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APS MEMBERSHIP STATUS

SEPTEMBER 1967

Active Members	2869
Retired Members	168
Honorary Members	18
Associate Members	218
	3273

DECEASED MEMBERS

The following deaths were reported since the 1967 Spring Meeting.

Aaron Arkin - 11/1/66	Gregory Pincus - 8/22/67
Edgar C. Black - 3/11/67	George B. Roth - 5/23/67
Peter Heinbecker - 5/22/67	Douglas E. Smith - 8/28/66
Leslie G. Kilborn - 6/23/67	Samuel A. Talbot - 2/20/67

NEWLY ELECTED MEMBERS

The following, nominated by the Council, were elected to membership in the American Physiological Society at the Fall Meeting, 1967.

FULL MEMBERS

ABBRECHT, Peter H.: Asst. Prof. Physiol., Univ. of Michigan
 ABDEL-LATIF, Ata A.: Dept. Biochem., Med. Coll. of Georgia
 AFONSO, Skoda A.: Asst. Prof. Med. & Physiol., Univ. of Wisconsin
 ATWOOD, Harold L.: Asst. Prof. Zool., Univ. of Toronto
 AVERILL, Robert L.W.: Asst. Prof. Physiol. & Biophys., Univ. Tennessee
 AVIOLI, Louis V.: Asst. Prof. Med., Washington Univ.
 BALAGURA, Sulamita: Asst. Prof. Physiol., Cornell Univ. Med. Coll.
 BALOURDAS, Theodore A.: Asst. Prof. Pharmacol., Howard Univ.
 BENDIXEN, Henrik H.: Anesthesiol. & Exec. Officer, Mass. Gen. Hosp.
 BESCH, Paige K.: Assoc. Prof. Obstet.-Gyn., Ohio State Univ. Coll. Med.
 BIGNALL, Keith E.: Asst. Prof. Physiol., Univ. of Rochester
 BISHOP, Jonathan S.: Res. Fellow, USPHS, Biochem., Univ. of Minnesota
 BISHOP, Vernon S.: Chief, Weightlessness Sect., USAF Sch. Aerospace Med., Texas
 BLAUSTEIN, Mordecai P.: NIH Postdoct. Fellow, Physiol., Cambridge England
 BLOOR, Colin M.: Res. Internist, C.V. Diseases, Walter Reed Army Med. Inst.
 BOND, Robert F.: Instr. Physiol., Bowman Gray Sch. of Med.
 BROWN, Henry: Cl. Assoc. in Surg., Harvard Med. Sch.
 BROWN, Joel E.: Asst. Prof. Physiol., Mass. Inst. of Technology
 CALARESU, Franco R.: Asst. Prof. Physiol., Univ. of Alberta
 CALLANTINE, Merritt R.: Head, Sect. Endocrinol., Parke, Davis Res. Labs.
 CARREGAL, Enrique J. A.: Assoc. Prof. Physiol., Univ. Southern Calif.

- CASEY, Kenneth L.: Asst. Prof. Physiol., Univ. of Michigan
 CHAVIN, Walter: Prof. of Biology, Wayne State Univ.
 CHOWDHURY, Tushar K.: Asst. Prof. Physiol., George Washington Univ.
 CIVAN, Mortimer M.: Instr. Med., Harvard Med. School
 CLIFTON, James A.: Prof. Int. Med., Univ. of Iowa Hosps.
 CONSTANTINE, Jay W.: Supvr. Pharmacol., Chas. Pfizer & Co., Inc.
 CONTE, Frank P.: Assoc. Prof. Rad. Biol., Oregon State Univ.
 COOPER, George W.: Asst. Prof. Biol., The City College, N. Y.
 COVELL, James W.: Sr. Invest. Cardiol. Br., NHI, NIH
 CRITZ, Jerry B.: Assoc. Prof. Physiol., Univ. of South Dakota
 DANTZLER, William H.: Asst. Prof. Pharmacol., Columbia Univ.
 DAVIS, Warren W.: Cl. Endocrinol. Br., NHI, NIH
 DELLENBACK, Robert J.: Asst. Prof. Physiol., Columbia Univ.
 DEWS, Peter B.: Prof. Psychol. & Psychobiol., Harvard Med. Sch.
 DIANA, John N.: Asst. Prof. Physiol., Michigan State Univ.
 DiPASQUALE, Gene: Sr. Scientist, Warner-Lambert Res. Inst.
 DIRKS, John H.: Asst. Prof. Med., Royal Victoria Hosp., Montreal
 DUBNER, Ronald: Sr. Invest., Natl. Inst. Dental Res., NIH
 DUKELOW, W. Richard: Oregon Regional Res. Ctr., Beaverton, Ore.
 EISENBERG, M. Michael: Dept. Surg., Univ. of Florida Coll. Med.
 EISINGER, Robert P.: Chief, Nephrology Sect., VA Hosp., New York
 ELDRIDGE, Frederic L.: Assoc. Prof. Med., Stanford Med. Ctr.
 EPSTEIN, Robert M.: Assoc. Prof. Anesthesiol., Columbia Univ.
 FAIRHURST, Alan S.: Assoc. Res. Pharmacologist, UCLA Ctr. for Health Sciences
 FAM, Wadie M.: Res. Assoc., Cardiology Dept., Royal Victoria Hosp.
 FEIR, Dorothy J.: Assoc. Prof. Biol., St. Louis Univ.
 FILKINS, James P.: Asst. Prof. Physiol. & Biophys., Univ. Tennessee
 FISHER, Vincent J.: Asst. Prof. Physiol., State Univ. New York, Downstate Med. Ctr.
 FOREMAN, Charles W.: Prof. Biol., Univ. of the South, Sewanee, Tenn.
 FOZZARD, Harry A.: Assoc. Prof. Med., Univ. of Chicago
 FREEDMAN, Henry H.: Sr. Res. Assoc., Warner-Lambert Res. Inst.
 FREEMAN, Alan R.: Asst. Prof. Physiol., Rutgers Med. Sch.
 FRIED, George H.: Asst. Prof. Biol., Brooklyn College
 FRONEK, Kitty: Res. Assoc., Temple Univ. Med. Ctr.
 GILL, John R., Jr.: Sr. Invest., Natl. Heart Inst., NIH
 GOLD, Martin: Res. Asst. Prof. Physiol., Hahnemann Med. Coll.
 GOLDBERG, Alan H.: School of Med., Boston Univ.
 GOODMAN, A. David: Assoc. Prof. Med., Albany Med. Coll.
 GOODRIDGE, Alan G.: Asst. Prof. Physiol., Univ. of Kansas Med. Ctr.
 GRAZIADEI, Pasquale P. C.: Vis. Prof. Biol. Sci., Florida State Univ.
 GRIGGS, Douglas M. Jr.: Assoc. Prof. Med., Hahnemann Med. Coll.
 GRINNELL, Edward H.: Assoc. Prof. Physiol., Pharmacol., Creighton Univ.
 GROOM, Alan C.: Assoc. Prof. Biophys., Univ. of Western Ontario
 HACKNEY, Jack D.: Physiol.-Biophys. Lab., Asst. Prof., Loma Linda Univ.
 HAHN, Eric W.: Asst. Prof. Rad. Biol. & Biophys., Univ. of Rochester
 HAMPTON, James W.: Asst. Prof. Med., Univ. of Oklahoma Med. Ctr.
 HARRISON, Donald C.: Asst. Prof. Med., Stanford Univ. Sch. Med.
 HARRISON, Florence L.: Biologist, Lawrence Radiation Lab., Livermore

- HEFNER, Lloyd L.: Prof. Med., Univ. of Alabama Med. Ctr.
HENINGER, Richard W.: Assoc. Prof. Zool., Brigham Young Univ.
HERRERA, M. Guillermo: Asst. Prof. Med., Harvard Sch. Public Health
HIRSCH, Leroy J.: Res. Assoc. C.V. Inst., Michael Reese Hosp. & Med. Ctr.
HOFMANN, Alan F.: Assoc. Prof. Med., Univ. Minnesota
HORRES, Alan D.: Assoc. Prof. Physiol., Med. Coll. of South Carolina
JACOBS, Gerald H.: Asst. Prof. Psychol., Univ. of Texas, Austin
JORDAN, John P.: Assoc. Prof. Chem., Oklahoma City Univ.
KAHN, Samuel G.: Asst. Res. Supvr. Nutr. Res., Squibb Inst. Med. Res.
KATZ, Jay H.: Asst. Prof. Physiol., Tufts Med. School
KELLEY, Maurice L. Jr.: Assoc. Prof. Med., Univ. of Rochester
KIM, Kwang S.: Assoc. Res. Prof. Pharmacol., George Washington Univ.
KRATOCHVIL, Clyde H.: Cmdr., 6571st Aeromed. Res. Lab., Holloman AFB, New Mexico
LEHMANN, Dietrich: Sr. Res. Member, Inst. of Visual Sci., San Francisco
LEVINE, Leonard: Prof. Physiol., Pacific Univ., Forest Grove, Ore.
LLINAS, Rodolfo R.: Assoc. Member Inst. Biomed. Res., American Med. Assoc.
LORKOVIC, Hrvoje R.: Res. Fellow Physiol., Univ. of Minnesota
LOSITO, Raymond: Res. Assoc. Physiol. Chem., Mayo Clinic
MAST, Truman E.: Dept. Audiology, Eye & Ear Hosp., Pittsburgh
MAURO, Alexander: Assoc. Prof. Biophys., The Rockefeller Univ.
MELBY, James C.: Assoc. Prof. Med., Boston Univ.
MESSER, Joseph V.: Circulation Lab., Boston City Hosp.
MILHORN, Howard T. Jr.: Asst. Prof. Physiol. & Biophys., Univ. of Mississippi
MOODY, Frank G.: Assoc. Prof. Surg., Univ. of Alabama Med. Ctr.
MORTIMORE, Glenn E.: Sr. Invest., Cl. Endocrinol. Br., NIH
MURRAY, John F.: Assoc. Prof. Med., Staff Member, C.V. Res. Inst. Univ. of California, San Francisco
NAFTCHI, Nosrat E.: Res. Assoc. Med., Circulatory Physiol., Mt. Sinai Hosp., New York
NAUGHTON, John P.: Asst. Prof. Physiol.-Med., Univ. of Oklahoma Med. Ctr.
NEWTON, Joseph E. O.: Invest., Pavlovian Lab., Johns Hopkins Univ.
NDEN, Albert H.: Assoc. Prof. Med., Univ. of Chicago
PARER, Julian T.: Instr., Obstet. & Gyn., Univ. of Washington
PEAKALL, David B.: Res. Asst. Prof. Pharmacol., Upstate Med. Ctr. Syracuse
POOL, Peter E.: Res. Assoc. Cardiol. Br., NHI, NIH
POSNER, Jerome B.: Asst. Prof. Neurol., Cornell Univ. Med. Coll.
PRINCE, David A.: Dept. Med., Stanford Univ., Palo Alto
PRIVITERA, Carmelo: Assoc. Prof. Biol., State Univ. of N. Y., Buffalo
PROFFIT, William R.: Asst. Prof., Chrmn. Dept. Orthodontics, Univ. of Kentucky
PURPLE, Richard L.: Asst. Prof. Physiol., Univ. of Minnesota
RICHMAN, Harold G.: Instr. Med., C.V. Sect., VA Hosp., Minneapolis
ROSENBLUM, William I.: Res. Assoc., NINDB, NIH
ROSS, Gordon: Asst. Prof. Physiol., UCLA

- SACHS, George: Assoc. Prof. Physiol. & Med., Univ. of Alabama Med. Ctr.
- SARDESAI, Vishwanath M.: Asst. Prof. Surg., Wayne State Univ.
- SATO, Makoto: Asst. Prof. Neurosurg., Univ. of Oregon Med. Sch.
- SCHIFFER, Lewis M.: Assoc. Sci., Brookhaven National Lab.
- SCHREIBER, Sidney S.: Asst. Prof. Med., New York Univ. Sch. Med.
- SCHWARTZ, Manuel: Prof. & Head Engr. Physics, Univ. of Louisville
- SHAFFER, Aaron B.: Res. Assoc., C.V. Res. Inst., Michael Reese Hosp.
- SHAPIRO, William: Asst. Prof., Int. Med., Univ. of Texas, Dallas
- SHARPLESS, Seth K.: Assoc. Prof. Pharmacol., Albert Einstein Coll. Med.
- SMITH, Gerard P.: Asst. Prof. Physiol., Univ. of Pennsylvania
- STRAUSSER, Helen R.: Assoc. Prof. Physiol., Rutgers Univ.
- SWAN, Kenneth G.: Fellow in Surg., Cornell Univ. Med. Coll.
- TALBOT, William H.: Instr. Physiol., Johns Hopkins Univ.
- TUCKER, H. Allen: Asst. Prof. Dairy & Physiol. Depts., Michigan State Univ.
- USHIYAMA, Junji: Asst. Prof. Physiol., State Univ. of New York, Downstate Med. Ctr.
- van BEAUMONT, Karel W.: Res. Physiologist, Procter & Gamble Co.
- WATANABE, Yoshio: Res. Asst. Prof. Med., Hahnemann Med. Coll.
- WATSON, John F.: Asst. Prof. Med., State Univ. of N.Y., Buffalo
- WEBSTER, Paul D. III: Assoc. Med., Duke Univ.
- ZIEVE, Philip D.: Asst. Chief Med., Baltimore City Hosps.

ASSOCIATE MEMBERS

- BUERGER, Alfred A.: USPHS Trainee & Grad. Student, Cornell Univ.
- CALVIN, William H.: Res. Instr. Physiol. & Biophys., Univ. of Washington
- COMEAU, Roger W.: Instr. Physiol., State Univ. of N.Y., Buffalo
- EDELHAUSER, Henry F.: USPHS Postdoctoral Fellow, Physiol., Marquette Univ.
- FAULKNER, Lloyd C.: Animal Reproduction Lab., Colorado State Univ.
- GAREY, Walter F.: Physiol., Res. Lab., Scripps Inst. Oceanography, La Jolla, Calif.
- GIANNINA, Thomas: Assoc. Sci., Warner Lambert Res. Inst.
- JOHNSON, Leonard R.: Grad. Student, Physiol., Univ. of Michigan
- LACKEY, Gerald F.: Grad. Student, Physiol., Bowman Gray Sch. Med.
- LETO, Salvatore: Gerontology Res. Ctr., Baltimore City Hosps.
- McGINNIS, Charles H. Jr.: Res. Avian Physiologist, Hess & Clark, Ashland, Ohio
- MILLER, Josef M.: Res. Assoc., Kresge Hearing Res. Inst., Univ. of Michigan
- MUNSON, John B.: Res. Assoc., Univ. of Florida, Dept. Physiol.
- SCHAFER, James A.: Grad. Student Physiol., Univ. of Michigan
- SHIRLEY, Barbara A.: Asst. Prof. Zool., Univ. of Tulsa
- TANSEY, Martin F.: Asst. Prof., Chrmn. Physiol., Temple Univ.
- WATERS, Irving W.: Asst. Prof. Pharmacol., Univ. of Mississippi
- WEINER, Richard: Instr. Physiol., New York Med. Coll., N.Y.

THE AMERICAN PHYSIOLOGICAL SOCIETY

Founded December 30, 1887; Incorporated June 2, 1923

OFFICERS, 1967-1968

President - Robert W. Berliner, Intramural Research, National Heart Institute, NIH, Bethesda, Maryland 20014

President-Elect - Loren D. Carlson, University of California Medical School, Davis, California 95616

Past-President - Robert E. Forster, Graduate School of Medicine, University of Pennsylvania, Philadelphia, Pennsylvania 19104

Council - R. W. Berliner (1969), L. D. Carlson (1970), R. E. Forster (1968), H. D. Patton (1971), J. R. Brobeck (1970), C. L. Prosser (1969), J. D. Hardy (1968)

Executive Secretary-Treasurer - Ray G. Daggs, 9650 Rockville Pike, Bethesda, Maryland 20014

STANDING COMMITTEES

Publications - A. C. Barger (1969), Chairman; D. S. Fredrickson (1969), Jere Mead (1968). Ex officio - J. R. Brobeck, Physiological Reviews; J. M. Brookhart, Journal of Neurophysiology; A. P. Fishman, Handbooks; R. G. Daggs, Executive Secretary-Treasurer; Sara F. Leslie, Publications Manager and Executive Editor

Finance - J. M. Brookhart (1970), Chairman; E. E. Selkurt (1969), R. M. Berne (1968). Ex officio - R. G. Daggs, Executive Secretary-Treasurer; W. A. Sonnenberg, Business Manager

Education - A. C. Guyton (1970), Chairman; W. C. Randall (1970), J. F. Stevenson (1970), L. H. Marshall (1969), E. W. Hawthorne (1969), D. K. Detweiler (1968); Representatives from the Society of General Physiologists - I. J. Deyrup-Olsen (1970), J. W. Green (1970); Representatives from the Comparative Physiology Division of the American Society of Zoologists - G. C. Stephens (1969), I. J. Deyrup-Olsen (1968); R. G. Daggs, Executive Director of Education Programs

Membership Advisory - D. F. Bohr (1969), Chairman; Carlos Eyzaguirre (1970), G. F. Cahill (1970), I. S. Edelman (1970), W. B. Kinter (1968), A. B. Otis (1968)

Program Advisory - A. P. Fishman (1968), Chairman; Neena B. Schwartz (1970), S. B. Barker (1969).

Public Affairs - V. B. Mountcastle (1970), Chairman; R. K. Crane (1970), B. F. Hoffman (1970)

Senior Physiologists - D. B. Dill (1968), Chairman; Hallowell Davis (1969), E. M. Landis (1968), H. E. Essex (1969)

International Physiology - M. B. Visscher (1971), Chairman; L. D. Carlson (1973), R. E. Forster (1972), J. M. Brookhart (1969)

Legal Counsel - W. H. Pattison, Jr.

