these groups to other classifications is shown in tabular form by Branham (1953), and in a more condensed form in the 7th Edition of Bergey's Manual of Determinative Bacteriology.

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Regardless of whether newer or older nomenclature has been employed, work with Neisseria meningitidis has been greatly handicapped by the lack of standard reference strains for the serological groups of this organism. Each center of activity in this field has been compelled to choose its own reference strains, or has obtained them from some other laboratory or center. Within major serologic groups individual strains of meningococcus may vary greatly in antigenic pattern. Some are "broad" enough to include all members of their group while others are so "narrow" that they fail to cover many strains, and might even be considered to form sero-types within the broad groups. Interest in the meningococcus is world wide and laboratories in scattered nations are concerned in its study. The use of uniform strains, broad enough to give good coverage to their respective serologic groups, yet sufficiently specific to avoid cross agglutination, would be of great advantage to workers making comparative studies. The International Committee on Bacteriological Nomenclature has suggested that "type" strains be chosen to represent the four major groups of meningococcus.

Since August 1, 1928, the author has received approximately 2200 strains of N. meningitidis for study, in addition to a number of strains of other Neisseriae. This period included the epidemics of 1928-30, of 1936-37, and of 1941-45. Although the majority of cultures came from acute infections during these three epidemics many were obtained from sporadic infections as well. The greatest number of all cultures came from the United States, but a few were from Canada, South America, Britain, and the European Continent. Not all of these meningococcus cultures were conserved, though histories and records of study were kept for all. About 500 strains, representative of different periods and antigenic patterns, were preserved in a freeze-dried state. These cultures and records seemed to afford excellent material for a search for suitable strains to use as a beginning for establishment of a uniform basis of classification. Such a study was encouraged by both the Chairman of the International Committee on Bacteriological Nomenclature and by the Permanent Secretary for Medical Bacteriology.

A screening of this collection was done during 1956 and the early part of 1957. Group A strains were studied first,

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then those of B, C, and D were taken in order.¹ Although it is not a meningococcus, *N. flavescens* was also included since it was involved in an epidemic, and this collection has the original strains (Branham, 1930).

In the preliminary screening of the collection, strains were studied in groups of 16. They were reconstituted from the dried state and primary cultures were made on blood agar slants and in semi-solid trypticase soy agar. The next day the growth was plated out on 5 per cent rabbit's blood agar and on the third day the 24-hour colonies were studied with a dissecting microscope and gram-stained smears prepared for microscopic examination for characteristic morphology.

Often 2 colony forms were apparent: one was a round raised and shining translucent cushion, and the other flatter and duller, but of similar translucency. As a rule neither form behaved like a "rough" colony, and they were not easily separable into cultures showing only one form. In such cases the whole culture was used for further study. With those strains that showed definitely "rough" and "smooth" colonies, "smooth" forms were chosen for further investigation.

After the study of colony form and of morphology, fermentation reactions were checked using a semi-solid, sugar-free agar base with indicator and 0.5 per cent of the desired carbohydrate added. All strains of meningococcus produced acid from dextrose and maltose only, though they varied in both rate of fermentation and in amount of acid produced. Sometimes the indicator change was very transient.

Antigenicity was checked by determining the presence of specific soluble capsular substance as shown by development of halos around implanted colonies on agar plates containing various dilutions (5 per cent, 2.5 per cent, and 1.25 per cent) of polyvalent anti-meningococcus serum (Pittman, Branham, and Sockrider, 1938, and Branham and Pittman, 1940). This polyvalent serum had been prepared previously in horses for diagnostic purposes and is not generally available. Halos were recorded as +, ++, +++, +++++. All smooth specific

¹The author was aided by Mrs. Marion W. Grabowski and Mr. Donald B. Riggs, without whose help this intensive study would have been impossible.

strains of Groups A, B, and C produced halos of precipitate; Group D was not represented in the serum. All D strains available seemed to be completely rough. Halo production by Group B was less pronounced than by A and C, but all smooth strains did produce such rings to some extent. Halo formation proved to be one of the most valuable tests in screening out rougher, less specific, and less antigenic strains. Since capsule swelling has never been demonstrated with Group B strains of meningococci, this halo precipitation technique has a distinct advantage for screening cultures of this group.