REPRESENTATIVES TO OTHER ORGANIZATIONS

Federation Board - L. D. Carlson (1970), R. W. Berliner (1969), R. E. Forster (1968)

Federation Executive Committee - L. D. Carlson (1970)
Federation Public Affairs Committee - V. B. Mountcastle (1970)
Federation Public Information Committee - C. S. Tidball (1970)
Federation Proceedings Editorial Committee - J. H. Comroe, Jr. (1970)
American Association for the Advancement of Science - W. G. Van der Kloot (1970), R. G. Daggs
American Institute of Biological Sciences - A. W. Martin (1969)
U.S. National Committee for International Union of Physiological Sciences - L. D. Carlson (1973), R. E. Forster (1972), M. B. Visscher (1971), J. M. Brookhart (1969)
U.S. National Committee for International Union of Biological Sciences - Ernst Knobil (1973)
U.S. National Committee for International Union of Pure and Applied Biophysics - A. P. Gagge (1973)
U.S. National Committee for Engineering in Medicine and Biology - J. W. Moore (1969)
National Research Council, Division of Biology and Agriculture - D. K. Detweiler (1970); Division of Medical Sciences - N. W. Shock (1970)
American Documentation Institute - S. F. Leslie (1970)
Council on Medical Education and Hospitals of the AMA - D. C. Tosteson (1970)
National Society for Medical Research - B. J. Cohen (1970)

PUBLICATIONS

Publications Committee - A. C. Barger (1969), Chairman; D. S. Fredrickson (1969), Jere Mead (1968)
Publications Manager and Executive Editor - Sara F. Leslie
Journal of Neurophysiology - J. M. Brookhart, Chief Editor
Physiological Reviews - J. R. Brobeck, Chairman Editorial Board; R. G. Daggs, Associate Editor
The Physiologist - R. G. Daggs, Editor

EDITORIAL BOARDS

American Journal of Physiology and Journal of Applied Physiology
Section Editors - Philip Dow, Theodore Cooper (Circulation); A. B. DuBois, J. W. Severinghaus (Respiration); Jack Orloff (Renal and Electrolyte Physiology); O. D. Ratnoff (Hematology); Eugene Grim (Gastrointestinal Physiology); B. R. Landau, R. O. Scow (Endocrinology and Metabolism); J. D. Hardy (Environmental Physiology); A. W. Martin (Comparative and General Physiology); D. P. Purpura (Neurophysiology)

Editors - Mary E. Avery (1969), C. H. Baker (1969), Bruno Balke (1970), D. E. Bass (1970), D. F. Bohr (1969), Arend Bouhuys (1969), Eugene Braunwald (1970), F. P. Brooks (1968), R. W. Bullard (1970), E. R. Buskirk (1970), C. R. Collier (1968), P. F. Curran (1969), J. O. Davis (1969), R. P. Durbin (1970), R. W. Eckstein (1969), Sydney Ellis (1969), L. E. Farhi (1970), A. P. Gagge (1969), G. H. Giebisch (1968), J. P. Gilmore (1969), F. J. Haddy (1969), R. J. Havel (1970), E. W. Hawthorne (1969), W. N. Holmes (1969), T. F. Hornbein (1970), S. M. Horvath (1970), R. E. Hyatt (1968), P. C. Johnson (1970), A. M. Katz (1968), Frederic Kavalier (1970), D. L. Kline (1970), J. L. Kostyo

- (1970), E. H. Lambert (1968), F. N. LeBaron (1968), D. H. K. Lee (1970), N. G. Levinsky (1968), M. N. Levy (1970), Nathan Lifson (1969), L. S. Lilienfeld (1968), P. T. Macklem (1969), R. L. Malvin (1969), M. B. McIlroy (1969), R. A. Mitchell (1969), H. E. Morgan (1970), Q. R. Murphy (1969), J. A. Nadel (1969), Simon Ostrach (1970), J. R. Pappenheimer (1970), Solbert Permutt (1968), C. L. Prosser (1969), E. P. Radford (1970), W. C. Randall (1970), D. W. Rennie (1970), John Ross, Jr. (1970), Aser Rothstein (1968), G. C. Salmoiraghi (1968), G. M. Schoepfle (1968), J. T. Shepherd (1969), R. A. Shipley (1970), William Sleator, Jr (1969), R. E. Smith (1968), N. C. Staub (1970), Robert Steele (1970), J. A. J. Stolwijk (1969), S. M. Tenney (1968), Jay Tepperman (1968), C. S. Tidball (1969), D. F. Tierney (1969), D. C. Van Dyke (1970), H. D. Van Liew (1969), A. G. Wallace (1969), W. H. Waugh (1969), J. W. Weinberg (1970), L. G. Welt (1970)
- Physiological Reviews - J. R. Brobeck (1969), Chairman; V. E. Amassian (1969), J. A. Clements (1969), J. C. Eccles (1969), C. W. Gottschalk (1969), R. C. Swan (1969), J. W. Woodbury (1969). Appointed from the Society of General Physiologists - H. N. Eisen (1969), A. G. Szent-Gyorgyi (1968). Appointed from the American Society of Biological Chemists - J. M. Buchanan (1968), R. H. Burris (1969). Appointed from the American Institute of Nutrition - F. J. Stare (1970).
- European Editorial Committee - Eric Neil, Chairman; Bengt Andersson, Pierre Dejours, R. B. Fisher, J. N. Hunt, Hans Schaefer.
- Journal of Neurophysiology - J. M. Brookhart, Chief Editor; I. T. Diamond, Elwood Henneman, D. H. Hubel, C. C. Hunt, Bernard Katz, Donald Kennedy, Anders Lundberg, V. B. Mountcastle, J. E. Rose.
- Handbook of Physiology, Editorial Committee - A. P. Fishman (1972), Chairman; J. M. Brookhart (1970), G. F. Cahill, Jr. (1971), L. D. Carlson (1970), C. L. Prosser (1970).

PAST OFFICERS

- Presidents - 1888 H. P. Bowditch. 1889-1890 S. W. Mitchell. 1891-1895 H. P. Bowditch. 1896-1904 R. H. Chittenden. 1905-1910 W. H. Howell. 1911-1913 S. J. Meltzer. 1914-1916 W. B. Cannon. 1917-1918 F. S. Lee. 1919-1920 W. P. Lombard. 1921-1922 J. J. R. MacLeod. 1923-1925 A. J. Carlson. 1926-1929 Joseph Erlanger. 1930-1932 W. J. Meek. 1933-1934 A. B. Luckhardt. 1935 C. W. Greene. 1936-1937 F. C. Mann. 1938-1939 W. E. Garrey. 1938 W. T. Porter Honorary President. 1940-1941 A. C. Ivy. 1942-1945 Philip Bard. 1946-1947 W. O. Fenn. 1948 M. B. Visscher. 1949 C. J. Wiggers. 1950 H. C. Bazett (April to July); D. B. Dill. 1951 R. W. Gerard. 1952 E. M. Landis. 1953 E. F. Adolph. 1954 H. E. Essex. 1955 W. F. Hamilton. 1956 A. C. Burton. 1957 L. N. Katz. 1958 Hallowell Davis. 1959 R. F. Pitts. 1960 J. H. Comroe, Jr. 1961 H. W. Davenport. 1962 H. S. Mayerson. 1963 Hermann Rahn. 1964 J. R. Pappenheimer. 1965 J. M. Brookhart. 1966 R. E. Forster.
- Secretaries - 1888-1892 H. N. Martin. 1893-1894 W. P. Lombard. 1895-1903 F. S. Lee. 1904 W. T. Porter. 1905-1907 L. B. Mendel. 1908-1909 Reid Hunt. 1910-1914 A. J. Carlson. 1915-1923 C. W. Greene. 1924-1929 W. J. Meek. 1930 A. C. Redfield. 1931-1932 A. B. Luckhardt. 1933-1935 F. C. Mann. 1936-1939 A. C. Ivy. 1940-1941 Philip Bard.

1942 C. J. Wiggers. 1943-1946 W. O. Fenn. 1947 M. B. Visscher.
Treasurers - 1888-1892 H. N. Martin. 1893-1894 W. P. Lombard.
1895-1903 F. S. Lee. 1904 W. T. Porter. 1905-1912 W. B. Cannon.
1913-1923 Joseph Erlanger. 1924-1926 C. K. Drinker. 1927-1936
Alexander Forbes. 1937-1940 W. O. Fenn. 1941 C. J. Wiggers.
1942-1946 Hallowell Davis. 1947 D. B. Dill.
Executive Secretary-Treasurer - 1948-1956 M. O. Lee. 1956 -R. G.
Daggs.

CONSTITUTION AND BYLAWS

CONSTITUTION

(Adopted at the 1953 Spring Meeting)

ARTICLE I. Name

The name of this organization is THE AMERICAN PHYSIOLOGICAL SOCIETY.

ARTICLE II. Purpose

The purpose of the Society is to promote the increase of physiological knowledge and its utilization.

BYLAWS

(Amended April 1966)

ARTICLE I. Principal Office

SECTION 1. The Society shall have its principal place of business at 9650 Rockville Pike, Bethesda, Maryland 20014. The Central Office shall house all activities delegated to the employees of the Society.

ARTICLE II. Corporate Seal

SECTION 1. The corporate seal of the Society shall be a circle surrounded by the words, THE AMERICAN PHYSIOLOGICAL SOCIETY. The seal shall also show the founding date and the date and place of incorporation.

SECTION 2. The Executive Secretary-Treasurer shall have custody of the seal. It shall be used on all official documents requiring it, and shall be placed on the documents by the Executive Secretary-Treasurer upon approval by Council.

ARTICLE III. Membership

SECTION 1. The Society shall consist of regular members, honorary members, associate members, retired members and sustaining associates.

SECTION 2. Regular Members. Any person who as conducted and published meritorious original research in physiology, who is presently engaged in physiological work, and who is a resident of North America

shall be eligible for proposal for regular membership in the Society.

SECTION 3. Honorary Members. Distinguished scientists of any country who have contributed to the advance of physiology shall be eligible for proposal as honorary members of the Society.

SECTION 4. Associate Members. Advanced graduate students in physiology at a predoctoral level, teachers of physiology, and investigators who have not yet had the opportunity or time to satisfy the requirements for regular membership shall be eligible for proposal for associate membership in the Society provided they are residents of North America. Associate members may later be proposed for regular membership.

SECTION 5. Retired Members. A regular or associate member who has reached the age of 65 years and/or is retired from regular employment may, upon application to Council be granted retired member status.

SECTION 6. Sustaining Associates. Individuals and organizations who have an interest in the advancement of biological investigation may be invited by the President, with approval of Council, to become sustaining associates.

SECTION 7. Nominations for Membership. Two regular members of the Society must join in proposing a person for regular membership, honorary membership or associate membership, in writing and on forms provided by the Executive Secretary-Treasurer. The Membership Committee shall investigate their qualifications and recommend nominations to Council. Council shall nominate members for election at the Spring and Fall meetings of the Society. A list of nominees shall be sent to each regular member at least one month before the Spring and Fall meetings.

SECTION 8. Election of Members. Election of regular members, honorary members and associate members shall be by secret ballot at Spring and Fall business meetings of the Society. A two-thirds majority vote of the members present and voting shall be necessary for election.

SECTION 9. Voting. Only regular members shall be voting members. Honorary, retired and associate members shall have the privilege of attending business meetings of the Society but shall have no vote.

ARTICLE IV. Officers

SECTION 1. Council. The management of the Society shall be vested in a Council consisting of the President, the President-Elect, the immediate Past-President, and four other regular members. The terms of the President and of President-Elect shall be one year. The terms of the four additional Councilors shall be four years each and they shall not be eligible for immediate reelection except those who have served for two years or less in filling interim vacancies.

A quorum for conducting official business of the Society shall be five of the seven elected members of Council.

The Chairman of the Publications Committee; the Chairman of the Finance Committee; and the Executive Secretary-Treasurer are ex-officio members of the Council without vote. The Council may fill any interim vacancies in its membership. Council shall appoint members to all committees.

SECTION 2. President. A person shall serve only one term as President, except that if the President-Elect becomes President after September 30 he shall continue as President for the year beginning the next July 1. The President shall chair all sessions of the Council and business meetings of the Society and shall be an ex officio member of all committees without vote.

SECTION 3. President-Elect. The President-Elect shall serve as Vice-President of the Society and as official secretary of the Council. Should he have to function as President prematurely, the Council shall select from among its own members an official secretary.

SECTION 4. Election of Officers. Nominations and election of a President-Elect and Councilor(s) shall be by secret ballot at the Spring business meeting of the Society. They shall assume office on July 1 following their election.

SECTION 5. Executive Secretary-Treasurer. The Council shall be empowered to appoint and compensate an Executive Secretary-Treasurer who shall assist it in carrying on the functions of the Society including the receipt and disbursement of funds under the direction of the Council. He shall be responsible for management of the Central Office of the Society under general supervision of the Council.

ARTICLE V. Standing Committees

SECTION 1. Publications Committee. A Publications Committee composed of three regular members of the Society appointed by Council shall be responsible for the management of all of the publications of the Society. The term of each member of the Publications Committee shall be three years; a member may not serve more than two consecutive terms. The Council shall designate the Chairman of the Committee who shall be an ex officio member of the Council, without vote. Council is empowered to appoint and compensate a Publications Manager who shall assist in carrying out the functions of the Publications Committee under the supervision of the Executive Secretary-Treasurer. The President, Executive Secretary-Treasurer and the Publications Manager shall be ex officio members of the Publications Committee without vote. The Committee shall have the power to appoint editorial boards for the Society's publications. The Committee shall present an annual report on publications and policies to the Council for approval and present an annual budget coordinated through the Executive Secretary-Treasurer, to the Finance Committee for its approval and recommendation to Council.

SECTION 2. Finance Committee. A Finance Committee, composed of three regular members of the Society appointed by Council, shall receive the total coordinated budget proposals annually from the Executive Secretary-Treasurer and shall determine the annual budgets, reserve funds and investments of the Society, subject to approval by the Council. The term of each member of the Finance Committee shall be three years, a member may not serve more than two consecutive terms. The Council shall designate the Chairman of the Committee who shall be an ex officio member of the Council, without vote. Council is empowered to appoint and compensate a Business Manager who shall assist in carrying out the functions of the Finance Committee under the supervision of the Executive Secretary-Treasurer. The President-Elect, Executive Secretary-Treas-

urer and the Business Manager shall be ex officio members of the Finance Committee, without vote.

SECTION 3. Membership Committee. A Membership Committee, composed of six or more regular members of the Society appointed by the Council, shall receive and review processed applications for membership and make recommendations for nomination to the Council. The term of each member of the Membership Committee shall be three years; a member shall not be eligible for immediate reappointment. The Chairman of the Committee shall be designated by the Council.

SECTION 4. Education Committee. An Education Committee, composed of five or more regular members of the Society and representatives of such other societies as may be designated by the Council appointed by the Council, shall conduct such educational, teaching and recruitment programs as may be required or deemed advisable. The term of each member of the Education Committee shall be three years. The Chairman of the Committee shall be designated by the Council. The Executive Secretary-Treasurer may act as Executive Director of the educational programs with approval of the Council. The Committee shall present an annual report to the Council and an annual budget through the Executive Secretary-Treasurer to the Finance Committee for its approval.

SECTION 5. The Council may appoint such special and other standing committees as it deems necessary or that are voted by the Society. The Council may name regular members of the Society as representatives to other organizations whenever it deems such action desirable.

ARTICLE VI. Dues

SECTION 1. Annual Dues. The annual dues for regular members and associate members shall be determined by the Council and shall be paid in advance of July 1. Honorary members and retired members shall pay no membership dues.

SECTION 2. Non-payment of dues. A regular or associate member whose dues are two years in arrears shall cease to be a member of the Society, unless after payment of his dues in arrears and application to the Council, he shall be reinstated at the next meeting by vote of the Council. It shall be the duty of the President-Elect to notify the delinquent of his right to request reinstatement.

SECTION 3. Retirement. A regular or associate member who has been granted retired membership status is relieved from the payment of dues but retains the other privileges of his former membership status, except voting privileges.

ARTICLE VII. Financial

SECTION 1. Society Operating Fund. The Society Operating Fund shall consist of all funds, other than Publication Operating Funds and Publication Contingency and Reserve Funds, restricted or unrestricted, uninvested or invested, short or long term. The Executive Secretary-Treasurer shall be the responsible agent to the Council with signatory powers. Signatory powers may be delegated to the Business Manager by the Executive Secretary-Treasurer.

SECTION 2. Publications Operating Fund. The Publications Operating Fund shall consist of all funds that involve receipts, expenses,

short-term investments relating to the annual receipts, disbursements and continuing operation of the Society's publications. The Executive Secretary-Treasurer shall be the responsible agent to the Council with signatory powers. Signatory powers may be delegated to the Publication Manager and/or the Business Manager by the Executive Secretary-Treasurer.

SECTION 3. Publications Contingency and Reserve Fund. The Publications Contingency and Reserve Fund shall consist of the long-term capital investments of publication earnings. The Executive Secretary-Treasurer, with advice from the Finance Committee, shall have discretionary and signatory powers, except for withdrawals. Authority for any withdrawal from this fund, shall require the following five signatures: 1) the Chairman of the Publications Committee (alternate, the senior member of the Committee); 2) the President of the Society (alternate, the President-Elect); 3) the Executive Secretary-Treasurer (alternate, the Publications Manager); 4) and 5) any two members of Council. The Finance Committee shall not recommend to Council the expenditure of any of this capital fund for non-publication purposes without the consent of the Publications Committee. The Finance Committee shall be responsible for the separate investment of the reserve fund for publications; any capital gains from such investment shall accrue to the fund (capital losses will, however, reduce its value). Any dividends, interest or income, other than capital gains, from this invested fund may be used for emergency support of any of the activities of the Society, including publications, as determined annually by the Council but the primary goal shall be to increase the investment capital.

SECTION 4. Fiscal Year. The official fiscal year shall be from January 1 through December 31.

SECTION 5. Audit. All statements of net assets and related statements of income, expenditures and fund capital shall be audited annually by an independent auditing firm.

SECTION 6. Bonding. All persons having signatory powers for the funds of the Society shall be bonded.

ARTICLE VIII. Publications

SECTION 1. The official organs of the Society shall be the American Journal of Physiology, the Journal of Applied Physiology, Physiological Reviews, the Journal of Neurophysiology, The Physiologist, and such other publications as the Society may own. All publications shall be under the jurisdiction and management of the Publications Committee unless otherwise designated by the Council. The names of the journals and publications may be changed by the Council on recommendation from the Publications Committee and any publication may be dropped by Council on recommendation from the Publications Committee.

ARTICLE IX. Meetings

SECTION 1. Spring Meeting. A meeting of the Society for transacting business, electing officers and members, presenting communications, and related activities, shall ordinarily be held in the Spring of each year.

SECTION 2. Fall Meeting. A Fall meeting of the Society shall be held at a time and place determined by the Council for presenting communica-

tions, electing members, and for transacting business except for the election of officers and adoption of amendments to the Bylaws. Under exceptional circumstances Council may cancel such a meeting.

SECTION 3. Special Meetings. Special meetings of the Society or of the Council may be held at such times and places as the Council may determine.

SECTION 4. Quorum. At all business meetings of the Society fifty regular members shall constitute a quorum.

SECTION 5. Parliamentary Authority. The rules contained in Roberts Rules of Order, Revised shall govern the conduct of the business meetings of the Society in all cases to which they are applicable and in which they are not inconsistent with the Bylaws or special rules of order of the Society.

ARTICLE X. Society Affiliations

SECTION 1. The Society shall maintain membership in such organizations as determined by Council.

ARTICLE XI. Regulations

SECTION 1. General Prohibitions. Notwithstanding any provision of the Constitution or Bylaws which might be susceptible to contrary interpretation:

- a. The Society is organized and operated exclusively for scientific and educational purposes.
- b. No part of the net earnings of the Society shall or may under any circumstances inure to the benefit of any member or individuals.
- c. No substantial part of the activities of the Society shall consist of carrying on propaganda, or otherwise attempt to influence local, state or national legislation. (All activities of the Society shall be determined by Council). The Society shall not participate in, or intervene in (including the publishing or distributing of statements) any campaign on behalf of any candidate for public office.
- d. The Society shall not be organized or operated for profit.

SECTION 2. Distribution on Dissolution. Upon lawful dissolution of the Society and after payment of all just debts and obligations of the Society, Council shall distribute all remaining assets of the Society to one or more organizations selected by the Council which have been approved by the United States Internal Revenue Service as organizations formed and dedicated to exempt purposes.

ARTICLE XII. General

SECTION 1. Records. All official records, archives and historical material shall be held in the Central Office in the custody of the Executive Secretary-Treasurer.

SECTION 2. Procedures and Customs. The Society shall maintain

a current Operational Guide detailing the procedures and current customs of the Society operations as well as the duties and responsibilities of officers, committees, and major employees. The Operational Guide shall be maintained current by the Executive Secretary-Treasurer as determined by the Council.

ARTICLE XIII. Amendments

SECTION 1. Presentation. Amendments to these Bylaws may be proposed in writing, by any regular member, to Council at any time up to three months in advance of the Spring meeting, or at a business meeting of the Society. Such proposed amendments must be presented in writing at the following Spring business meeting for action by the Society.

SECTION 2. Adoption. These Bylaws may be amended at any Spring business meeting of the Society by a two-thirds majority vote of the regular members present and voting.

PAST-PRESIDENT'S ADDRESS

ROBERT E. FORSTER

PREJUDICES ON THE FUTURE OF PHYSIOLOGY

I start by expressing my deep appreciation for the honor bestowed on me by my election to the presidency of the American Physiological Society, although I point out in honesty that only 10% of the electorate were present, and that a large percentage of those were my friends. I believe I turned the Society over to my successor in as pristine and uncomplicated a state as that in which I received it. I would like to have established the Handbooks, but Dr. Visscher had already done so. The Publications Committee successfully prevented me from establishing several new journals, at great saving. The one thing that was accomplished in my administration, and about which I am most proud, and for which I have the least responsibility, is the establishment of the Porter Development Fund by Dr. Barger, Dr. Hawthorne and their committee. I would like to take this occasion to pay tribute to them.

I will address you tonight upon my prejudices about physiology. I will plagiarize outrageously without recognition, be more serious than many of my predecessors, and hopefully briefer. My brevity should be exceeded in the history of the society, only by that of my successor, Dr. Berliner, who will not talk at all. I shall also be pompous, as befits a past-president, and may retell you more about generalities in physiology than you want to know.