All strains were tested for agglutinability with polyvalent and with homologous group sera, and also for cross agglutination with specific sera representing other groups. The specific group sera had been prepared at the National Institutes of Health and were those used routinely for diagnostic purposes. Their breadth and specificity had been established by extensive use. The regular tube agglutination technique was used with 4 to 6 dilutions of serum in 0.85 per cent NaCl solution buffered to pH = 6.8. Antigens were suspensions of 18 hour slant cultures in the buffered 0.85 per cent NaCl and standardized to contain approximately 1 billion (10^9 , or a thousand million) meningococci per ml. The test was incubated at 37° C. in a water bath for 2 hours and then held in an icebox overnight before final reading. This method gives specific agglutination, whereas longer incubation is apt to result in "crossing".

On the basis of these preliminary observations a number of strains were selected for further study. Choice was made chiefly with two criteria in mind: breadth of coverage for strains of the same group, and specificity for the homologous group. Some strains were also selected for narrower characteristic serologic patterns which indicate the possibility of sero-types within the broad groups.

In order to determine the serological relation of these selected strains to each other and to their groups as a whole, it was necessary to prepare antisera for them. Rabbits were immunized by intravenous injection of 5-hour blood agar slant cultures. It was found best to begin with small amounts (i.e., 50,000,000 cells) of formalinized suspension, changing to living cultures as soon as practicable. No definite rate

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of increase in size of doses can be prescribed, since individual response in rabbits varies widely, and the weight and condition of the rabbit is the safest guide. In general the dose schedule was as follows:

3 injections on successive days; rest 4 days.
Repeat this for 2 more weeks. Rest one week.
Repeat the above. Make trial bleeding from ear.

With Groups A and C a good agglutinating serum is usually obtained at the end of 8 weeks, though a second 6-week period of immunization is often advisable. With Group B several such courses are usually necessary. If immunization is long continued, the serum will "spread" and cross agglutination will occur as somatic agglutinins appear. A lower titered serum that is strictly specific is often preferable to one of high titer that cross agglutinates strains of other groups. When a satisfactory titer is obtained, the rabbits are bled from the heart.

An intensive serological study was made with the following strains chosen in the preliminary screening: 18 of Group A, 28 of Group B, and 27 of Group C. Since only 2 strains of Group D were in the collection, they were not studied in a similar fashion, though they were carefully checked separately for purity and specificity.

The serologic study of Group A strains presented few complications. The strains studied in this phase of the project included representatives from the epidemics of meningitis occurring from the period of World War I to the present, with several strains from sporadic cases. Group A is relatively homogeneous and differences among the strains are chiefly of degree of antigenicity, agglutinability, and halo intensity; i.e., those that were the best antigens produced agglutinating sera with broader coverage and higher titer.

Group C ranks next in order of homogeneity. More differences in serological pattern, in specificity, and in breadth of coverage have been found with Group C than with Group A.

Group B is relatively complex. Strains vary both qualitatively and quantitatively. With B more than with any other

group broad strains of recognized coverage are necessary for preparation of diagnostic sera. If agglutinating sera made from "narrow" members of this group are used for diagnostic purposes some strains of B are apt to be missed. There is considerable evidence for "sero-types" within Group B though there is always overlapping.

There is some evidence for the occurrence of "types" within all groups of meningococcus. Gordon and Murray (1915), by absorption of agglutinins, found Types I and III within the broad Group A. This is the most homogeneous group with the simplest antigenic composition. It is likely that the more complex Groups B and C would yield "types" if painstaking studies were made.