A concern of many members of the Society this last year has been the future of physiology. Changes in scientific knowledge have reduced the eminence of accustomed areas of physiology and attenuated its image in the eyes of our scientific colleagues. Administrative changes in universities have altered the status of departments of physiology. What does this portend for the science and our profession?

The name physiology comes from the Greek words, physis, meaning nature...the same root as for physics...and logos, knowledge or the study of. Originally physiology encompassed all nature, the moon, the seas and man. Physiology could have been considered the materialistic apposite of philosophy, which was more encompassing and not confined to matter. The term appears to have been used for the first time in the modern sense by Frenel in 1544 to replace the term he had used two years earlier, naturalis pars medicinae...natural or scientific part of medicine. The term still included the study of non-living matter, precious stones, in 1651. Two hundred years after its minting, it had come to stand for the study of living things, animal and plant. It was not limited to function, but also for example included anatomy, because in the initial approach to the study of living things one needed some knowledge of structure. You should remark that function was being sought, not structure. You do not need to know structure to apply a partial knowledge of function, as any lady can tell you about the automobile. History tells me that physiology came before anatomy. Only relatively recently has it been restricted to the function of living things.

In any discussion of the future of physiology we must distinguish between that body of human knowledge defined as the science of physiology on the one hand and the organization of the academic discipline and the profession on the other. I shall consider the future of the science first.

Physiology has always been in the main stream of human thought. Man has a selfish interest in knowing how his body functions for his health's sake, and how his environment lives in order to control it. One could develop an argument that physiology should be called Queen of the sciences and DuBois-Reymond said it was. There are indications that we are entering the decades of biological dominance, just as we have had decades of emphasis on the physical sciences. Problems of biological nature are coming into public prominence and their solutions are widely debated. Society will need physiological knowledge for its intrinsic worth and will certainly exert efforts to obtain it.

In the United States, there is an increasing demand for medical services and increasing governmental impetus toward the application of medical science in the care of the sick. This will be accompanied by an increased demand for physiological knowledge to support the burgeoning medical practice.

Therefore on at least these two counts the future of physiological science is as great as the material future of man.

The future of the profession and discipline is a less certain matter than that of the science. The strength of the discipline has resided in its encompassment of a broad study of the function of living things, which in reality includes much of what man wants to know about the material side of life. The survival of the discipline depends on the faithfulness of the physiologist to the study of life processes as a whole, and not just of the elements that go to make up living things, no matter how otherwise important, exciting or rewarding. The point may be made through over-emphasis that no physiologist should have for his ultimate goal...and I emphasize the word ultimate...the study of anything less than the smallest unit that includes all the functions of life, by definition today, the cell. We have reached the end of the road and can go no further. Heresy leads insidiously to the worship of false gods, devotion to the study of non-living matter, the application of favored techniques or the exposition of mental exercises. Be these accomplishments ever so important, they are not of the essence of physiology.

The history of physiology is a long story of shrinking boundaries and specialization. Once it had in its compass the stars; today if some had their way it would be retired to a musty museum of organ specimens. In the last fifty years disciplines representing pharmacology, experimental pathology, nutrition, general physiology, biochemistry, and biophysics have separated from the main trunk of physiology, apparently taking with them much that is new, exciting and spectacular. If this continues what will be left of physiology? Will it come to occupy a position in science analogous to that of philosophy? These branchings from parent physiology arose because a sufficient number of imaginative

scholars perceived the advantages of applying the fruits of other disciplines to the study of specific functions of living things in the physiologic tradition. But once separated the pride of the new discipline ruled out the study of function as a *raison d'être*. Its goals became in some measure less than the study of life.

A tenet of modern biology is that all phenomena of life can be explained by the laws of non-living matter. Logically therefore scientists could synthesize life from physics, or deduce physics from life. The physiologist, being more humble before nature believes that life is too complicated to analyze in the foreseeable future and that if we are not to lose our way, our aim should be clearly fixed upon the whole. The hubris of our colleagues causes them to put caution aside and all their faith in chemistry and physics. This reductionist approach has been attempted before and has its dangers, for, encouraged by Harvey's success with the circulation of the blood, two schools rose in the 17th century attempting to explain all living phenomena through physics and chemistry; the iatrophysical school led by Borelli (1608-1679) and the iatrochemical school led by Sylvius (de Le Boë 1614-1672). They made exaggerated claims but were unable to explain some phenomena of life, several of which are still beyond us today. A reaction set in and the vitalists arose, in all probability resulting in a net reduction in the rate of progress. The implications of the genetic code have not liquidated biology, to the contrary they appear to have exposed another echelon of the endless sophistication of living processes. I do not imply that all biological science should pay obeisance to physiology, but that the study of life is still life. Serendipity is incompatible with reductionism.

Eventually the prodigal children return to physiology for new stimulus in the study of living matter, as Antaeus had to touch the earth to recover his strength in wrestling Hercules. Anatomy early separated off into the study of structure alone. In the mid 19th century it was revived by physiological principles resulting in the development of functional anatomy. The first physiological institute was in Breslau, founded October, 1829, led by Purkinje and devoted to histology. Pathology, once limited to the description of the structural changes resulting from disease, was reborn with Virchow in pathological physiology. There are indications that other of our associate disciplines are returning for inspiration to the study of function and life. Let us be sure that physiology is still there to receive them, for lusty with post sputnik and broadly spread medical care funds, some of physiology's daughters are prepared to join in her partition, taking the popular cellular and general physiological segments for themselves, leaving organ physiology to the clinical departments, and neurophysiology as a citadel to be enveloped.

A major part of the troubles of physiology today is that of the medical school. Although over half of our membership is associated with medical schools and almost all receive support from funds which were originally provided for health research or education, I apologize to those of you who are not involved for the digression that follows.

Society requires physiology, but could provide for it in a number of

ways. In America it has been supported largely as part of medical education, presumably because law makers and philanthropists are more easily persuaded to part with their funds for personal and public health. This is a marriage of convenience but not of necessity.

A medical school must be the most complicated social structure of western civilization (at least in Philadelphia). It contains the elements of the profession of medicine, "hands", sometimes called a "trade", along with the scientific, academic aspects of the university, the "brains". In spite of changes in public image, the physician is still, next to the senator, the most prestigious figure in our society today according to a recent survey. A clinical faculty charged with the care of the sick combines a measure of prestige, appeal to humanitarian instincts and access to private and public resources that make them a formidable force in any educational institution, giving qualms to the administration of any university contemplating a medical school, and indigestion to any university that has one. The most successful medical schools have achieved a balance between hands and brains by creating their own basic medical science departments, dedicated to the scientific aspects of medicine, loyal to the medical school (from whence cometh their budgets), and sufficiently familiar with clinical medicine, that they are not awed by the trappings of the clinician and can effectively represent the more purely academic interests of the university in the arena of the medical school. If this equilibrium is disturbed, the medical school tends to become a trade school. This is obvious when the basic science departments are weak. What is not as apparent, is that the same may obtain when the basic science departments became too strong. In this case their more purely scientific interests strengthen their bonds with the departments of biology, chemistry and physics of the general university, which is good, but weakens their bonds and loyalties to the clinical departments, which is bad. Through their indifference, these clinical departments then acquire excessive influence in the medical school and it becomes a trade school. Two decades of generous support for research have encouraged the development of a significant number of faculty members who are neither interested in, nor loyal to, the teaching function of their institutions.

What has this to do with physiology?

The medical school physiology department occupies a position in the center of these interactions. It is the basic science department most closely related to medicine, on the other hand, cellular physiology is in the forefront of biology.

Bernard truly said "Physiology is the basis of all medicine." The medical school physiologist has on his left his colleagues in biochemistry, biophysics, molecular biology and microbiology who complain that he is old fashioned and should drop everything and follow DNA out of Hamelin with them. On his right there are continuous mutterings from the clinician that his teaching is not practical enough for the medical student. The most gentle wind of change in a medical school can be a hurricane in physiology. And the stresses are increasing. From the right, society is making more practical demands and placing more responsibility for medical care upon

the universities and medical schools. The stunning successes in chemistry and biology similarly are increasing the pressures from the left. In an effort to reduce the usual decade required for the gestation of a new medical school as well as to make better use of the limited number of trained faculty available, the traditional structure of the medical school, and even the necessity for a department of physiology, are being questioned. Numerous present day academic clinical faculty members are well founded in physiology and believe, often with justification, that they can teach and do research in physiology as well as some professional physiologists. Untried organizational structures are being established in medical schools, presumably attempts to balance the ancient influence of clinical faculty by raw administrative power. Nevertheless the physiology department, has been and for the useful future, will remain the intellectual corner stone of the academic medical school.

But all of physiology's troubles cannot be blamed on external forces. Some areas have not kept up with the times. Although there may be a body of information, such as that of classical organ physiology, that does not change rapidly, this does not excuse us from moving ahead in other directions. There has been a dearth of synthesizers, trying to tie our tedious facts into theories. The remedy is not to seek refuge in increased experimental sophistication but to ask more important questions.

The suggestion that physiology has become so ubiquitous one department cannot represent it, and that it should be turned over to the tender ministrations of other disciplines brings to mind the missionary, trekking through the veldt who found himself surrounded by a pride of lions. He fell to his knees and prayed for deliverance, opening his eyes to find the lions all kneeling with their heads in their paws. He thanked God loudly for his miraculous escape, at which point the largest lion opened his eyes and said "please be silent during grace."

We must heed the critiques of physiology implicit in recommendations for new faculty appointments in our universities. Although they may be prejudiced, short sighted or unfair, this mechanism for judgment of scholarship by scholars in other disciplines maintains the vigor of our institutions. We should seek to learn and to prove them wrong; not to ignore them.

What do I expect to happen and what should we as professional physiologists do about it?

I predict that professional physiology will fall upon hard times for a few years and then rise again, although its fortunes might be past the nadir now. The liquidation of intellectual crash programs will leave a surfeit of information to be synthesized.

The conflict between the profession and the academy is as old as medicine and physiology and will always be with us. The superior clinical teacher will learn that while he may know the physiology of today, his clinical students soon will require the physiology of tomorrow. However, we may expect increasingly the experimental establishment

of chairs in clinical physiology.

The demands of the public for increased medical care are forcing a more pragmatic appraisal of the resources allotted. The scientist no longer speaks to the public *ex-cathedra*. An increasing proportion of the funds granted will be to projects specifically related to medical problems, and for institutional grants which will strengthen the organization of the medical schools and increase support for certain areas of physiology. Those academic administrators who do not remember history will be condemned to repeat it, even back to before the Flexner report.

And we should remain dedicated to the true pursuit of physiology and not led aside by instruments, techniques or the fads of the purse holders. We should not be confined to a reservation for integrative control. There is much to be done in organ physiology, and we need not be ashamed of it. General and cellular physiology are of our own and we should claim them. A physiologist should be neither a servant of medicine nor vendor of scientific gadgets. Yet we should not hesitate to use the methods of any science, physics, chemistry, mathematics, fearing to become thereby any less a physiologist. We must remember the words of that silly old man whose tenure was terminated by a sword thrust through the arras; done in by a Dane, not a dean; "This above all, to thine ownself be true, and it must follow, as night the day, thou canst not then be false to any man."

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ABSTRACTS FOR 1968 SPRING MEETING

At the business meeting of April 20, 1967, Council was instructed to determine the number of 10-minute papers to be presented at the 1968 Spring meeting in Atlantic City and to devise a non-selective system for keeping the number of papers presented within that limit. Accordingly, the following system will be used:

The number of papers to be presented orally will be essentially the same as for 1967 (approximately 850). Each abstract will be given a number as it is received in the Central Office. To reduce the number to be presented orally to 850, every n^{th} paper will be excluded. No sponsored abstracts will be accepted. A person's name can appear on only one abstract. An APS regular, retired or honorary member must be one of the authors. Associate members, since they are not members of the Federation, are treated as non-members for the Spring meeting. Abstracts that are excluded by the above mentioned method will be printed in Federation Proceedings but will not appear on the program for oral presentation.

Members are also to note carefully the new Form A for submitting abstracts for the 1968 Spring meeting.

NEW REVISED LABORATORY EXPERIMENTS IN GENERAL PHYSIOLOGY

The original collection of experiments published several years ago under the auspices of the Education Committee of APS as part of its general program for furthering education in physiology at various levels has had a wide distribution. The extensive, international interest and use of the experiments indicates that one of the principal aims has been achieved - that of the stimulation of the use and development of current research materials in the teaching laboratory.

The present revised collection, although designed in part for the use of advanced undergraduate students, is planned to serve more as source material for the college instructor in general physiology. It is not a laboratory manual - rather it offers the instructor background material, exercises and references which it is hoped will provide basic material from which he can compose his own set of experiments.

The collection contains selected type experiments illustrating principles as well as techniques. Users are encouraged to duplicate, modify, or rewrite any of the experiments to make them suitable for their own use in point of emphasis, level of student experience and preparation, and in relation to equipment available. The Committee responsible for the collection of experiments would appreciate hearing from users relating any new ideas about the laboratory presentation. The Committee members are S. R. Tipton (Tennessee), J. D. Anderson (Illinois), I. Deyrup-Olsen (Washington), J. W. Green (Rutgers), and R. R. Ronkin (Delaware).

The collection contains experiments on: The isolation and study of subcellular organelles; Chemical components of cells; Electrical phenomena in excitable tissue; Water and solutes; Respiration; Movement in cells and organisms; Endocrine mechanisms. In addition there are the following appendices: Care of live animals; Isolation of subcellular particles; Work with radioisotopes; Electrical phenomena in excitable tissue; Statistical treatment of data.

The Revised Laboratory Experiments (156 - 8-1/2 X 11 pages) can be obtained by sending \$3.00 prepaid to The American Physiological Society, 9650 Rockville Pike, Bethesda, Maryland 20014.

EXCITATION OF THE VENTRICLES*

ALLEN M. SCHER

The study of excitation of the myocardium relates, on the one hand, to cellular events such as activity in excitable tissues, the mechanisms of cell-to-cell conduction, and the function of the conduction system. On the other hand, studies of excitation of the heart are related to the physics of conduction in volume conductors and ultimately to the understanding and use of the electrocardiogram, a clinical diagnostic tool.

About the beginning of this century, Einthoven (6) invented a string galvanometer which made it possible to record electrocardiograms with relative ease. Shortly thereafter, particularly in the decade 1910-1920, Sir Thomas Lewis (12) in England performed a noteworthy series of studies which included a partial description of atrial excitation and of the excitation of the surface of the ventricles. Lewis realized that if the sequence of depolarization in the ventricles is altered the QRS complex of the electrocardiogram will be altered, and he attempted, at times unsuccessfully, to classify certain abnormal electrocardiograms in terms of anatomical changes. Lewis showed that ventricular excitation is faster on the endocardial surface of the ventricular wall and that the wave of depolarization probably moves from inside-out in the wall.

In the 1920's, Craib (2), paralleling work of Helmholtz (8), extended electromagnetic theory into the realm of electrocardiography and discussed the potentials that would be produced in a volume conductor by excitable tissues. In the 1930's and 1940's, Wilson and co-workers (16) at the University of Michigan introduced our present system of electrocardiographic recording and, often in an extremely lucid fashion, related excitation of the ventricles through appropriate applications of physical laws to the resultant body surface electrocardiogram. However, it should be noted that there was no real evidence about excitation of the ventricle at this time.

The late 1940's and early 1950's saw a number of advances related to cardiac excitation. At the cellular level there was the brilliant work of Hodgkin and Huxley (9) and on the mechanism of potential changes in nerve and muscle and the often brilliant extension of this work to cardiac cellular electrophysiology in the laboratories of Weidman (15), Brady and Woodbury (1), Dudel and co-workers (3), Hoffman and Cranefield (10), and others. Although we lack some important parts of the picture for cardiac muscle, we know it depolarizes, as does skeletal muscle, through changes in permeability of sodium, and the argument between the Cambridge school and others about the cellular ionic events during repolarization will undoubtedly be resolved in the near future. Beginning about 1950, a number of laboratories (14, 5, 13), widely scattered throughout the world, undertook to study the pathway of excitation in the ventricles.

Supported by Public Health Service research grant 5R01 HEO1315.

*Taken from the introductory remarks given at the session on Cardiac Electrophysiology at the 1967 Federation Meetings.

The intracellular electrode, because of its fragility, could not be inserted into the depths of the myocardium, and in addition there was some need recognized in most laboratories for simultaneous recording of information on several channels, and such techniques have not even today been solved for intracellular recording. For this reason, electrodes were generally constructed of a macroscopic size, usually employing individual recording terminals .003 inches or larger, and electrodes were made up of bundles of recording wires along a single central shaft (Fig. 1). These electrodes could be inserted into the myocardium, and potentials recorded at the exposed tips could be used to indicate the time of activity at various places within the myocardium (Fig. 2).

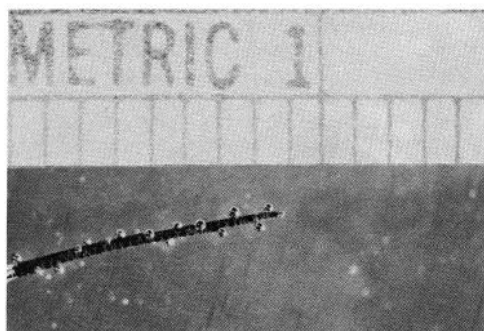


Fig. 1. One of the multi-polar electrodes used in this study. This electrode has 15 terminals staggered around a central shaft. Direct current has been passed through each terminal with the electrode in a bath so that a bubble has been formed. The scale shows millimeter intervals.

A brief summary of the physics of current flow in volume conductors seems useful at this time. We can view a resting cell as a closed polarized membrane as shown in Figure 3. Positive and negative charges are lined up against the membrane of the cell.

The recorded potential at any point is proportional to the solid angle subtended at the recording point by the boundary between active and resting tissue and to the charge density per unit area across the boundary. The sign of the potential is determined by the charges on the sides of the boundary nearest the recording point. In the case of the resting cell (or any other cell which is uniformly polarized or depolarized), positive and negative boundaries will be equal and opposite, and no potential will be recorded at an external electrode. In the case of a cell which is half depolarized and half resting, the recording electrode will be influenced by the positive charges on one side of the boundary and the positive charges on the other side of the cell, and will record a positive potential if depolarization is approaching, a negative potential if depolarization is receding (Fig. 4). This is then a simple rule of thumb: an approaching wave of depolarization produces a positive potential, a receding wave of depolarization produces a negative potential, the uniformly resting or depolarized cell produces no potential. The rules for repolarization are, of course, opposite.

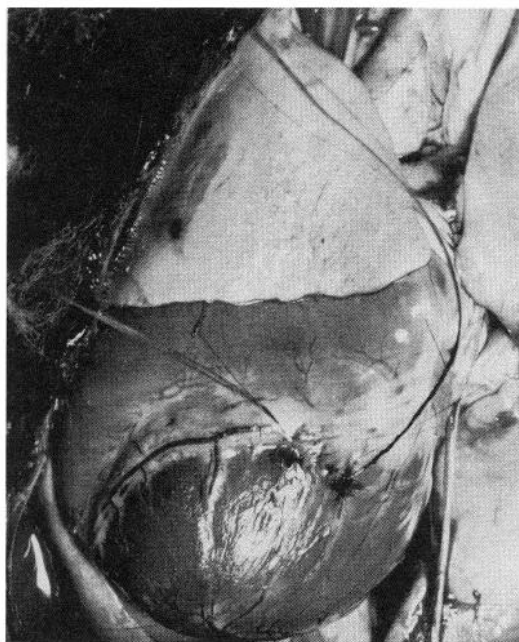


Fig.2. A beating heart with recording electrodes in place.

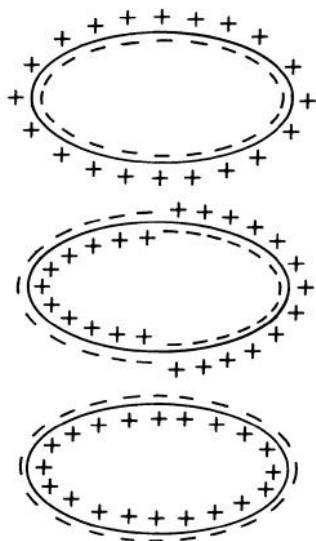


Fig.3. A resting cell can be viewed as having positive charges lined up against the outside of the membrane and negative charges on the inside of the membrane (top). A depolarized cell has the opposite charge distribution (bottom). A cell which is half-resting and half-depolarized is shown in the center of the figure.