Some of the complications arising in a serological study of meningococcus may well be mentioned here. Some strains acquire a tendency to agglutinate spontaneously. This is usually due to the occurrence of rough forms in the culture and is remedied by plating out, and picking and comparing several smooth colonies. A similar procedure may be employed when a strain habitually does not agglutinate well. Individual colonies vary considerably in agglutinability. Cross agglutination between groups, likewise, may be due to the presence of rough organisms in the culture, since rough meningococci have lost their specific capsular substances and the somatic antigens react nonspecifically. Antisera agglutinate nonspecifically if: (1) they are prepared by the use of rough antigens; or (2) if immunization of the rabbits is carried on too long. The sensitivity of an agglutination test can be increased by (1) lowering the pH of the salt solution used; or (2) slightly decreasing the density of the antigen suspension. The stability of a suspension can be increased by lowering the concentration of electrolyte, i.e., from 0.85 per cent NaCl to 0.5 per cent.

On the basis of the studies made, strains of meningococci have been chosen to form a special collection. For each group there is suggested a "type strain", or more properly, a "neotype", to serve as a reference strain for the group, and two other similar strains as "runners-up" in case a substitution should seem desirable. These are chosen on the basis of specificity, antigenicity, and breadth of coverage for their group. In addition there are a few other selected

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strains which represent special serological patterns, possible sero-types within the broad groups, individual outbreaks of meningitis, and strains of special historical interest. These strains are listed in the appended tables.

Although N. flavescens is not a meningococcus it was also studied since it is the only other member of the genus that has been known to be involved in an epidemic of meningitis (1930). Available strains were studied in the same manner as described above for the meningococcus except that new antisera were not prepared for them since good agglutinating serum was already on hand. This species of Neisseria ferments no carbohydrates, produces a golden yellow pigment (greenish yellow on Loeffler's blood serum medium) and agglutinates specifically. Six strains of N. flavescens are included in this special collection. These are listed at the end of the table below.

The strains in this special collection have been dried from a frozen state and sealed in vacuo. As long as the supply lasts laboratories and qualified individual workers may obtain them on request from the Division of Biologics Standards, National Institutes of Health, Bethesda 14, Maryland, U.S.A. They are also being deposited in the American Type Culture Collection, 2112 M Street, NW., Washington, D. C., U.S.A.

It is hoped that requests will specify which strains are desired; i.e., whether the neotypes only, or others for special work, so that specific needs of workers may be met.

SUMMARY

Neotype strains have been suggested to represent the major serologic groups of meningococci: A, B, C, and D. Two other similar strains of each group have been selected as "runners-up" for these. It is hoped that these will be useful as reference strains in classification and in comparative studies.

These reference strains, together with a few others which represent special serologic patterns, or which have historical significance, form a special collection which is available to workers in this field.

Serogroups and Strains of Neisseria meningitidis and of N. flavescens

Serogroup	NIH* Strain number	Date received at NIH	Date and place isolated	Received from	Source	Labelled	Comment
A	M1027	4/12/37	4/37, Municipal Contagious Dis. Hospital, Chicago, Ill.	Dr. C.P. Miller Univ. of Chic.	Spinal fluid	"21" A fatal case	Neotype strain for Group A. Neotype strain for species.
A reliable strain. Makes good agglutinating serum for Group A. Has a tendency to agglutinate spontaneously at times. This can be easily overcome by plating out and testing individual colonies for stability.							
A	M962	1/12/37	1/37, Baltimore, Md.	City Health Dept. Baltimore, Md.	Spinal fluid	"S-3032-S"	A good "runner-up" for neotype strain of Group A.
An epidemic strain from outbreak of 1936-37.							
A	M1894	7/30/43	7/43, Washington, D.C.	Gallinger Hospital (now D.C. General)	Spinal fluid	"Bernard Bice"	A good "runner-up" for neotype strain of Group A.
An epidemic strain of World War II.							
A	M947	12/10/36	12/36, Boston, Massachusetts	Antitoxin and Vaccine Lab., Jamaica Plain	Spinal fluid	"Whitehouse"	A good specific strain.
An example of the strains involved in epidemic of 1936.							
A	M973	1/22/37	1/37, Boston, Massachusetts	Antitoxin and Vaccine Lab., Jamaica Plain		"Horan (2)"	Specific, antigenic.
Another typical epidemic strain.							
A	M1036	4/26/37	4/37, Wilmington, N.C.	James Walker Memorial Hospital	Spinal fluid	"James Scott"	Specific.
Another Group A strain typical of those in epidemic of 1936-37.							