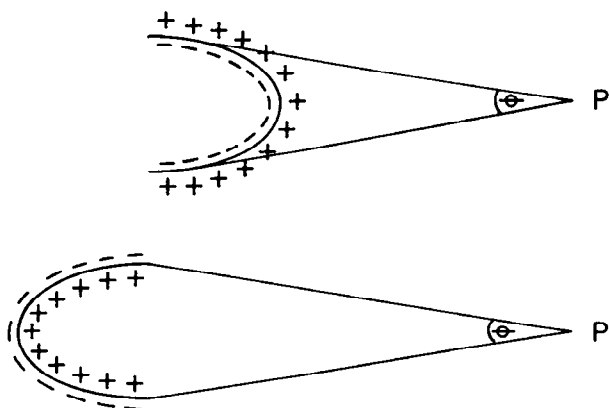


Fig.4. A cell which is half-resting and half-depolarized can be viewed as two half cells. The recording point, P, is influenced by the positive charges on the outside of the resting portion (top) and by the positive charges on the inside of the depolarized half (bottom). Point P would thus record a positive potential, a wave of depolarization is approaching P.

From the potentials recorded by such an electrode, one can instantaneously make some qualitative judgments. For instance, if a recording point shows positive and then negative potentials, activity is initially approaching and then receding from that location; a location which continuously records negative potentials is always "seeing" receding activity and must be excited somewhat early. Contrariwise, one which always records positive potentials is undoubtedly excited late in ventricular depolarization.

If there is a true wave-like motion, and if one records the potential between two adjacent electrode tips 1 mm apart, one may consider this space derivative a rough equivalent of the time derivative of depolarization in the mass of muscle, and the peak of such a bipolar potential indicates the instant of local activity, while the polarity indicates the direction in which the wave passes a point (Fig. 5). One can record time of activity at many points using this technique and refer them all to the same point within the ventricle (Fig. 6). One can then make a map showing time of activity at numerous places in the ventricles; with sufficient measurements one can determine, in more or less detail, the pathway of excitation in a mass of tissue.

Figure 4 shows potentials recorded along an electrode within the myocardium. Figure 5 shows a cross section of the heart indicating time of depolarization before and after a particular time reference point in milliseconds. Figure 7 shows a three-dimensional picture of excitation in the ventricles obtained by the techniques indicated above.

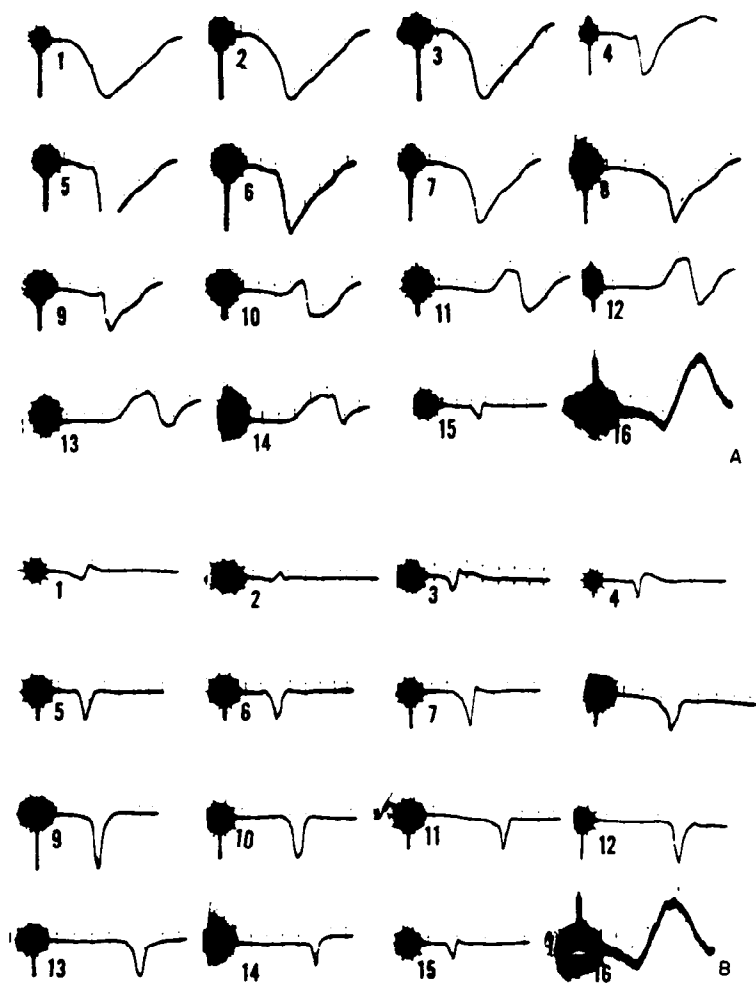


Fig.5. Potentials recorded across the mid-lateral left ventricular wall of the rhesus monkey. A represents the unipolar potentials. B represents the bipolar potentials. Terminals 1,2, and 3 of the unipolar record show the characteristic central left cavity records. The 15th terminal, from which no unipolar record is taken, was at the epicardial surface. Bipolar channel 1 records the potential difference between unipolar records 1 and 2, and bipolar channel 2 records the potential difference between 2 and 3, etc. Channel 15 records the fixed time-reference potential, and channel 16 records the lead-II QRS. In the bipolar record the instant of local activity is evident from the positive or negative picture of the potential.

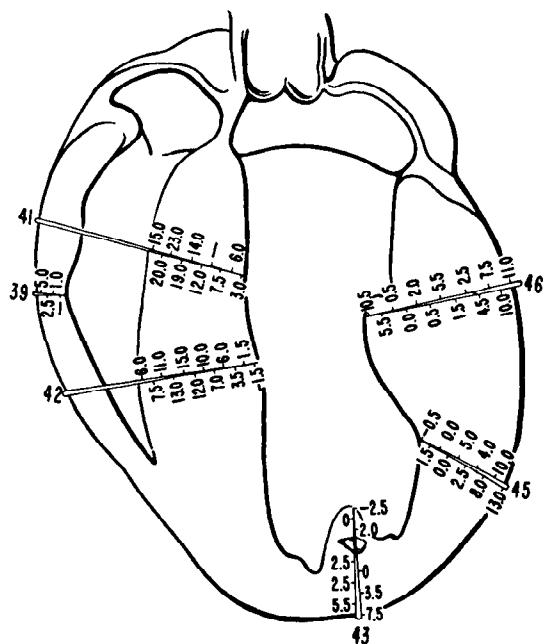


Fig.6. Time of activity in milliseconds before or after the time-reference potential in a coronal section of the dog heart.

When our laboratory started to work on this problem in 1950, some anatomists, supported by some physiologists, felt that there was no demonstrable conduction system in the ventricles of non-ungulates. When our studies were completed, it became apparent, with the clarity that hindsight bestows, that the pathway of excitation was in surprising agreement with the anatomical distribution of the conduction system. Ventricular excitation can be summarized as follows (Fig. 7). Initially there is activity on both sides of the septum, much more extensive on the left than on the right, and this activity proceeds toward the center of the septum. Its duration is short, and immediately after this activity begins, activity begins in the periendocardial regions of the wall of both right and left ventricles, then proceeds from the endocardium toward the epicardium. Activity tends to occur initially in the apical and middle regions of the heart and to move up toward the base of the heart and toward the base of the septum by conduction through ordinary muscle cells, which is somewhat slow. The thinness of the wall is seen in the fact that the right wall is completely depolarized before excitation is complete in the lateral and basal portions of the left wall. The last regions to become depolarized are in the posterior left wall and in the basal septum.

The pathway of activation is, as indicated, in excellent accord with the anatomical distribution of specialized conduction tissue. The right and left bundles terminate in the middle and apical portions of the intra-ventricular septum, and these terminations are much more extensive on the left than on the right. This accounts for the early activity on the

septum and for the fact that the activity is more extensive on the left. Because the activity is more extensive on the left, a greater portion of the septum is excited from left to right than is excited from right to left. The right and left bundles give rise to the Purkinje fibers which cross the cavities and terminate in the peri-endocardial regions.

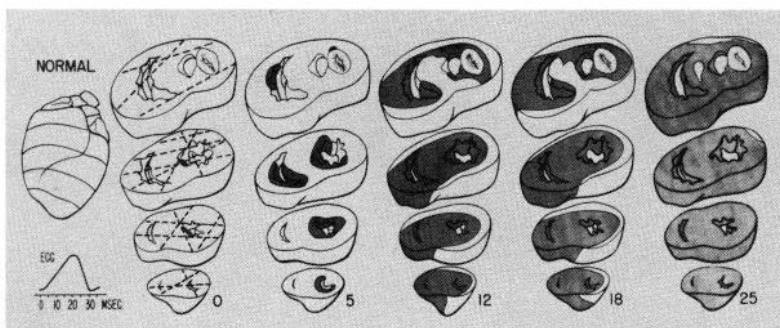


Fig. 7. A plot of total ventricular activation. Seventeen electrode tracks are shown in 4 cross sections of the heart. The time of activity in milliseconds before or after the time reference was noted at each terminal of the electrodes (electrodes were inserted across the heart and gradually withdrawn to prevent overlap between successive positions of each electrode). A single correction was applied to correct all times to the beginning of the lead-II QRS. Lines were then drawn to connect the points activated at 5-msec intervals. Tissue activated within a particular interval is shaded in the same manner in all sections. Time after the beginning of QRS is shown below each vertical row.

These fibers conduct the impulse to these peri-endocardial regions, and the impulse, having been widely distributed to a curved sheet of muscle near the endocardium, can proceed only in one direction, toward the epicardium. A lack of Purkinje tissues in the basal walls of the right ventricle, and particularly in the basal and posterior walls of the left ventricle and in the septum, leaves these regions to be excited by slow conduction through ordinary myocardium. Conduction velocity in the main bundles is about 2 meters/sec, in the periendocardial Purkinje tissue, about 1 meter/sec, and cell-to-cell conduction is about .4 meter/sec in ordinary myocardial cells.

The electrocardiographic complex recorded at the body surface is determined by the pattern of activation and the position of recording leads. In any lead, the complex is influenced by the shape of the torso and the conductivity of the tissues. As with the excitation of the heart, our approach here will be semi-quantitative, i.e., will consider the signs and, to some extent, magnitude of potentials, but not the absolute magnitude. We can summarize our picture of ventricular excitation in the dog by three arrows (Fig. 8) which indicate (a) left to right septal activity, (b) inside-out activity in the wall, and (c) movement of activity toward the base of the heart. This pattern of excitation applies to the human also. Experiments in our laboratory have demonstrated inside-out activity in a human heart perfused post mortem, and Durrer and

co-workers have evidence that canine and human excitation patterns are similar (4). Jacobson and co-workers (11) have studied the effects of infarction and conduction disturbances in the human to see if the resulting deficits are consistent with the pattern of excitation seen in the dog. In general, they find a good correspondence using this rather critical, although indirect, test.

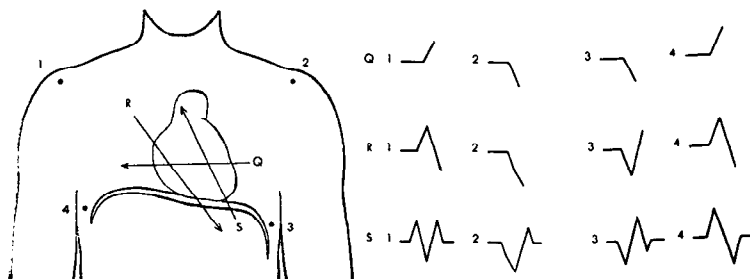


Fig. 8. Production of the QRS complex. If we take the pattern of depolarization shown in Figure 7 and transpose it to the human heart in its normal position within the thorax, we get three major directions of activity, represented qualitatively in this figure by Q, R, and S. The initial deflection, produced by activity from left to right in the septum, is directed from left to right and somewhat anteriorly. The movement of the wave from inside-out in the walls can be averaged by an arrow pointing towards the left leg and somewhat posteriorly, and the movement towards the base of the septum by the arrow labeled S which points roughly cephalad. This would produce QRS complexes roughly as shown at the recording points labeled 1, 2, 3, and 4 on the torso.

The initial activity in the septum would produce activity directed not only to the right, but cephalad and anteriorly also. From this (Fig. 8) we would expect an initial negative potential in leads 1, 2, and 3, and generally a positive potential on the right precordium and a negative potential on the left precordium. The second component, which we must remember develops smoothly from the first, consists of inside-out activity in the wall. At the height of this potential, activity is directed leftward, posteriorly and inferiorly. We would expect negative potentials at the unipolar upper extremity leads, positive potentials in leads 1, 2, and 3, negative potentials on the right side of the precordium, and positive potentials on the left side of the precordium and at the left leg. The final portion of activation, which is directed toward the base of the heart, should give us positive potentials at V_R and V_L ; we would expect negative potentials in leads 2 and 3 and in all the precordial leads, and small negative potentials in lead 1. These predictions are well borne out (although not perfectly) in the normal QRS complex. Qualitatively, then, we can predict the human QRS complex by transposing data concerning canine ventricular activation to the human heart in the human torso.

Recently, Gelernter and Swihart (7) have suggested a method of handling the volume conduction problem so that we should be able to mathema-

tically predict electrocardiograms from a knowledge of events within the heart and of anatomy. When computation involving their suggestion is complete, we may have a quantitative understanding of the origin of the electrocardiogram.

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SESSION ON TEACHING:
IMPACT OF NATIONAL BOARD EXAMINATIONS
ON TEACHING IN MEDICAL SCHOOLS
SPONSORED BY THE EDUCATION COMMITTEE

INTRODUCTORY REMARKS
WILLIAM D. BLAKE

Welcome to the Session on Teaching being sponsored by the Education Committee of the American Physiological Society. The proximate cause for our being here is to discuss the influence of National Board Examinations on medical education with particular reference to physiology. Less immediate but perhaps more powerful in defining the trend of these sessions is the unrest among physiologists, articulated by recent past-presidential addresses, about the future of physiology as a science and its role in education, particularly in the medical school environment. Many believe that physiology is becoming schizophrenic, heading in two seemingly opposite directions, toward the molecular on the one hand and toward integrative biology or control systems analysis on the other. The classical organ-systems approach is still viable but not much more than that. In addition, physiologists like others are becoming more and more specialized.

If this is what's happening in physiology, is this reflected in the educational programs in medical schools? What are the changes being made? Are the National Boards influencing these developments or any other aspects of educational programs and, if so, for better or for worse. (Fortunately, it would appear to be more of a common law arrangement with no vows given or taken.)

First, let's look superficially at some of the "grand-design" changes in pedagogy (I won't say education) most of which are concerned with reorganization of the curriculum to alleviate the anxieties of the faculty. Key phrases are: 1) integration 2) the "core" program with electives to allow for the multi-track approach and 3) early introduction of "stimulating" clinical material.

Complete integration, once achieved as such, or as juxtaposition of related lecture material, tends to freeze the program into an organ-system approach and, perhaps, has substituted an even less flexible conglomeration of logic-tight compartments for the pre-existing disciplinary ones. And now that faculties are learning more and more about less and less, the students are to learn less and less about more and more. More consistent with the faculty approach is the core program with multi-track electives which has the advantage of relieving the faculty of much didactic teaching to large groups and substitutes the more enjoyable tutorial approach which is equally time-consuming. However, if the current rather superficial courses have only waved the vermouth cork over the martini glass, the core programs won't even remove the foil from the top of the bottle.

Early introduction of clinical material is the clinical device for routing out the basic scientists gently but firmly. The more insidious device, perpetrated in part by our own offspring, is the conversion of physiology

departments into biochemistry. None of these "grand-design" changes are being introduced or influenced by the National Boards; they observe, follow, and sponsor rather good educational conferences wherein these changes are discussed.

But, curricula don't teach; people do, and this involves (despite the resistance of some faculties) teaching techniques including: lectures, laboratories, conferences, and perhaps projects and examinations. If we look at each of these techniques briefly, we might find some areas where National Boards play a role. After all, 19 of the 73 respondents to the questionnaire sent to all heads of physiology departments admitted that National Boards did have some influence on their teaching programs.

Lectures, used by most to stimulate, to identify important concepts, and clarify difficult areas, are used by some as a substitute for the textbook. Used as such, the content may be defined by the examinations given or anticipated, including the National Boards. Of necessity, and properly, the National Boards contain only widely-accepted, classically-oriented physiology and some educators feel obligated to emphasize this approach to be fair to their students and perhaps also because of pressure from above. Over 50% of the respondents indicated that the school administration used National Board results for making interschool and intra-school comparisons, even of teaching proficiency in some cases.

Laboratory exercises and projects are used to teach skills both manual and intellectual, critical thinking about how observations are made and how analyzed. Many teachers consider the laboratory the most important contribution a physiology course can make, others do not, particularly the students when they find little relevance of the laboratory to the examinations given or the grades received. There are probably fewer so-called "practicals" in physiology lab courses than in any other basic science department and certainly National Board exams emphasize "book learning". As several respondents pointed out, this devalues the laboratory in the minds of their students.

Conferences can be successfully used to identify misunderstandings on the part of the students and are probably a better source of immediate feedback to both students and staff of how well material is being put across and learned. By examination time it is too late to repair the damage; the students have moved on to the next field.

Examinations are the crux of today's discussion and, to paraphrase, by their exams shall ye know them. Certainly, regardless of what the professor may say, most students are going to behave in a manner appropriate to immediate needs. If their perception is that memorizing masses of facts is what will serve them best, then this is what they will attempt to do. So the type of examination used, although it may not define the course given, will certainly influence student attitudes and learning. So a hard look is warranted: because National Boards have set examination standards for licensure in many states, because they have a public relations press good enough to convince many schools to make them a requirement; because many departments use National Board type questions in their own grading procedures.

The good exam, should be valid, reliable, and objective. Reliable and objective National Boards are. Their validity is less certain. Fifty per cent of the respondents thought the exams were valid for what they taught the students, for what medical students should know, and for licensure. One-third were partly satisfied and one-sixth not at all. But when asked about using National Board exams for their own courses, 75% wanted no part of them, 25% would prefer partial use of National Boards, and none would use them exclusively. Perhaps this intuitive mistrust is in part related to ignorance; perhaps it is because of the type of learning it fosters, the magnetic-tape-type mind; perhaps it is because we aren't sure how or why a student arrives at the correct answer, which he selects, but does not generate. It is by "examsmanship", by guess, by a process of elimination, by simple memorization without understanding, or by coherent reasoning.

Some of these speculations will be considered in more detail by members of the panel. In any case, the evidence is clear that the National Boards are influencing medical education - not at the level of curriculum design but in the pragmatics of pedagogy. Remember, over 50% of respondents indicated that the school administration used National Boards scores to make comparisons, which as everyone knows, are odious. It takes an excellent student body to be able to ignore the pressures imposed by city hall.

Before introducing the speakers one word of amelioration - are some of us reluctant to accept National Boards because they are associated with licensure rather than physiology, or is it because the questions are trivial, ambiguous, or the balance of the exam is misplaced? How would the exam rate as part of a comprehensive for graduate students? As a test of factual knowledge is it good? Is extensive knowledge primarily important for the student of medicine or is the ability to use a lesser quantity in a more meaningful way what we strive for?

And now to the panel. Dr. Lambertsen will discuss policies and procedures of the National Board, how the examinations are constructed, what is being done to improve them, and how they correlate with other evaluative procedures. Dr. Brooks will offer a critique of objective examinations. Dr. Brobeck will elaborate on how and why he uses National Boards as part of his grading system. In the final round Dr. Alexander will come out swinging on the issue, for better or for worse. Questions will be held until the end. I am sure all of you know about the speakers but I would like to add that the National Board is fortunate indeed to have Dr. Lambertsen as Executive Secretary for Part I. Without his discriminating judgment much that has been accomplished would not have been possible.

THE DEVELOPMENT OF THE NATIONAL BOARD EXAMINATIONS IN BASIC SCIENCES. Christian J. Lambertsen, Univ. of Pennsylvania Medical School, Philadelphia.

The present system for development of the National Board Examinations has been attained by the same natural evolution that has occurred in the medical schools of this country. The beginning of this effort in

1916 consisted of a full week of written, bedside and other practical examinations. These went so far as to include demonstration by the candidate of his ability to perform an anastomosis of loops of the small intestine in the dog.

Over many years thereafter, the National Board employed essay questions and bedside examinations devised and graded by many different teachers of the medical sciences. As the number of students increased, the growing burden of the task made it impractical for the senior teachers to keep up with the problem of equitable, uniform and accurate appraisals of the candidates' performances.

In 1950, after several years of study, a gradual transition from essay to objective examinations was begun. These new examinations, still prepared and judged entirely by teachers of medical sciences, could be scored by computer. This system has undergone almost continuous evolution over the past seventeen years. At present, the overall examination system is a composite of several methods. These are still heavily based upon objective techniques, with extension to the use of questions concerned with analysis of experimental data, with clinical or laboratory situations. Motion pictures, radiographs, and methods of providing feedback of accuracy during the examination are also being gradually introduced to extend the usefulness of the examinations.

THE NATIONAL BOARD EXAMINERS

The composition of the National Board of Medical Examiners has considerable importance in an understanding of the methods and purposes of this body. A professional staff at the National Board headquarters in Philadelphia provides the continuity of service required for the operation of such a system. The larger portion of individuals who comprise the National Board system includes approximately one hundred medical educators who contribute their time, ideas and philosophy not only to the development of examinations, but also to the important function of keeping the examination policy abreast of the changing times.

Table 1 illustrates key functional units of the National Board system. The central function of preparing actual examinations is carried out by the members of the six-member Examination Committees, such as those for Anatomy and Physiology. The members of these individual Committees, serving overlapping four-year terms, are nominated by their academic peers for appointment by the Board of Trustees. These men, all recognized as leaders in the teaching and research activities of medical schools, are the true examiners of the National Board. The Trustees comprise an elected group of individuals prominent in national affairs concerned with medicine and medical education. The Chairmen of the fourteen basic and clinical examination committees serve as full members of the Board of Trustees in addition to carrying out their exacting work in preparing the examinations. Between the extremes of examination writing and policy making fall the important supporting functions which are carried out by the Board staff and by the Secretaries for Basic and Clinical Science. Their activities receive extremely important guidance from the coordinating and quality-control efforts of the Basic Sciences Committee and

the Clinical Sciences Committee, groups comprised of the individual Examination Committee Chairmen.

TABLE 1

THE NATIONAL BOARD OF MEDICAL EXAMINERS
THE BOARD OF TRUSTEES*
EXECUTIVE COMMITTEE
PRESIDENT AND STAFF

Secretary for Basic Sciences Basic Sciences Committee**	Secretary for Clinical Sciences Clinical Sciences Committee**
Anatomy Committee	Medicine Committee
Physiology Committee	Surgery Committee
Biochemistry Committee	Pediatrics Committee
Microbiology Committee	Psychiatry Committee
Pathology Committee	Preventive Medicine Committee
Pharmacology Committee	Obstetrics Committee
Post Internship Examination Committee	

* Chairmen of individual Examination Committees are full members of the Board of Trustees, and....

**Also comprise the Basic and Clinical Sciences Committees for Policy and Coordination.

The consequence of this direct and effective organization, which closely resembles the structures of the medical schools from which essentially all of the members come, is the maintenance of a continuing, close relationship with ongoing teaching programs and teachers.

Table 2 shows for Physiology, the men who have acted as National Board Examiners over the past fifteen years. Many are in the audience and still actively contribute to the evolution of the examining system.

TABLE 2

NBME EXAMINERS IN PHYSIOLOGY

1952-53 David Rapport	1958-61 Walter S. Root
1952-53 Chandler McC. Brooks	1958-61 Arthur C. Guyton
1952-54 Harold C. Wiggers	1959-62 John M. Brookhart
1952-53 Robert F. Pitts	1959-62 Harold D. Green
1952-53 Philip Bard	1960-61 Stephen Marsh Tenney
1952-55 H. Burr Steinbach	1961-64 James D. Hardy
1952-56 John R. Brobeck	1962-66 William Blake
1953-57 William D. Lotspeich	1962-66 John F. Perkins, Jr.
1953-57 John W. Bean	1962-66 Philip Dow
1953-58 Gordon K. Moe	1963-67 Jay Tepperman
1954-58 Hebbel E. Hoff	1963- Harry D. Patton
1955-58 H. Davis Bruner	1965- Walter C. Randall
1956-59 Hymen S. Mayerson	1966- David F. Bohr
1957-59 Vernon B. Mountcastle	1966- Carl W. Gottschalk
1957-60 John Gray	1966- Ralph H. Kellogg

Table 3 shows the schools from which these men came to serve as Examiners. Representation by schools as well as by individual teachers concerned with the basic and clinical examinations is continually changing. The Board is aided at any one time by approximately 36 basic science and over 40 clinical teachers from a majority of the medical schools of this country.

TABLE 3

NBME PHYSIOLOGY EXAMINATION
MEDICAL SCHOOL REPRESENTATION

1952-53 Tufts University	1958-61 Columbia University
1952-53 State U. of N. Y. (Downstate)	1958-61 Mississippi
1952-54 Albany Med. Coll.	1959-62 Oregon
1952-53 Cornell Univ.	1959-62 Bowman Gray Sch. Med.
1952-53 Johns Hopkins Univ.	1960-61 Dartmouth College
1952-55 Minnesota	1961-64 Yale University
1952-56 Pennsylvania	1962-66 Maryland
1953-57 Cincinnati	1962-66 Chicago
1953-57 Michigan	1962-66 Med. Coll. Georgia
1953-58 State U. N. Y. (Syracuse)	1963-67 State U. New York
1954-58 Baylor Univ.	1963- Washington
1955-58 Emory Univ.	1965 Stritch University
1956-59 Tulane Univ.	1966- Michigan
1957-59 Johns Hopkins Univ.	1966- North Carolina
1957-60 Northwestern Univ.	1966- California (S. F.)

THE EXAMINATIONS

The National Board Examinations, as used for certification of medical competence, have a number of well-recognized advantages and problems.

ADVANTAGES:

National Scope
Academic Representation at All Levels
Changing Examiner Group
Multi-School Representation
Natural Evolution

PROBLEMS:

National Scope
Universal Problem of Relative Grading
Interdisciplinary Communication
Lack of Feedback for Teaching Purposes
Misuse of Examinations by Individual Schools
or Departments
The Rapidly Changing and Diverse Trends in
Teaching
Short Half-Life of Questions
Limited Examiner Time

The advantages have already been largely described. The problems center about those encountered in any activity which is national in scope. Communication among the many disciplines is accomplished in National Board functions with the same difficulty as in any medical school. The time of the individual Examiner, while given freely, is in fact limited. As trends in teaching change, the useful "half-life" of individual questions shortens, and the demands placed upon the Examiners in the attempt to devise current and valid examinations increase. It continues to be true that most examinations, including those of the National Board, are relative examinations which, by their grades, rank the candidates but are not able to effect an absolute rating. National examinations, graded for many thousands of students, certainly do not lend themselves to the subsequent detailed review and discussion that provide the teaching feedback which is practical, but not routinely practiced in an individual medical school department. Finally, when a teaching department requests and employs a National Board Examination for its own purposes it is expected that the faculty members of that department will judge the pertinence of that particular examination to the educational aims, the philosophy and the scope of its own teaching program. The regular National Board Examinations remain comprehensive examinations prepared by a large group of educators for purposes which are national. Reference to the overall national examination may be useful, but it is considered a misuse of the individual examination for a department to employ it for grading purposes in lieu of its own, unique examinations.

A characteristic feature of National Board examinations is the objective question, e.g. a question scorable by automatic methods. The term "objective" is unfortunately sometimes considered to mean "true-false," "factual" or "simple memory" questions. All of these critical interpretations can be true, and there are many of us who believe that concept, thought and synthesis somehow depend upon a body of information. Moreover, an examiner should be capable of writing objective, machine-scorable questions which are in fact not answerable by dependence upon factual memory alone. The following examples of National Board questions in Physiology incorporate requirement for manipulation of previously learned information and principles, synthesis of anatomical and physiological knowledge, and the interpretation of familiar data.

NBME PHYSIOLOGY

If no heat were lost to the environment, the body temperature of the resting human adult would rise about

- A 0.1 C per hour
- B 1 C per hour
- C 5 C per hour
- D 10 C per hour
- E 15 C per hour

(Select what you consider to be the one best answer.)

NBME PHYSIOLOGY

Upon carotid sinus denervation in a vagotomized dog, minimally anesthetized with a barbituate, electrical impulse traffic will be expected to

1. Increase in the cardioaccelerator nerves.
2. Decrease in the preganglionic sympathetic fibers of the adrenal medulla.
3. Increase in the distal fibers of the cut carotid sinus nerve.
4. Increase in the post-ganglionic sympathetic fibers of the renal arterial supply.

(None, any, or all answers may be correct)

NBME PHYSIOLOGY

	Arterial O ₂ Content (ml/100 ml)	Mixed Venous O ₂ Content (ml/100 ml)	Total Hemoglobin (gm/100 ml)
Subject A	19.5	17.0	15
Subject B	19.5	13.5	19.5
Subject C	19.5	13.5	15
Subject D	19.5	9.5	15
Subject E	10	3	15

The above table lists the oxygen contents of arterial and mixed venous blood, and the total hemoglobin in the blood, of five subjects of equal size and resting metabolic rate who have no cardiovascular or pulmonary disease. The subjects are breathing air at sea level unless otherwise specified.

159. A subject performing exhausting physical exercise.
160. A patient with nonfatal sodium cyanide poisoning.
161. A patient with nonfatal carbon monoxide poisoning.
162. An Andean native living at an altitude of 14,000 feet above sea level.

(For each of the numbered questions, select the one lettered subject that best represents the conditions cited.)

One final example which will interest the teacher of Physiology illustrates the fate of at least two of every three questions written by the Examination Committee members. Following an effort in Committee session to repair and improve the original version, the question was deleted.

NBME PHYSIOLOGY

38. Administration of 100% Oxygen at one Atmosphere.

1. Is Responsible for Producing Retrolental Fibroplasia in Premature Infants.
2. Produces Convulsions in Adults within Twelve Hours.
3. Leads to Respiratory Arrest in Individuals Acclimatized to an Altitude of 14,000 Feet.
4. Increases Myocardial Oxygenation in Methemoglobinemia

It is expected that the dedication, the intensive efforts, and the critical attitudes of the teacher-examiners who contribute their time and philosophy to the National Board will make possible the continuous adaptation of national examinations to the changing patterns of medical education. While such examinations having national purpose cannot be expected to meet the exact needs of a discipline such as Physiology, a single department or a school, it should be possible for the principles and assets employed by the National Board to be used for purposes of more extensive examination in special disciplines such as Physiology. This can be accomplished if the interested group is prepared to devote the time of skilled members to define the scope and to assure the pertinence of the examinations.

SOME OBJECTIONS TO OBJECTIVE EXAMINATIONS. Chandler McC. Brooks, State Univ. of New York, Downstate Med. Ctr.

INTRODUCTION

Before I proceed with my commission, which is to attack rather than defend, I should like to present my true position.

In speaking of objective examinations, discussion of National Board examinations is unavoidable. This Board has been very considerate of me. I have criticized often and they have been tolerant. Although I do not know what physiologists are now serving this Board, I am aware they work hard and do the best job they can under the circumstances. I do not wish to offend them and especially I do not wish to be inconsiderate of Dr. Lambertsen. I do feel that uncertainties of purpose and the philosophies of the National Board make their job unduly difficult.

They should get on with the job of providing good questions and good examinations under some steadily reasonable form or methodology and a lot of the pretense eliminated.

It is my job to criticize if this is possible and I hope to offer some constructive criticism - the first of which is to do well what the Board is supposed to do - prepare a good objective examination for use in licensing qualification judgments.

I consider the National Board and its examination program essential. Our need for it, as a stabilizer, is very great in this present age of uncertainties when a lot of people (NIH, foundations, "professional educators," testers) are messing around with our educational system - trying to inflict their peculiar fads. So even if I succeed in convincing you that the National Board examinations are not what they should be and some National Board procedures are not good, I wish you to recognize that I think they do serve as a good means of determining qualification for licensing; they give us all a point of reference; they can affect and do affect standards; they can give us some knowledge of our success in preparing men to practice medicine. They can have, through defects in nature and handling, some bad influence on American education and this is what alarms me.

Some of the criticisms I will offer are specific and some are of objective examinations in general. I will object to: - The confinement of the method; The use some wish to make of these tests; Defects of technique used; Specific examination and question defects.

OBJECTIONS AND CRITICISMS

Limitations of Objective Examining

I believe that one of the procedures most relied upon in medical diagnosis is to ask the patient what is the matter with him - what his trouble is. I believe the best way to find out what a student knows is to ask him to tell you what he knows about this or that subject. But that isn't modern; there are too many students and some think that there are no physiologists competent to judge whether the answers are right or wrong - only the psychologists can do that. I just disagree.

At any rate objective tests, these National Board examinations, do not permit the asking of major questions about the most important aspects of physiological reactions: their totality, their complexity, their variability and the evidence available on which to base conclusions. Extensive objective examination use creates the wrong educational atmosphere and aim. The influence the NBME has and its efforts to establish their procedures and their examinations as criteria for judging educational accomplishment is very bad indeed because of these limitations. The pooriness of the examinations as tests of educational accomplishment, as means for judging the teaching of physiology, makes such attempts absurd. I will support this attack by later analysis.

Proper Function of the NB Test

To my way of thinking the National Board is recognized as an agency for determining whether men are qualified to receive a license to practice medicine. Examinations are given to determine whether candidates are prepared, know enough basic science, clinical science, etc. to practice acceptably good medicine.

I believe that objective examinations can do this quite nicely. However, this concept implies that the examinations should call for what can be

classified as significant basic information - facts or knowledge which a practicing physician definitely should possess.

In the National Board Examination all too often the call is for, pragmatically speaking, insignificant information or details of small significance to a physician. I will defend this later but the point I wish to make now is that there is a confusion - some think the NB objective examinations do or should assay educational accomplishment. When this concept enters, the examinations tend to become even poor criteria for judging qualification for licensing - this is the trend unfortunately. Certainly the objective examinations used are totally inappropriate for testing educational accomplishment in other than a most indirect fashion. That is easily substantiated. Both in intrinsic limitation and in actual example the NBME tests are not acceptable for use as criteria of education. The two purposes cannot be met in one examination.

I think medicine or participation in biomedical scientific endeavor is basically dependent upon the training of the mind to perceive, to think in terms of evidence, to appreciate the true complexities and variants in biological processes, etc. It is evidence, not conclusion, that is of permanent basic value - who ever saw in one of our examinations a call for evidence?

The making of an arbitrary choice of an officially correct answer from four others which are officially incorrect, is a process completely inappropriate to the best procedures of physiological thought. The student should be trained (educated) to marshal evidence in support of a qualified conclusion he then suggests. Objective exams now used do not test that ability.

In brief, poor accomplishment on National Boards may mean that your course has an unusual educational excellence - your students are not primarily concerned with "the answer." This "the answer" business is something we have to oppose in academic life and objective testing is our opponent. If a National Board question stimulates thought, there is no means of recording or giving a student credit for its reasonableness. Thought and uncertainty are actual handicaps to a student in taking these examinations - if thought, as it must, consumes much time. I will illustrate later how a little thought makes a lot of National Board questions seem a bit unreasonable (8 out of 9 on page 4, 1966 examination).

Changing Methodology

We have some responsibility to help our students prepare for what they must encounter - be it use of the mind, use of knowledge or licensing examinations. It is obvious that familiarity with types of questions, types of problems, testing procedures, is a help to students and it clears the way for use of knowledge in a testing situation. Therefore, we have to watch the ever fluctuating methods of testing and give our students reasonable aid - the fact that you are here indicates some interest of this nature on your part.

Three things normally inspire me to take a look at N. B. examinations:

1) When any considerable number flunk the N. B. when they passed similar examinations I gave, I can't really blame Microbiology, Pathology, and Medicine fully for this deterioration. 2) When our standing fails precipitously and the Professor of Pathology nails to the student bulletin board a curve showing Pathology 2 or 3 in the country and Brooks at the bottom of the tank - I don't mind but the Dean thinks something should be done even if he doesn't say so. 3) When students complain about the examination, I tell them that I can't do anything since the Oracle of Delphi has spoken but I can look up the exam and make the N. B. people uncomfortable too - you appreciate the situation now.

On such occasion I usually find - a) That some new devices or forms have been incorporated in the examination. Some committee member has got his inspired insight for testing incorporated in the exam. b) That the examination was badly out of balance and had a run of questions in some field our students were not well prepared in, because of our concepts of what physiology should deal with. I believe it was in 1960-61; this was an exam with some 23% of questions dealing with blood-hematology, immunological affairs and an additional 40% of the questions dealt with heart and peripheral vascular physiology. At that time I sent my analysis to the N. B. and that imbalance was corrected. c) That a high percentage of questions were controversial, sometimes 40 or 50%. My associates think that in the 1966 exam over 25% cannot have one correct answer and I place the criticizable questions closer to 40%. I will illustrate later.

Originally when the N. B. adopted objective examinations certain type questions (7 or 8 in all) were devised and each was advertised as testing some special intellectual procedure. Each year there was some tinkering with form.

Then another group of examiners was appointed which decided that "problem solving ability" is the real criterion of intellectual readiness. They had their idea too of what a problem should be.

In 1966 another form change was made. Certain types of questions were dropped and new emphases instituted. I do not think this change was completely good - it did make question forming easier in that some types more difficult to manage were dropped. I do not like the tinkering. Techniques or forms are changing but questions are not improving.

I disagree with abandonment of the concept of a pool of well analyzed questions which are known to be good, proved to serve a specific purpose well as comprising the core of every examination. This is a retrograde step. Finally - students can be trained to pass objective examinations - however, that is not worthwhile educational enterprise. Whenever there is a change in examination form, one does not know what percentage of failure in initial use is due to unfamiliarity with the question form. Knowledge of this must tempt examiners to diddle with results - use correction formulas.

Use of Correction Factors

I have given objective examinations for many years. I do not steal

National Board questions but I use their types and my students taking these exams get averages of 50 or 60 with top marks being in upper 70's and low in upper 40's. These same students when they take National Boards (a year later) get grades from 72 to 90+, most well above 75 and a high percent of honors. Why?

I have suggested that the N.B. system raises standings to a "reasonable level." This has been denied and also officially confirmed and I do not disapprove this for licensing purposes. Diddled figures, however, are not useful in classifying educational accomplishment unless you know how correction factors were used for your students and other groups. If there is an arbitrary 13% \pm , as mentioned by Dr. Lambertsen, failure required I question the method. I know we have groups of students in some years so uniform and good that none should fail.

If some of my students must fail by a formula then I think the procedure isn't even acceptable as a licensing practice - I may have been misled by Dr. Lambertsen's remarks.

Balance

The National Board subdivides physiology into a number of fields. We all do - some 10 or 12. It is reasonable to assume that knowledge of some of these subdivisions is more important to a physician, etc. than is that of others. I have my concept of these divisions and the correct apportionment of percentages.

When one analyzes the National Board's objective examinations on this bases, one finds a number of things - variation for one and neglect of certain areas for another.

One thing clearly shown is that a student must be strong in cardiovascular, respiratory, kidney physiology and endocrinology if he wants to do well - approximately 70% of questions pertain to these fields.

The rest of physiology is relatively insignificant.

For licensing I don't disapprove except that integrative physiology should be one of the majors (10% not 1%). For educational assay this balance is poor as is shown here:

National Board Exams

(Questions having dual coverage were counted twice)

My Judgment of Desirability for Licensing:				
<u>Field</u>	<u>approximately</u>	<u>1964</u>	<u>1965</u>	<u>1966</u>
General Physiology	5%	1%	1%	2%
Membrane, Permeability				
Pumps, Fluxes				
Nerve-Muscle	5%	3%	2%	5%

Cardiovascular	20%	31%	36%	29%
Heart				
Circulation				
Block				
Respiration	10%	16%	13%	15%
Kidney-pH, Salt-Water	8%	9%	10%	8%
Balance, Excretion				
Digestion-Nutrition	8%	6%	5%	6%
Energy & Gen. Metabolism	6%	3%	4%	3%
Specific Metabolic				
Processes				
Sensory Reception	5%	9%	2%	7%
Autonomic System	5%	9%	1%	1%
C. N. S.	9%	11%	11%	7%

(National Board nervous system questions have generally been few and poor. They are getting more numerous but are still poor.)