*NIH refers to the National Institutes of Health, Bethesda, Maryland

Serogroups and Strains of *Neisseria meningitidis* and of *N. flavescens* Con't.

Serogroup	Strain number	Date received at NIH	Date and place isolated	Received from	Source	Labelled	Comment
A	M1157	2/10/40	2/40, Wilkesbarre, Penn.	Dr. Edward S. Pugh Kirby Health Center	Spinal fluid	"Stella Pendock"	An early World War II strain. During epidemic.
A	M2055	1/31/46	1/46, Washington, D.C.	D.C. General Hospital	Spinal fluid	"Robert Jones"	A reliable specific strain. Not from an epidemic but from a sporadic postwar case.
A	M2184	1/6/56	1/56, Helena, Montana	Miss E. Kuhns Montana State Lab.	Blood	"Clarence Bird Rattler"	Most recent A strain. From sharp outbreak on Blackfoot Indian Reservation, aborted by giving sulfadiazine to entire community.
A	M57	6/8/17	World War I	Rockefeller Inst., New York	Spinal fluid	"Irregular, 3C, Isadore"	Still a good strain. A very old strain representative of Gordon and Murray's Type III. Also Wollstein's "Irregular" (1914). Used as a reference strain for "Type III" for years in USA. Evans' Tropin group "R" (1920). A good representative of Group A. Kept both for historic reasons and because it is still a good strain.
A	M423	6/29/31	1915, London, England	Dr. W.M. Scott	Spinal fluid	"Myott"	Isolated by Gordon and Murray in 1915. Preserved as "Type III" (Gordon and Murray) in National Type Culture Collection (London), but <u>not</u> the original standard "Type III". Considered degenerate by Scott and certainly "rough" now, though some "halo" production indicates presence of some specific cells. Kept for historic reasons.
A	M331	5/1/30	5/30, Memphis, Tenn.	Dr. A.D. Dulaney Univ. of Tenn.	Spinal fluid	"30-7"	Narrow A. Used for a long time as a reference strain for "Type I" of Gordon and Murray; sufficiently narrow not to cross agglutinate with "Type III" of Gordon and Murray. No longer used as reference strain but included here because of its history.
A	M123	1918	----	Rockefeller Inst., New York	Spinal fluid	"Rockefeller Inst., F5"	A very old strain. Long used at NIH as reference strain for "Type I" of Gordon and Murray. Evans' Tropin group "R" (1920). Now rough. Kept for historic reasons.

Serogroups and Strains of Neisseria meningitidis and of N. flavescens Con't.

Serogroup	Strain number	Date received at NIH	Date and place isolated	Received from	Source	Labelled	Comment
B	M2092	1/8/48	1/48, Boston, Mass.	Antitoxin and Vaccine Lab., Jamaica Plain	Spinal fluid	"Linda Cunningham"	Neotype strain for Group B. This strain is a good immunizing agent and makes good broad agglutinating serum that includes all B's, yet does not cross with other groups. It agglutinates itself well, but is agglutinated rather poorly by many other B sera.
B	M2091	10/29/47	10/47, Boston, Mass.	Antitoxin and Vaccine Lab., Jamaica Plain	Nose	"Elaine Street"	A "runner-up" for neotype of Group B. The only shortcoming of this strain is a tendency to become "rough" and to agglutinate spontaneously. Otherwise it is an excellent antigen, makes a good broad diagnostic serum which agglutinates specifically. Occasionally necessary to plate out and test picked colonies for stability.
B	M997	2/20/37	2/37, Baltimore, Maryland	City Health Department, Baltimore, Md.	Spinal fluid	"S-3250-L"	A "runner-up" for neotype of Group B. This strain is a slow immunizing agent, but will make an excellent agglutinating serum if immunization is continued long enough. The serum is both broad and specific.
B	M1385	4/23/42	4/42, Washington, D. C.	Children's Hospital	Blood	"Eugene McKinney"	A broad strain. This strain makes a serum that is fairly inclusive for Group B, but it has a tendency to overlap other groups and to cross agglutinate to some extent.
B	M1180	6/6/40	6/40, Syracuse, N. Y.	Dr. A. C. Harris	Spinal fluid	"Margaret Sarafin"	A relatively narrow B strain. Has characteristic antigenic pattern resembling M2176 and M2189.
B	M1206	2/20/41	2/41, Phillipsburg, Pennsylvania	Dr. Vernon Nisbet, Department of Health Philadelphia	Spinal fluid	"Anna Potella 18 months' old"	Fairly narrow B strain. Has characteristic serologic pattern unlike M1180, M2176, M2189.