Endocrines & Reproduction	9%	11%	11%	15%
Integrative Physiology	10%	1%	7%	4%
Temp. reg. reactions to				
cold, high altitude, exercise,				
shock, etc. hemorrhage				

There is another type of balance also - that is in question types and field coverage in each question type. Question types differ in that some are easy while others are difficult. Whether or not success is high depends somewhat on proportion of difficult and easy question types. Success in a field depends on the proportion of questions about that field in hard or easy question types. Here balance in the National Boards is very poor.

In 1964 - there were 7 question types used in Part A. Part B was problem solving. In Part B - problem solving only involved cardiovascular system, respiration and kidney. In Part A - all sensory, C. N. S. and autonomic questions were in question type III. All fields were touched on only in question type V. In each of the other five question types 4 to 6 of the 12 fields covered were absent.

In 1965 - there were 6 question types in A and problem solving in B. Again problem solving was confined chiefly to circulation, respiration, kidney. All nervous system questions were again in one question type and more than half of the fields were uncovered in other question types.

In 1966 - the number of question types was reduced as you know. There has been an evolution toward questions which are more easily made. Most of the questions were in Section A - Type I and II - distribution in these was good. In part B - (Problems of 3 types) distribution was poor. It was chiefly peripheral circulation (no heart), respiration with some kidney in all three and endocrines in one type (diagram solving).

Incidentally I do not think the present choice of question types is an improvement - it is just another change to bother us.

Use of Different Quality Questions

Some are easy, for example:

Enterogastrone (1966) (#8)

- A. Stimulates secretion of gastric juice
- B. " " " pancreatic juice
- C. " " " bile
- D. " " " succus entericus
- E. Inhibits gastric secretion and gastric motility, 90% of all students get this one right. Is it a good question? Yes.

There are questions which normally only about 10% of the class get right. Are these good questions? Yes!

Our discussions previous to this presentation here have confused me. Evidently the grading technique eliminates some questions if the response is not of a certain nature. Are questions on which opinion is divided eliminated; are those in which the majority of students vote against the examiners eliminated? Are all hard questions eliminated? My judgment is that until this procedure is known the whole procedure is suspect. Dr. Lambertsen claims hard questions are not eliminated, while Dr. Alexander suggests they would be. In my own case we have studied our questions. We find they can be classified and there is a definite percentage expectancy for each.

In my opinion a well constructed examination should have a reasonable distribution of questions of graded difficulty in: a) Each question type; b) In each field of physiology. Furthermore: In addition to proper handling of easy and difficult questions; The numbers and percentages for each field should be related to what you are trying to test - licensing I say. The information called for should be significant in that it is knowledge essential to purpose - licensing I say. Finally the questions should be physiological - no neuroanatomy, etc. A good question of function is hard but not impossible to formulate.

Significant Information

The first question is: "Significant to what?" A physician can certainly practice medicine without knowing what percentage reduction in Na⁺ ion abolishes the overshoot in an action potential; he should not be allowed to practice medicine if he doesn't know the events of the cardiac cycle and how they are determined and what abnormalities in heart sounds, in ECG indicate, etc.

If an examination is for licensing qualification, then information of minor importance can be identified and there is a good deal of it in the objective examinations of the N.B. For example in the 1966 Examination (my opinion) 60% of the questions were significant (permanent need) and 40% were insignificant (no need),

If one considers the exam as a test of what a physiologist should

know at the end of his training, the insignificance is much reduced.

I will not try to list all the significant information not asked for in the 1966 exam. I would not expect 100% coverage but a man could have passed that 1966 exam without knowing anything about the ECG except the PR interval, only that vagus action could change it, about heart sounds, - 13 of the 15 heart questions dealt with dynamics of ventricular contraction.

There is no time to discuss this matter of significance further or to defend my claim. It is the business of the NBME to decide what they are trying to do and then call for questions appropriate to that purpose. If they desire to test educational accomplishment they should work on a methodology and questions adequate for that.

Correctness of Official Answer

This is the most difficult problem of all. Telling the student to choose the "Best" answer does not help much when there are two answers which factually cannot be considered incorrect. The examiners may prefer one but can't say the other fellow was wrong - he just didn't meet their preference. Students should not have to calculate what the examiners want. As I said previously the percent of questionable questions is easily 25 in 1966 and I tend to judge it much higher (40%).

When it comes to criticizable questions in these objective exams, it is rather discouraging. Of course students cope with life, the N.B. copes with life and no great injustices are done, but we would prefer perfection would we not?

But I have exceeded my time. I have talked this way to the National Board before - but have not changed the examinations noticeably. I am not too disappointed because I want the National Board kept and I can live with it and objective examinations if you can. I may be an optimist but I think questions could be improved as well as procedures. That is what I propose but it means more work, more wisdom, more power will be required of the physiologist involved.

I feel that our own uncertainties about the role of our subject and how it should be taught, disqualifies us from being too critical. Many of you are agreeing to or even fostering the dissolution of departments of physiology and the teaching of courses of physiology by physiologists. This is the same kind of confusion as that which affects the NBME. Lose sight of what you are, your purposes and then you are nothing.

NATIONAL BOARDS IN STUDENT EVALUATION. John R. Brobeck,
Univ. of Pennsylvania Medical School, Philadelphia.

Mammalian Physiology is the title of a course that occupies one-half of the attention and time of first year medical students in their second semester at the University of Pennsylvania. The course ends early in June, and grades for the course must be recorded in the Dean's office within a week following the final examination. Approximately 130 medical

students plus some 12 to 20 graduate students take the course each year.

In all but one of the spring semesters from 1953 to 1963, inclusive, the final examination was objective in nature, manufactured by our staff in the style of the National Board Examinations. The principal advantages of having our own objective examinations were the ease with which they could be graded, and the presumption that the subject matter covered was determined by our own teaching faculty. At the time we began this procedure the chairman of the department was a member of the National Board committee responsible for questions in physiology.

Eventually the limitations of this kind of final examination came to outweigh its advantages, and in 1964 we began to utilize examinations supplied (for a fee paid by the department) by the National Board of Medical Examiners. We now use them not only for this course, but also for a course in physiology for approximately 140 dental students in the fall semester, and as a make-up examination for students required to take a re-examination after they have failed to pass either course.

One of the most important problems with our own examinations was the discovery that they did not fairly represent the importance of material in the course after all. It is much easier to formulate definitive questions in some fields than in others, so that certain topics came to be represented by more questions than they deserved. Although questions were solicited so as to cover the subjects fairly, by the time the questions were reviewed, revised, and selected, the goals of coverage and emphasis were impossible to preserve. In other words, we were not skillful enough as examiners to be confident that our examinations were, in fact, representative of what we thought students ought to know at the end of the course. Rather, the examination tended to become a compendium of that material upon which it was relatively easy to formulate questions.

Another major problem was the amount of time required to put together an examination that met even minimal standards of clarity and fairness. We found that construction, evaluation, revision, editing and selection of questions occupied our teaching staff almost full time for many weeks. In this same period our secretarial staff was equally or even more busy in typing, duplicating, re-typing and further re-typing of the items under consideration. To do a conscientious job of examination construction seemed to take at least a month of time from our staff, both professional and secretarial.

But the final and eventually fatal problem was the tendency of students to hoard and study old examinations. By the end of ten years of this type of examining, it was clear that questions had a tendency to reappear in some form or other, and that the most effective way of studying for the final was to analyze the questions on old exams. We did not provide official answers; but we permitted students to keep their lists of questions each year. Perhaps a security system like that of the National Board could have been put into effect, although by the time we found we needed it it seemed too late to begin. If the examinations had been good enough to serve as a syllabus for the course, we would not have objected to student use in this fashion. But we knew very well the deficiencies of

the exams.

With the use of examinations provided by the National Board, all of these problems vanished. We have reason to believe that their skill in formulating questions is at least as good as ours; and even though there may be some question as to adequacy of coverage, this does not matter now because the questions are used merely to test the student's achievement, and not as a guide for his study. But even if the two types of examinations were of the same technical competence, we gain a very large amount of time in not having to prepare or grade them. The atmosphere of the entire department in the month of May has changed from one of "quiet desperation" to one that preserves the more even pace of normal academic life.

Our experience with examinations given in 1964 through 1966 is summarized in the accompanying figures. The first one shows the frequency of each score for the three years, in the population that includes both medical and graduate students. Our students tend to be distributed with a peak frequency towards the honor level - a score of 88, but in every year a significant number of students was below the passing level - 75. Our experience suggests that the National Board does not use a score of 74. And I should mention that one of the scores of 99 in 1966 was given to a composite answer sheet submitted by three enterprising members of our teaching staff.

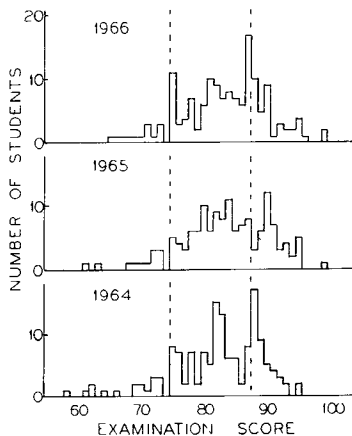


Fig.1. Scores of medical and graduate students in N.B. physiology examinations, 1964-66.

About half of our students take a National Board examination in physiology twice, since they take it also for Board credit after their second year. We were interested to try to find out whether it is true, as we are often told, that students learn their physiology in the pharmacology course. The second figure compares their scores at the end of their first year with those a year or more later. For students who took the second examination in June of the second year, there was no improvement in scores on the average (open circles). But students who arranged

to take the second examination in September did better than they had done at the end of their first year (filled circles).

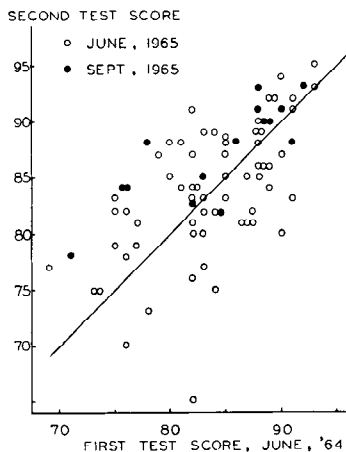


Fig.2. Comparison of first and second score of students who took physiology examinations after first year and again after second year of medical school.

The half of our medical students who take the examination for National Board credit after their second year appear to be a somewhat selected group. According to the analysis of Fig.3, they had higher scores on the first examination than did the group who subsequently did not take the examination for credit. Dr. Arthur B. DuBois made a calculation that showed the mean scores of the two groups to be 83.8 and 81.0, respectively, on their first examination.

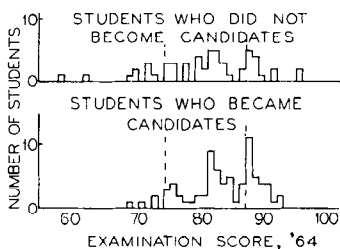


Fig.3. Comparison of N.B. scores in physiology for two populations of medical students.

Finally, we plotted examination scores against the grades students were given for the course, including all students for the three years (Fig.4). There is obviously a correlation between these two measures, although one cannot decide whether the correlation means that the faculty

is using the examination score in determining the course grade, or merely that students who do well by one measure tend to do well by other criteria as well. The most important point of this plot, however, is that the correlation is not perfect. For example, in the range of 84-88 (N. B. score), students were given grades varying all the way from D to A. Similarly, with scores above 88 (the honor level), some students finished the course with grades of C, even though most of the students with similar scores received B or A. Twenty-three students who failed the examination by N. B. criteria were given grades of D or even C, whereas only one student who passed the examination was given a failing grade for the course.

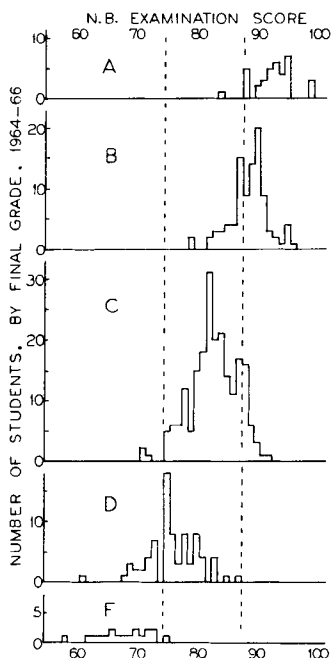


Fig.4. Frequency of scores on N.B. physiology examination as a function of grades students received for the course in Mammalian Physiology.

To interpret these correlations one should know how our grades are assigned. The course grade includes some recognition of a student's class standing on 3 or 4 progress examinations, plus an evaluation of laboratory performance, conference participation, and general attitude toward the course. The grades are assigned in a general meeting of the teaching staff. When all the data for each student have been assembled and recorded on a 3x5 card bearing his photograph, the teaching staff reviews all these data and assigns the student to one of five categories of performance. We usually begin the grading session with a "trial

balance" arrived at ahead of time and quite arbitrarily. Occasionally this is merely an ordering of the students by their N. B. scores; more often the ranking is done by some mathematical formula that includes other criteria. We then attempt to divide the ranked students into three groups - above average, average, below average. Next we reconsider the position of each student, while viewing his photograph projected onto a screen along with his record, so as to make sure that the arbitrary ranking and classification have put him into the category where we believe he belongs. For most of the students there is no problem, since their entire record will be either superior, average or inferior. But at the borderlines between categories, or in the case of students with records internally inconsistent, we spend a fair amount of time debating the validity of our data, and comparing students who are to be above or below the plane of separation.

At the end of this evaluation process we always find that the superior group includes a few students who should be distinguished by being assigned a grade of A, while the rest are given B. The below average group likewise divides itself into those permitted to pass (D) and those who fail (F). The idea that there should be this latter division is obvious; but we usually have difficulty in deciding whether certain students are above or below the passing line. Of the class of 140-150 students, perhaps 70-80 receive a grade of C.

Our experience thus far with the use of the National Board Examination seems entirely favorable, although we evaluate the situation year by year and consider other possibilities for the final examination. We expect to continue to include in our grading some measure of laboratory performance, and in our progress examinations we expect the students to solve problems and to write essays. Perhaps the most satisfactory feature of our grading is the staff meeting where the grades are assigned. Intellectually it is hard work; perhaps twenty persons spend not less than four hours discussing, criticising and justifying the performance of the entire class. But at the end of the session everyone recognizes that every bit of relevant information has been reviewed by the entire staff, and we prolong the meeting until no one has anything more to say about any student's grade. This process might be called a grading by consensus. It almost invariably gives the student the more favorable side of any doubtful situation.

USE AND MISUSE OF NATIONAL BOARDS. Robert S. Alexander,
Albany Medical College.

The examinations administered by the National Board of Medical Examiners have justifiably earned themselves the reputation of being licensure examinations of excellent quality administered with a high degree of efficiency. As examinations to serve as a basis for licensure, they are not being subjected to criticism. The issue under consideration here is whether they have values and uses to the medical educator over and above their function as a licensure device. This question is particularly timely, not only because it has been raised by a number of physiologists, but also because of the promotional campaign which the National Board has recently unleashed on the medical community in an attempt to

greatly broaden its scope. I will return to this point later.

First let us briefly consider uses of the examinations which are of value to all medical teachers. They offer us objective evidence of the achievement of our students on a standardized examination. In addition, thanks to the item analysis service which the National Board has recently made available to us, we can obtain evidence as to how our students handled specific questions on the examination. Results in both of these dimensions warrant our earnest evaluation. I hasten to stress, however, that in this process we must not forfeit our responsibility to dictate our own course content; we must never yield to the National Board the decision of what our course should be designed to teach. In so far as the examination content is deemed to fairly represent actual or desirable goals for our own teaching program, then any significant deficiencies in the performance of our students clearly dictates a reappraisal of our teaching program. On the other hand, in so far as the specific content of the examination is considered to poorly reflect the objectives and content of our own course, student performance should be discounted as having relevance to that course.

A third use of National Board scores which I would endorse is their employment by Deans or other administrators for evaluating the relative performance of different departments within the same medical school. I know that some of you will take issue with me on this point, but Deans are going to do this whether we like it or not. Actually I believe that they have every right to make such comparisons because they deal with a controlled population. The same group of students are being compared on the several examinations and the comparisons therefore have some validity. Should we wish to challenge this validity on the basis that the examination is not representative of the content of the course that we teach, we have a perfect right to make such a challenge and also a clear responsibility to justify our differing course content to the administration. This is an important job of any department chairman. Should the National Boards offer evidence of a true deficiency in our teaching program, an able chairman should use that evidence as a lever with the administration to gain more financial support to strengthen his department. Contrariwise, strength in National Board performance can be used, with a bit of a shift in our logical reference, as evidence that our department warrants more administrative support to accord with the demonstrated excellence of our program. If we will just spring to the offense rather than the defense, we have nothing to fear from our Deans comparing scores.

Now let us turn and consider some of the misuses of these examinations. First, I would condemn use of the National Board scores to compare one medical school with another. How can I at one moment commend their use for comparison of departments within the same school, and in the next breath condemn their use to compare departments in different schools? The answer is very simple and has already been alluded to: The presence or absence of a controlled population. In the same school the population is controlled; in comparison between different schools the population is quite uncontrolled. Several years ago I became curious as to just what might lie behind inter-school comparisons, and conducted an informal

survey with which a number of this audience cooperated. The results gave positive evidence of what anyone could have guessed: the "good" schools score high, the "poor" schools score low. More specifically it became clear that the schools that score high are the schools that admit students with high Medical College Admissions Test (MCAT) scores, while schools that score low are schools that admit students with relatively lower MCAT scores. One might raise the question here whether we are dealing with a skill in mastery of a unique type of objective examination format which may have little relevance to anything else. Putting that argument aside, however, subsequent studies have been published by others showing that National Board scores show a rather poor correlation with grades in medical school basic science, almost no correlation with medical school clinical grades, but a high correlation with MCAT scores. Thus it is clear that when we compare National Board scores from different schools, we are comparing different populations of students in terms of skills which they possessed before they entered medical school. If we want to compare their skills in this dimension, then let's look at the original data: the MCAT scores. I do not know of a single piece of evidence that demonstrates that National Boards are a valid indication of the quality of the instructional programs at the medical schools themselves. Comparison of scores of different schools can therefore lead to thoroughly erroneous conclusions about those schools.

A second use of National Boards with which I must take strong issue is their employment as a regular school examination to contribute to the grades earned in medical school. In declaring myself on this point, I am quite aware that I am locking horns with my good friend and fellow panelist, Dr. John Brobeck, who is on this platform to endorse such usage. I respect his right to his opinions, but in this instance, I can not share them. If one wants to become insulting in academic circles, one accuses someone of running a "diploma mill" or, even worse, a "license mill." I feel that those who use the National Boards as official school examinations are, by definition, pleading guilty to operating "license mills." This is the goal they have defined for their students.

Licensure should be considered at best a bare minimal goal of medical education; I would prefer to consider it a by-product of an adequate medical education. This is not the place to enlarge upon the far loftier and more challenging goals to which a faculty should address itself and towards which it should expend every effort to direct its students' attention. In attempting to inspire our students towards these higher goals, we hear throughout educational circles profound discussions of the problem of "motivation." In my simple-minded way of looking at things, the mystery of motivation evaporates when one inspects the examination system. Show me your examinations and I will show you what type of motivation you are offering your students. This is the operant conditioning to which all of our students have been exposed throughout their educational careers. In our own course in physiology, for example, I became exasperated a number of years ago over the degree to which our students, fresh from their experience in gross anatomy, proceeded to rote memorize their physiology text with slight concern as to whether they understood anything. The solution was simple: announce that all examinations in our

course would be "open book" type, with students allowed free access to their texts and lecture notes. At Albany we still have many educational problems to solve, but rote memorization is no longer one of them.

An even more vivid illustration of this point was recounted on one of the questionnaires which Dr. Blake circulated in collecting background information for this session. The faculty of a major medical school voted several years ago to adopt National Boards for their course examinations. The very distinguished professor of physiology introduced his course with the customary review of suitable texts that were available in medical physiology, a discussion in which his students seemed particularly uninterested.

It later came to his attention that, as a group of highly intelligent students whose morale was temporarily disturbed over the new National Board policy, they had done a little research and discovered that Dr. Arthur Guyton was Chairman of the Physiology Test Committee that year. The class therefore went out and bought up Guyton's text to a man. The professor proceeded to give lectures expounding the great insights in physiology which he wished to convey to the students; they seemed disinterested, took few if any notes, and then rushed home to study Guyton. He exposed them to some challenging laboratory experiments; the students polished off the laboratory with as little attention and as little time as possible so they could get home to study Guyton. When he quizzed the students to discern how well his message was getting across, the only thing he elicited was quotations from Guyton. Now please don't misunderstand me; I am not intending to imply that these students would have learned more physiology by paying attention to their frustrated professor than by reading Guyton's text. The fact remains that the students bought this excellent text for the wrong reason, as I am sure Dr. Guyton would be among the first to agree. We define the motivation of our students when we design our examinations. If we use a licensure examination as a course examination, medical licensure inevitably becomes the motivating goal of our educational program and higher aspirations become futile.

Finally, to a third misuse of National Board Examinations which I most emphatically condemn. This is the use of the National Board to evaluate new developments in medical curriculum and new programs of medical education. The National Boards themselves are trying to sell this idea through their "minitests" and similar devices with what, in my opinion, are shabby promotional tactics far beneath the dignity of such an organization. Let me give you some specifics to back up this charge.

The National Board Examiner, February 1967, states: "The questions in Parts I and II - all of the objective, multiple-choice type - have been devised to test not only the candidate's knowledge, but also the subtler qualities of discrimination, judgment, and reasoning." Sounds like a T.V. commercial, doesn't it? Consider this statement a little more critically. Surely the evaluation of "judgment" by objective examination remains an unsolved problem of educational testing. The National Board has some competent educators on its staff; they should know better

than to be caught in print with such a false claim. Reasoning? Here the argument is a bit more equivocal. It is true that in recent years a considerable number of "problem" questions have been introduced into the examination. But how much time is allotted for reasoning? When confronted with 180 questions to read, interpret, and answer in 120 minutes, the candidate has but a few seconds to "solve" each problem. Time enough to manipulate a little simple arithmetic through a memorized formula, but surely not time for anything which should be truly classified as "reasoning."

To give due credit to the efforts of the test committee, I did spot a few questions on the 1966 examination that clearly did demand reasoning of some complexity. I eagerly turned to the answer sheet to see how the students had handled these questions, only to discover the words "Not scored." The computer had thrown out the questions! Here is the real proof of the falsity of the promotional claim quoted above. The computer is programmed to discard from the scoring any questions which does not prove to be "reliable", that is, where the correct answer did not appear with statistically acceptable frequency on the high-scoring papers. The significance of this technicality is that it reminds us that this test is scored as a uni-dimensional examination. Whatever dimension dominates the examination becomes the yard-stick against which all individual items are compared; anything which fails to correlate with this single dimension is automatically discarded by the computer. What dimension dominates this examination? Anyone with experience in constructing objective questions could easily guess what even a casual perusal of the examination will confirm: "knowledge" of the factual recall type. Factual recall, or something statistically indistinguishable from it, is the only skill which their scoring machine will tolerate as being reliable. It is thus evident that the claim in their promotional material that they are testing four different skills is a manifest impossibility.

Now let us turn to consider just what type of information the examinations are designed to recall. In the same issue of the Examiner for last February quoted above, they summarize their testing procedure with the impressive claim: "Thus the examinations are assured of being up-to-date and in step with current medical education throughout the country." If this statement were true, then the examinations would be monstrously unfair as licensure examinations. In medical science, the terms "up-to-date" and "current" are virtually synonymous with "controversial", "not universally accepted", "not yet in most textbooks." Surely any good modern course in medical physiology introduces the students to current ideas and newer concepts which would be quite unfair to include on a standardized national examination. Let's actually take a look at the 1966 examination. Figure 1 presents an analysis of the date on which the information solicited in each question was originally published. 17% of the material was 19th century, and over 40% was more than 50 years old. No one would suggest that the contributions of Helmholtz, Ringer, Pavlov, Starling, and Sherrington should be forgotten. But is the spectrum of figure 1 "modern" physiology? Where is the information explosion? It would be unfair to include modern and up-to-date material in an examination of this type, and such material most certainly is not there. I am supremely confident, however, that the material being taught in the medi-

cal schools in this country represents a far more modern spectrum than is represented in figure 1.

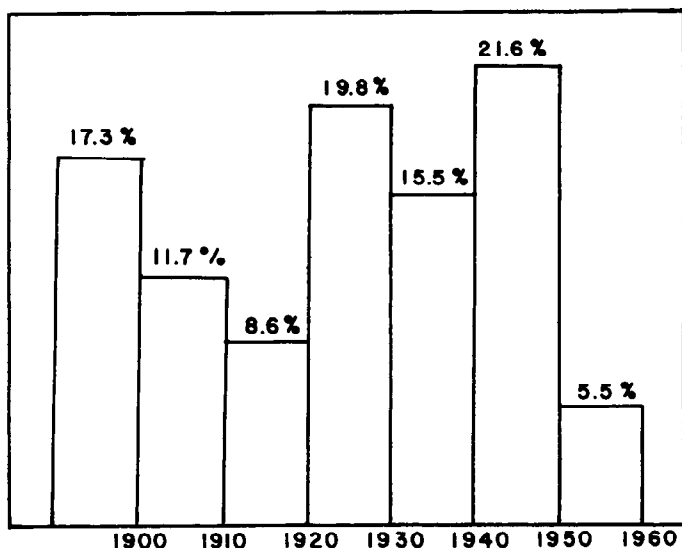


Fig.1. Date of original publication of information being solicited on the National Board Examination in Physiology for June, 1966, grouped in 10 year blocks except for the first block on the left, which includes all material published prior to 1900.

Finally we read in the National Board Examiner for October of 1966, their proud boast of their testing panels: "The members of these panels chosen from among the most prominent members of the medical faculties throughout the United States and Canada, represent a group considerably stronger in composite scientific eminence and background than can be gathered together on the departmental faculties of any but a few schools." This is Madison Avenue at its best. This statement suffers only from being an understatement; I question whether any department of physiology in the country can emulate the talent represented on the Physiology Test Committee. But such claims completely ignore the functional difference in the two types of operation. In your department and in mine, the neurophysiologist is responsible for examination questions in neurophysiology and the respiratory physiologist for questions in respiratory physiology. Not so on the National Boards. Although the committee members serve in part as expert consultants in their own particular field, the decisions are not left to the experts. The questions are selected by a vote of the entire group, in which as a rule only one member qualifies as an expert in the subject matter of the question. Thus when it comes to actually putting together the examinations, the National Board decision-making process employs men functioning as "general practitioners" of physiology. These men clearly are among the most competent in the country to serve

such a role, but let us not be hood-winked into supposing that such a process can yield more expertly framed questions than our own staffs can design in our own departments. This National Board system is commendable for a licensure examination, because it further guarantees that questions will be restricted to older and widely accepted information which a candidate for licensure should be expected to know. By the same tokens, we may be sure that these examinations will continue to be quite unrepresentative of newer developments in the fields of medical science, and hence thoroughly inappropriate as testing devices to employ in the evaluation of new approaches to medical education.

The National Board is eminently qualified to continue in its role of protecting the public from individuals who can not demonstrate the minimal knowledge necessary for the safe practice of medicine. Let it continue in that role, and not confuse this task with the vastly different challenge of evaluating medical education.

DISCUSSION

Summarized by William D. Blake

No verbatim record was made of the questions and comments following the prepared talks. The following is believed to reflect the tenor of the proceedings in a summary way.

The majority of questions related to the National Board Examinations, how they are prepared, the intended level of difficulty (or intellectual taxonomy) of questions, how graded, the meaning of the results, and their validity relative to licensure. The attitudes generated in students and teachers by such exams also received some attention.

Dr. Lambertsen reiterated that questions were derived mostly from new questions submitted each year by six individuals from as many different schools. Question half-life was short and the number of previously tested questions that could be drawn from an existing pool was small. The comment was made that pathologists circulated questions among themselves and that this helped to increase pool size. The question was raised as to whether the physiology question pool could not be improved, enlarged, and become more representative, if many departments submitted questions. The audience was polled and about two thirds alleged to be willing to submit questions if solicited. One voter indicated an unwillingness to submit. Several comments were made about what the exams were testing. Immediate recall of memorized "facts" appeared to be most likely since less than a minute was allowed per question and answers were selected rather than generated. Dr. Alexander noted that he found three excellent "thought" questions in the 1966 exam but on subsequent item analysis all three were excluded by the computer, a telling point. Dr. Lambertsen pointed out that very easy questions and very difficult questions (as well as those that proved to be ambiguous) were apt to be excluded by the computer since such questions frequently failed to discriminate between the top and bottom ranking students on the examination.

The grading of the examination was discussed. Dr. Lambertsen said

that the first step was to evaluate the questions on a sample of about 1000 exams. After the unusable questions were excluded, all exams were then graded and students ranked on the basis of raw scores. The lowest 12 to 13% were then arbitrarily considered to have failed. This figure was chosen because approximately 12% failed when essay exams were used prior to 1952. (An interim method of adjusting scores was abandoned). All raw scores were then adjusted so that 75 became the passing grade and that this usually represented about 55% correct answers on the exam. Then raw scores were adjusted accordingly. Dr. Lambertsen agreed that the system was highly arbitrary and hoped that, if anyone could suggest a better technique for defining the line between pass and fail, he would please communicate with the National Board Office.

The validity of the exams in terms of evaluating physiology courses and in terms of licensure were further discussed. Some in the audience believed that Part I grades were determined largely by the students' ability to take the particular type of examination involved and that the content of the exam was secondary. Evidence presented to support this was the very high correlation, 0.86, between results on the Medical College Aptitude Test and Part I of the National Boards. Not all agreed. Some found good correlation between their own independent evaluation (the nature of which could not be identified as clearly different from the National Boards) and results of the National Boards. (Author's comment. If the separate exams in the six subject-fields of Part I are of the same format, an analysis of variance, among and within fields, might shed some light on the importance of content vs. format.) The validity of the National Boards as a preliminary licensure examination was not discussed extensively. As an indication of the acquisition of adequate factual knowledge, it was considered acceptable. As an evaluator of other qualities that a physician must possess, such as judgment, sense of values, etc., it was considered wholly inadequate. It was also pointed out that Part I was of little predictive value in assessing eventual performance since the correlation between Parts I and II was low, about 0.3, and between Parts I and III was not significant. Presumably Part III is the best index, of the three Parts, of a physician's performance.

Irreconcilable viewpoints emerged relative to the use of National Boards as a test for evaluating medical student performance in physiology. Dr. Brobeck maintained that the function of a physiology department was to prepare students for medicine, that the National Board exam was as good an exam as could be prepared with practicality, and he saw no objection to using this prelicensure exam as a part of his grading procedure. Dr. Alexander was unalterably opposed to using any licensure exam for such a purpose because it fostered inappropriate attitudes in the students, e.g. being satisfied with meeting minimal licensure standards, and smacked of the "diploma-mill" approach. Dr. Lambertsen added that the physiology departments of 11 schools used a National Board prepared exam as the final exam in physiology. Of these 11 only four requested item analysis of the questions after the exam had been taken. Others in the audience conveyed similar objections to the National Board exams, particularly the development of poor study habits in students, e.g. memorization of details rather than understanding of concepts.

Other detrimental aspects of the National Boards included self-imposed limitation of course content and design by some departments and devaluation of the laboratory as a learning experience. Very few in the audience indicated that they gave "practical" exams. What fraction of National Board exams could be related to the laboratory experience? The final question was posed "why do students prefer essay exams", and remained unanswered.

In conclusion, many objections were raised to the National Board Exam in Physiology as a device for evaluating a student's understanding of physiology or a staff's performance in teaching it. Major reasons were the nature of the exam, the type of information it called for, the ambiguity and triviality of some of the questions, and the type of learning the exam fostered. Fewer objection was raised to the validity of the exam as a prelicensing procedure, even though it failed to evaluate much that was important for the physician, and did evaluate only relative accumulation of detailed information, arbitrarily failing 12 to 13% of the examined regardless of absolute knowledge.

Problems to be solved by the National Boards include: how to devise a just absolute standard, how to create a larger pool of better questions which examine into attributes other than immediate recall of factual information, and, consequently how to produce an examination which abets rather than impedes appropriate student attitudes toward learning. Suggestions to further these ends might include more communication from the National Boards to basic science faculties on the techniques for preparing and particularly for evaluating objective-type questions and solicitation of good questions that have been pretested on students by these faculties.

BACK ISSUES OF AJP NEEDED

The Central Office of the Society is continuing its attempt to secure a complete set of APS publications. We now have copies of all publications except the following:

American Journal of Physiology
Vol. 51 thru 66
Vol. 96 thru 99

If any persons interested in physiology have duplicate or unneeded copies of the volumes cited above they would do a great service to the Society if they could make available to the Central Office of the Society all or any of the volumes.

A CLOSED CIRCULATORY SYSTEM MODEL

MATTHEW N. LEVY AND HARRISON ZIESKE

Numerous physical models of the cardiovascular system have been devised for instructional purposes. In most or all of these models, the system is "open"; i.e., the liquid is exposed to atmospheric pressure at some point in the circuit, usually in the reservoir which represents the right atrium.

The model to be described is a "closed" system, comprised of four principal components: a pump, an arterial capacitance, a peripheral resistance, and a venous capacitance. The pump is servo-controlled, such that "cardiac output" is a function of venous pressure (Frank-Starling mechanism). Also, because the model is a closed system, the venous pressure is a function of the cardiac output. The model therefore assists the student in gaining insight into the interrelationships between cardiac output and venous return. The student is able to construct "cardiac output" and "venous return" curves, as described by Guyton (1, 2), and to determine how these curves are affected by changes in a variety of circulatory variables, such as peripheral resistance, blood volume, and myocardial contractility.

THE MECHANICAL MODEL

The physical model is depicted schematically in Figure 1. The analog of the heart is a piston pump (Harvard Apparatus Co., model 1405) in which systole comprises 35% of the cycle duration, and diastole occupies the remaining 65%. The pump is equipped with silastic ball valves (V_i and V_o , the inflow and outflow valves). Stroke volume and heart rate are continuously variable (dials A and B). By special request, the pump is equipped with a modulated control (Harvard Apparatus Co.) which regulates the stroke frequency. The electrical analog of the venous pressure is fed back to the modulated control through a circuit (box C attached to pump) which must be designed specifically for the type of recorder being used to register venous pressure.

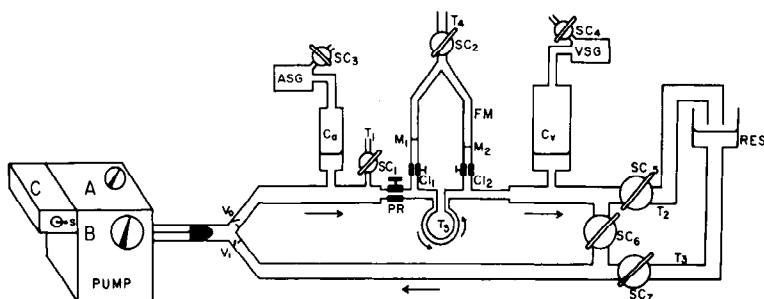


Fig.1. Schematic representation of the physical model of the cardiovascular system. Symbols defined in text.

Two compression chambers serve as the arterial and venous capacitances (C_a and C_v). The volume of air in each chamber, and hence the magnitude of the capacitance, can be varied by adding or withdrawing air through stopcocks SC_3 and SC_4 . Arterial and venous pressures are recorded by strain gauges ASG and VSG, respectively. The variable peripheral resistance (PR) is represented by a screw clamp.

Flow ("cardiac output") can be measured in several ways. For the student laboratory, a differential pressure flowmeter (FM) can be constructed simply by inserting a fixed hydraulic resistance (a length of narrow tubing; T_5) in series with the variable peripheral resistance. The pressure drop across this fixed resistance can be measured by 2 water manometers (M_1 and M_2), and is proportional to the rate of flow. Oscillations in these manometers can be damped by screw clamps Cl_1 and Cl_2 . Alternatively, a differential pressure strain gauge can be employed to register flow; it would replace manometers M_1 and M_2 . To obtain the records displayed in this paper, a square-wave electromagnetic flowmeter (Carolina Medical Electronics) was used.

OPERATION OF THE MODEL

Cardiac output curve. To construct a curve of cardiac output as a function of venous pressure, the feedback control is switched on (S, control box C) and the system is temporarily converted to an open system by closing stopcock SC_6 and opening SC_5 and SC_7 . Heart rate is set at a constant low frequency, and venous pressure is varied in a stepwise fashion by progressively changing the hydrostatic level of the reservoir (RES). The changes in cardiac output produced by such variations in venous pressure are shown in Figure 2. The cardiac output and venous pressure data from this record are plotted as the "cardiac output" curve in Figure 3. It is evident that as venous pressure is progressively raised from 0 to about 15 mm Hg, cardiac output increases linearly from 100 to 400 ml/min.

Venous pressure curve. The feedback is temporarily switched off and the circuit is converted to a closed system by closing stopcocks SC_5 and SC_7 and opening SC_6 . With the pump stopped, sufficient liquid is added (tube T_1) to raise arterial and venous pressures to some arbitrary value (e.g., 20 mm HG, left border of Fig. 4). This pressure constitutes the mean circulatory pressure (1, 2), and is the venous pressure axis intercept of a "venous pressure curve" (Fig. 3). The pump is then started, and cardiac output is raised in a stepwise fashion by rotating dial A. As cardiac output increases, arterial pressure increases proportionately, but venous pressure diminishes (Fig. 4.). The resulting data are plotted as a "venous pressure curve" (dashed line, Fig. 3).

Effects of alterations in circulatory variables

At the completion of the procedures followed in obtaining the data for the venous pressure curve, the feedback is switched on (arrow, Fig. 4). The cardiac output and venous pressures rapidly change to seek values (300 ml/min. and 9 mm HG, respectively) which represent the point of intersection of the cardiac output and venous pressure curves

("operating point", Fig.3). These equilibrium values persist to the left of arrow 1 in Fig. 5, which is a continuation of the tracings in Fig. 4.

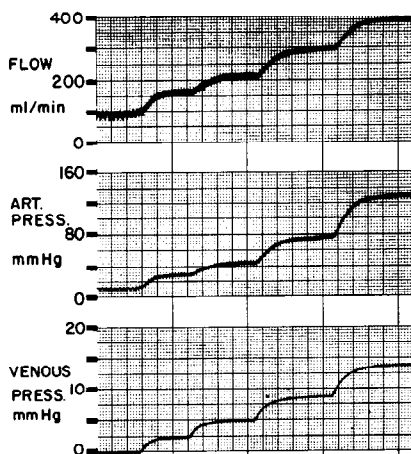


Fig.2. Record from which the data were obtained for construction of the "cardiac output curve" plotted in Fig.3. Model operating in the "open" mode, with feedback. Reservoir (RES, Fig.1) was elevated in steps to produce the observed changes in flow, arterial pressure, and venous pressure.

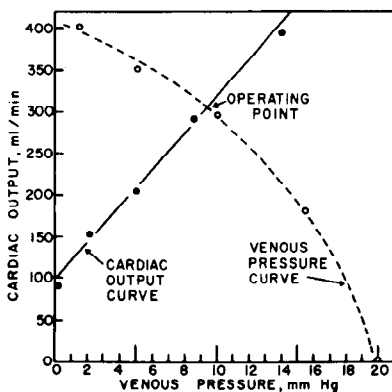


Fig.3. Cardiac output curve represents the changes in cardiac output as a function of venous pressure (Frank-Starling mechanism); data obtained from record shown in Fig.2. Venous pressure curve represents the changes in venous pressure as a function of cardiac output; data obtained from record in Fig.4.