Serogroups and Strains of Neisseria meningitidis and of N. Flavescens Con't.

Serogroup	Strain number	Date received at NIH	Date and place isolated	Received from	Source	Labelled	Comment
B	M1776	4/7/43	4/43, Washington, D. C.	Army Medical School (now Walter Reed Army Medical Center)	Naso-pharynx	"Burroughs, No. 4324"	Fairly narrow B strain.
From Camp Shelby, Mississippi, during World War II.							
B	M1992	4/1/44	4/44, Chicago, Illinois	Dr. C. P. Miller University of Chicago	Carrier	"Mn 116"	A narrow B strain.
Of a serological pattern designated as "Y" by Dr. Miller.							
B	M2176	3/25/54	3/54, Washington, D. C.	District General Hospital	Spinal fluid	"Ellen Ross, 18 mos. old"	A narrow B strain, related to M1180, M2189.
Isolated after death of child with Waterhouse-Friderichsen Syndrome.							
B	M2189	1/20/56	1955, Oslo, Norway	Dr. Kaare Jyssum, Rikshospitalet, Oslo, Norway	-----	"M10"	A very narrow specific B strain.
Not agglutinated by all Group B sera, but is agglutinated by those that are broad. Called "type N" by Jyssum (1956). Related to M1180 and M2176.							
B	M55	1917	-----	Rockefeller Institute, N. Y.	Spinal fluid	"Regular str. No. 1"	A very old strain.
This strain dates back to World War I. It was one of Dr. Wollstein's strains. Was long used at NIH as a reference strain for Gordon-Murray's "Type II". Also an example of Evans' Tropin Group "S" (1920). Now chiefly of historic interest as it has become "rough".							
B	M963	1/15/37	1/37, Toronto, Canada	Dr. Geoffrey Rake, Toronto, Canada	-----	"Herrington"	Old reference strain.
Used for years for testing therapeutic serum. It had a persistent mouse virulence and specificity, but was a very poor antigen for immunization. Is included for research purposes.							

Serogroups and Strains of Neisseria meningitidis and of N. Flavescens Con't.

Serogroup	Strain number	Date received at NIH	Date and place isolated	Received from	Source	Labelled	Comment
C	M1628	11/25/49	11/49, Hartford, Conn.	Dr. Friend Lee Mickle, Department Public Health	Spinal fluid	-----	Neotype strain for Group C.
A broad strain serologically for strains of Group C and also specific for the group. Makes a good "typing serum".							
C	M1054	6/3/37	6/37, Baltimore, Maryland	City Health Dept., Baltimore, Maryland	Spinal fluid	"S-3766-S"	A "runner-up" for neotype of Group C.
The original "II <u>alpha</u> ", studied in NIH Laboratories (1942).							
C	M1166	3/4/40	3/40, Buffalo, New York	Miss Sophia Cohen, N. Y. State Dept. of Health Lab., Albany	Spinal fluid	"No. 3855"	A "runner-up" for neotype of Group C.
The first strain of this group to be reported in the USA. Described by Cohen, 1940.							
C	M1170	3/21/40	3/40, Syracuse, New York	Dr. A. C. Harris, Department of Health	Spinal fluid	"Patient David Essig"	A narrow strain.
This strain is typical of a tight little group within the broad Group C. Has characteristic serologic pattern. Is useful in clarifying obscure relationships in Group C.							
C	M1375	4/10/42	4/42, Boston, Mass.	Thorndyke Labs., Boston, Mass.	Spinal fluid	"Lawrence"	A broad strain.
Typical of the "II alpha" strains found during World War II.							
C	M1875	6/4/43	6/43, Camp Blanding, Florida	Army Medical School Washington, D. C.	Blood	"Norman Prague, No. 6106"	An example of strains of this group found in World War II.

Serogroups and Strains of *Neisseria meningitidis* and of *N. flavescens* Con't.

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Serogroups and Strains of Neisseria meningitidis and of N. flavescens Con't.

Serogroup	Strain number	Date received at NIH	Date and place isolated	Received from	Source	Labelled	Comment
	N155	6/11/28	6/28, Chicago, Ill.	Chicago Dept. of Health	Spinal fluid	34A	<u>Neisseria flavescens</u>
This is the actual type strain of <u>N. flavescens</u> n. sp., found in the spinal fluid of 28 cases of meningitis in Chicago during the widespread meningococcus epidemics of 1928-30. Reported 1930.							
	N156	6/11/28	6/28, Chicago, Ill.	Chicago Dept. of Health	Spinal fluid	35A	<u>Neisseria flavescens</u>
Similar to the type strain, N155, and with same history.							
	N157	8/15/28	8/28, Chicago, Ill.	Chicago Dept. of Health	Spinal fluid	36A	<u>Neisseria flavescens</u>
Similar to the type strain, N155, and with same history.							
	N159	8/15/28	8/28, Chicago, Ill.	Chicago Dept. of Health	Spinal fluid	38A	<u>Neisseria flavescens</u>
Similar to the type strain, N155, and with a similar history.							
	N204	3/28/29	3/29, Chicago, Ill.	Chicago Dept. of Health	Spinal fluid	41A	<u>Neisseria flavescens</u>
	N208	3/22/29	3/29, Chicago, Ill.	Chicago Dept. of Health	Spinal fluid	48A	<u>Neisseria flavescens</u>

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REFERENCES

- Branham, Sara E. A new meningococcus-like organism (*Neisseria flavescens*, n. sp.) from epidemic meningitis. Pub. Health Reports 45:845-849. 1930.
- Branham, Sara E., and Margaret Pittman. A recommended procedure for the mouse protection test in evaluation of antimeningococcus serum. Pub. Health Reports 55:2340-2346. 1940.
- Branham, Sara E., and Sadie A. Carlin. Comments on a newly recognized group of the meningococcus. Proc. Soc. Expt. Biol. and Med. 49:141-144. 1942.
- Branham, Sara E. Serological relationships among meningococci. Bact. Revs. 17:175-188. 1953.
- Branham, Sara E. and M.J. Pelczar. in: Bergey's Manual of Determinative Bacteriology, The Williams and Wilkins Company, Baltimore. 7th Edition. pp. 480-490. 1957.
- Cohen, Sophia M. Serologic and immunologic studies of Group II meningococcus strains. Jour. Infect. Dis. 67:74-79. 1940.
- Dopter, Ch. Étude de quelque germes isolés du rhinopharynx voisins du méningocoque (paraméningocoques). Compt. rend. soc. biol. 67:74-76. 1909.
- Evans, Alice C. II. The tropin reactions of antimeningococcus serum. Hygienic Lab. Bull., No. 124, 43-87. 1920.
- Gordon, M. H., and E. G. D. Murray. Identification of the meningococcus. Jour. Roy. Army Med. Corps 25:411-423. 1915.
- International Bacteriological Code of Nomenclature. Jour. Bact. 55:287-306. 1948.
- Jyssum, Kaare. Serologic relationship of meningococci in Norway. Jour. Immunol. 76:433-440. 1956.
- Nicollé, M., E. Debains and C. Jouan. Études sur les méningocoques et los serums antiméningococciques. Ann. Inst. Pasteur 32:150-169. 1918.
- Pittman, Margaret, Sara E. Branham and Elsie M. Sockrider. A comparison of the precipitation reaction in immune serum agar plates with the protection of mice by antimeningococcus serum. Pub. Health Reports 53:1400-1408. 1938.
- Report of the Subcommittee on the family Neisseriaceae. Internatl. Bull. Bact. Nomen. and Tax. 4:95-105. 1954.
- Wollstein, Martha. Parameningococcus and its antiserum. Jour. Expt. Med. 20:201-217. 1914.