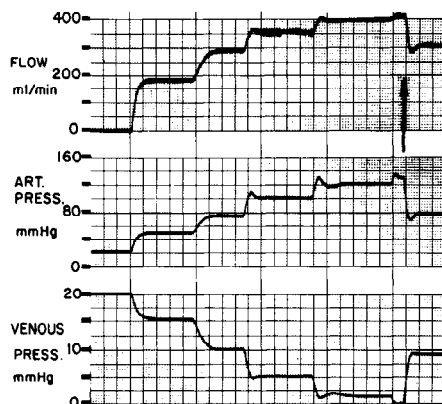


Fig.4. Record from which the data were obtained for construction of the "venous pressure curve" plotted in Fig.3. Model operating in the "closed" mode. To the left of the arrow, there was no feedback to the pump. At the arrow, the feedback was switched on. The equilibrium values for cardiac output and venous pressure to the right of the arrow are equivalent to the coordinates of the point of intersection of the curves in Fig.3.

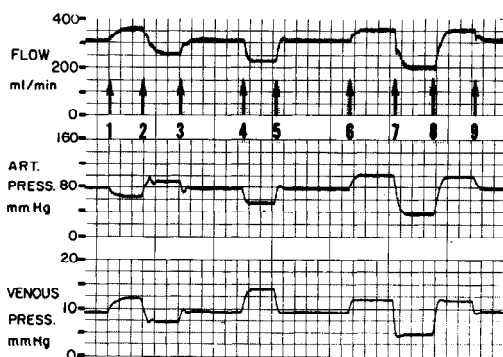


Fig.5. Effects of various interventions on flow, arterial pressure, and venous pressure. Model operating in "closed" mode, with feedback. Record is a continuation of that shown in Fig.4. Significance of arrows explained in text.

At arrow 1 in Fig. 5, peripheral resistance is decreased, eliciting a rise in cardiac output and venous pressure and fall in arterial pressure. Between arrows 2 and 3, peripheral resistance is increased beyond the control level, with the reverse effects on the circulatory variables.

Between arrows 4 and 5, the gain of the feedback is reduced. This is the analog of "cardiac failure". As a consequence, cardiac output and arterial pressure decrease, and venous pressure rises. Conversely, an increase in feedback gain would simulate the action of increased cardiac sympathetic neural activity.

Between arrows 6 and 7 and also between arrows 8 and 9, the "blood volume" is increased ("transfusion") by introducing additional liquid at tube T₁. Cardiac output and arterial and venous pressures all increase. Between arrows 7 and 8, the total blood volume was diminished ("hemorrhage"), with a consequent severe reduction in the three circulatory variables.

DISCUSSION

By operating the system in the "open" mode (SC₅ and SC₇ open, SC₆ closed) and with the feedback switched off, the circulatory model described herein resembles most of the models which have previously been constructed. By relatively simple, inexpensive modifications, however, the model can be altered to simulate more closely certain additional features of the cardiovascular system.

The interrelationships between cardiac output and venous return constitute a difficult area for the student of physiology to master. This apparatus permits the student actually to construct cardiac output and venous pressure curves, procedures which are usually not feasible upon intact animals in the student laboratory. Furthermore, he can easily simulate the effects of changes in blood volume, peripheral resistance, myocardial contractility, and arterial and venous capacitance upon these curves, and then upon the equilibrium levels of cardiac output, arterial pressure, and venous pressure in the operating circuit. He can observe that at equilibrium the values of cardiac output and venous pressure represent the point of intersection of these curves, and that the system returns to this equilibrium point when it is momentarily perturbed. Furthermore, he can verify that the equilibrium point will move to the point of intersection of a new set of curves if for any of the reasons enumerated above, there is a shift in either the cardiac output or venous pressure curve, or in both. Finally, with additional modifications, other feedback mechanisms could be introduced to simulate, for example, the baroreceptor reflexes.

One theoretical objection involving the model described herein is that the controlled variable is heart rate rather than stroke volume. The Frank-Starling mechanism would, of course, be simulated more closely if stroke volume were the controlled variable. However, this objection is only academic, and is easily circumvented by expressing cardiac output as flow per unit time rather than as flow per stroke.

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 2. Guyton, A. C. *Textbook of Medical Physiology*. Third Ed., W. B. Saunders Co., Philadelphia, pp. 339-347, 1966.
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EMERITUS BIOLOGISTS PROGRAM
OF THE
AMERICAN INSTITUTE OF BIOLOGICAL SCIENCES

In view of the United States participation in the International Biological Programme, it was reported at a recent Congressional Hearing that the annual production of Ph.D. ecologists may not be adequate for the task. This need will obviously be met in part by the training of new ecologists, however, if the immediate needs of the IBP are to be met, it will almost certainly be necessary to enlist the aid of emeritus biologists for many aspects of the work. A recommendation to this effect was made by Dr. John R. Olive, Executive Director of AIBS, to the House Subcommittee on Science, Research and Technology.

The utilization of emeritus biologists in significant positions in teaching, research and administration has been fostered through the AIBS Emeritus Biologists Program which is now in its third year. Many opportunities are still available to emeriti to replace biologists on sabbatical and for full or part-time teaching positions on a year-to-year basis. Through this Program, emeritus biologists have found positions in almost all regions of the United States and in overseas assignments.

If you are retired or planning to retire within a year or two, and are seriously considering continuing your active professional life after retirement, let the AIBS Emeritus Biologists Program assist you in obtaining a challenging professional appointment.

For further information, please write to the AIBS Emeritus Biologists Program, 3900 Wisconsin Avenue, N.W., Washington, D.C. 20016.

NEWS FROM SENIOR PHYSIOLOGISTS

D. B. DILL

Charles Haig retired because his health made it impossible to travel to the University and to negotiate stairways. "Plan your retirement well in advance, allowing for the contingency of disabling ill health."

Harold E. Himwich is Research Director of the Thudichum Psychiatric Research Laboratory at the Galesburg State Research Hospital. He advises postponement of retirement if possible.

J. Walter Wilson still has his office and laboratories, his research program, and his work with graduate students, including a seminar. He is working on a History of the Life Sciences at Brown.

H. Necheles on July 1st became Emeritus Director of Gastroenterology at Michael Reese Hospital. He hopes to be able to renew grants and continue research on a somewhat larger scale. "For those who are approaching retirement I advise never to stop working and never to give up. To retire in order to do nothing means decay."

Irvine H. Page is continuing scientific activities furiously. "In June I developed a myocardial infarction so now I am chained to the bed with two weeks to go. It should have come at the beginning instead of the end of my career as I have learned a lot from the inside out."

E. Cowles Andrus is continuing scientific activities in the laboratory working on cardiovascular conditional reflexes. "Anyone approaching retirement should arrange to continue some rewarding activity. The blessed are those who have already cultivated a satisfying hobby."

William F. Windle reports that at New York University Medical Center tenure ceases at age 65, but appointments continue on a year-by-year basis. He is Research Professor of Rehabilitation Medicine and is serving as Director of Research for the Institute of Rehabilitation Medicine.

Charles H. Best has been appointed a consultant in several departments at the University of Toronto and will likely have some extra-University activities as well. He gets a lot of satisfaction in reading scientific literature and historical books.

A. C. Ivy spends some ten hours a day on the job. He will speak in Lima, Peru, this September on the subject of "How the Body Maintains its Cholesterol Balance" and in the same month will attend the Symposium on "Hormones of a Polypeptide Nature", in Milan, Italy. "From 1963 to 1966, I studied law quite intensively. To me laboratory science is intriguing and challenging work; the practice of law is a game in which the best debator and strategist wins. My experimental subjects are volunteer 'hopeless' cancer patients; and, to observe subjective and objective improvement in some of them is very rewarding. On the other hand, it is heart-rending to fail in children, young people and a mother with children. But the work I am now doing is the most challenging I have ever undertaken; and, at the same time it requires the most patience."

Victor Guillemin is writing a non-technical book on "The Story of Quantum Mechanics." Although retired from Harvard he remains a member of the staff as Honorary Research Associate. "My advice to those approaching retirement is to get interested in some significant activity so there will still be a job though no longer a salary. Writing books has the great advantage of providing an income long after the work is done, plus the satisfaction of having a permanent document of one's work."

Arthur Grollman is actively pursuing scientific activities and does not plan to cease for at least the next five years.

Owen H. Wangenstein is continuing his research and hopes to pursue an interest in the History of Surgery with particular reference to the 18th and 19th Century preludes to Lister. "Having been born on a farm and brought up to hard work, it has become a habit and actually my best source of enjoyment and satisfaction."

D. Bailey Calvin retired from the University of Texas Medical Branch in 1964 and is now Assistant Dean for Research in the University of Miami School of Medicine. As a member of the Executive Committee composed of much younger people he finds it difficult not to say, "Boys, it won't work." "This is very important. Holding one's tongue does help under circumstances such as these."

Edward Larson during the past year presented a paper with coworkers to both the Florida Academy of Sciences and to the Federation.

Arthur C. DeGraff is still Professor of Therapeutics at New York University School of Medicine and will probably continue for at least two or three years more. He has been reappointed Editor of the Annual Review of Medicine for an additional five years. "My advice to those approaching retirement is, do not retire unless you must do so either because of the rules of the university or because of illness. If you must retire because of certain rules, then by all means get another job to keep the mind active."

Marie A. Hinrichs works at the AMA as medical consultant in Health Education, and also directing a summer workshop in Health Education for graduate students at Roosevelt University.

Alexander Sandow is continuing in full time as Member, and Head of the Division of Physiology, of the Institute for Muscle Disease. He is also Adjunct Professor of Biology in the Graduate School of New York University. These two jobs involve some administration, much research, teaching a course in biophysics, and sponsoring students for the doctorate.

John J. Sampson is able to teach, participate in investigative projects, do a moderate amount of committee and administrative work, and carry on a fairly active practice including consultations. He suggests that an association be maintained in some area where study and even clinical and investigative work may be carried on within the range of capacity of the individual with diminishing physical capacity, and expansion of previously developed recreational activities - especially artistic. Financial

security should be planned long in advance of retirement.

William Horsley Gantt reports that since he became emeritus at age 65 in 1958 his scientific activities have expanded instead of contracted. He set up a new laboratory in the Veterans Administration in Perry Point, Maryland and in 1960 the Pavlovian Laboratory was perpetuated by the Johns Hopkins. He has established the Pavlovian Society of North America, and in 1966 started a new journal "Conditional Reflex: A Pavlovian Journal of Research." "My advice would be rather to the universities than to their subjects for retirement. I think the universities are severely handicapping themselves by the automatic elimination of those who may have reached a stage of greater wisdom and discretion... My proposal would be that the universities offer their subjects the choice of retiring at double their current salaries or continuing at their present salaries... I realize that I am one of those who refuses to be hypnotized into thinking I am senile and may pose for the universities an embarrassment."

Sarah S. Tower continues the practice of psychiatry, and especially of psychoanalysis, teaching in the Johns Hopkins University and with the Baltimore Psychoanalytic Institute.

Raymond Gregory is still Professor and Chairman of the Department of Internal Medicine, University of Texas Medical Branch, Galveston, Texas.

Dwight Espe advises retirees, "Don't take the inevitable too seriously, enjoy it."

Jacob Sacks thinks he is on the point of finding a function for the anserine of muscle. Sometime next year there will be a decision on what will happen after he reaches age 67. He does not intend to vegetate. It may be continuation of research and teaching, teaching alone or administrative work.

Daniel T. Rolfe resigned as Dean of the School of Medicine at Meharry Medical College but retained his position as Chairman of the Department and Professor of Physiology. Also he is Dean of student affairs.

G. van Wageningen continues as a physiologist and anatomist working on the physiology of reproduction in the Department of Obstetrics and Gynecology at Yale Medical School with the title of Lecturer.

I. S. Ravdin has been ill and was unable to reply.

E. A. Spiegel continues in research on a reduced scale. He is also research consultant to the National Parkinson Institute.

Laurence Irving is with a lively and diverse research program with excellent facilities for looking into adaptations that carry natural northern populations through their changing seasons. At home he is happily involved in gardening.

Robert K. S. Lim has not yet retired, but will do so in October this year on reaching the age of 70. "After spending 14-1/2 years in two world wars and working the intervening years as a physiologist in Europe, Asia and America, it is difficult to contemplate a life of 'retirement' - even is one could afford it!"

James Bordley III is now located in Taipei, Taiwan, where he has a one-year appointment as Visiting Professor of Medicine at the National Defense Medical Center and the National Taiwan University Medical School.

Walter Redisch remains active and plans to continue scientific activity after retirement.

R. W. Gerard is fully active and may continue as a professor. He is Dean of the Graduate School at the University of California, Irvine, and does no research but gives a fair number of lectures. He says that he feels less able to advise a potential retiree now than he did five or ten years ago. "Certainly it is useful to get located in an area where one may wish to live in retirement, before actually retiring if possible - thus getting some functional roots into the community... I shall keep some sort of professional and intellectual activity going when I do retire and would hope the level could be adjusted to an optimal amount. At present I am overworked, but certainly prefer that to being bored."

Frederick L. Hisaw left the University of Wisconsin in 1935 for Harvard feeling that Harvard would be a wonderful place to grow old. He is very happy to report that in his case this proved to be an actual fact. After retirement in 1962 he continued his research, though on a reduced scale and organized a research group of colleagues (8-10). "We held a one or two day conference each fall and discussed our individual needs for information on the study in hand... It is remarkable how successful we were. Everyone received material from each autopsy (monkeys) and there was exchange of data, microscopic slides, photographs, opinions, manuscripts, etc... We sure had fun! Then the roof fell in. Harvard would no longer sponsor or administer research grants for retired professors who had attained the age of 75 years." However, he has been appointed Research Consultant in Reproductive Biology at Boston Hospital for Women, and will continue to occupy his laboratory in the Biological Laboratories, in Cambridge, and is trying to reorganize his research. Even so, he yet says Harvard is a wonderful place to grow old - provided one does not grow too old.

Caroline tum-Suden is still working at Edgewood Arsenal (Pharmacology Branch) on a rather routine but interesting EEG study in cats and is anticipating retirement within a year or two.

Curt P. Richter says nothing has changed in his life since his retirement seven years ago. He still has the same lab, facilities, help and is doing as much operating and experimenting as ever before. He produced one book - "Biological Clocks in Medicine and Psychiatry" two years ago and hopes to finish a monograph on the twenty-four hour clock this fall.

Gordon C. Ring starting September 1st becomes visiting professor of physiology at the University of Malaya. "I am delighted to go to this part of the world... will be looking for a position back in the United States without administrative responsibilities."

Will Forbes is continuing scientific activities having just accepted a position at Pahlavi University in Shirez teaching physiology in their medical school. He also will have administrative responsibility as "Associate Director of the Pennsylvania Team" in Iran. His advice: "Don't neglect your hobbies."

S. Howard Bartley is continuing his scientific activities. One reason for his staying on past voluntary retirement has been the chance of developing a small group of compatible scholars in his present laboratory. If this is accomplished right soon, he can turn over the administrative reins to one of these persons and still have a means of working as long as physically able.

Stuart Mudd is continuing scientific activities under contract with the United States Veterans Administration Central Office Research Service, and a grant from the USPHS. "I am also very active in the World Academy of Art and Science, of which I am also Chairman of the Committee of Publications. In this capacity I have edited a volume on "The Population Crisis and the Use of World Resources", and one on "Conflict Resolution and World Education". Both of these were originally published by Dr. W. Junk, Publishers, The Hague, Netherlands. There are American editions by the Indiana University Press, Bloomington, Indiana." He suggests that one should look ahead and arrange for satisfying and productive activities after retirement.

Paul Weiss is back in his laboratory at Rockefeller University and busier than ever. He has just received a sizeable research grant for three years from NIH and is continuing the work of the laboratory and many other functions without interruption. Emeritus status at Rockefeller means merely discontinuance of salary, but laboratory facilities, secretarial assistance and budget are retained.

Edgar A. Blair after retiring from the U.S. Army in 1958 moved to Galveston where he teaches physiology at the Medical Branch of the University of Texas. He was on leave 1961-1963 to teach in Karachi, Pakistan at the Postgraduate Medical Center. Since then he teaches for seven months each year. He suggests that retirement should avoid a patterned life in a fixed location: include flexibility and mobility.

David McK. Bloch is Director of the Division of Neuropsychiatry in the Walter Reed Army Institute of Research. His chief personal interest is to try to develop an operational terminology for describing behavior. "Retirement could be a great advantage in the sense that it would permit one to assess the factors which entered into technical and political decisions. This, I think, can only be done when it is clear that the decisions will have no consequences."

James T. Irving will continue at the Forsyth Dental Center until 1972;

the Center is no longer affiliated with Harvard. His research continues at its usual rate; last year he had seven research fellows. He is an editor of "The Archives of Oral Biology."

Aldo A. Luisada is continuing his scientific activities. He has given a lot of thought to retirement but does not have an answer because each scientist has his own problems partly based on his previous activities, hobbies, and family life.

Charles Huggins does not have the career problem completely solved yet and therefore is carrying on double time at the bench. "Life is a bowl of cherries for the scientist, provided he continues to experiment. Administration is death."

William Amberson has in press a report which demonstrates complex formation between his delta protein and F-actin. Delta protein presumably is a polymer of tropomyosin. It is a fibrous protein which may act to strengthen both of the filament arrays. He is working with Floyd Wiercenski in a study of the electrophoretic mobilities of myosin as influenced by pH and Ca concentrations. "Don't really retire. Keep your hand in, even without benefit of grants."

Harry Goldblatt gains most satisfaction in that, even at 76, he is privileged to carry on the same activities in which he was engaged at 36. "Don't retire, if you can possibly avoid it."

Paul Reznikoff has been an Emeritus Clinical Professor of Medicine since 1961 and a Consulting Physician at the New York Hospital - Cornell Medical Center. He is Secretary-General of the 12th Congress of the International Society of Hematology which will take place in New York City in 1968. He still thinks the capillaries are fascinating. "If possible don't retire. But by all means have an avocation or hobby which you can pursue if you are forced to retire, and start this early in life, long before retirement."

Hudson Hoagland expects to be retired from his administrative position on January 1st. He will retain his office and secretary and will be writing and participating in research projects for which he has been responsible for initiating over the years.

Samuel A. Matthews is carrying on his usual activities in the Department of Biology at Williams.

H. S. Mayerson's present position involves helping to run a 580 bed community hospital, about 110 years old, with all the trials and tribulations incident to a situation which involves some 2500 people - sick and well. This hospital has always been closely associated with the Tulane Medical School and serves as an affiliated hospital for residency programs for it and for Louisiana State University School of Medicine. About 75 per cent of the active staff are members of one or the other faculty. Students in various departments take their clinical work here and they have a School of Nursing and the usual para-medical training programs. "I am having fun and working harder than I have worked in many years..."

I was busy last spring doing the final touches on the proceedings of our lymph conference of December 1965. The volume should be out within the next four to five months. Modestly, I think its the best single collection of papers to date."

Wallace O. Fenn continues on the active list with a special appointment as "Distinguished University Professor of Physiology." He has no official duties in the University, but participates in the teaching by special invitation at times. "I have resigned as Director of the Space Science Center of the University, so I have no administrative responsibility except for my secretary and a technician. About half my time is spent in looking after the Physiological Congress affairs, and the other half is spent on my research project and in writing. I have a small laboratory and office for my use and remain busy and contented. In reality, I do not believe that anyone really retires until he fails to let himself be challenged by something which seems a little too big for him to handle properly. If it all seems easy it is probably time to quit."

Earl Thomas reports that his research field remains the same - G.I. Physiology with special emphasis on the pancreas. Recently he has returned to his first love, gastric and intestinal motility, but only as a sideline. He has resigned as Department Chairman but continues to teach and do research. "My greatest satisfaction comes from training young men and women in research methods and in the scientific approach to problems. The lasting friendship of these young people, whom one has opportunity to influence in many ways, is the teacher's greatest reward. My advice to those approaching retirement is 'Don't!'"

John Welsh plans to retire in 1968 and will stay on in Cambridge for two additional years of research and writing.

C. Beecher Weld is continuing at the Dalhousie University in the Department of Physiology and Biophysics on a full-time basis despite his retirement in 1965. His research activities have fallen away markedly; a much greater proportion of his time is spent in reading, teaching, general University affairs. "Some years before retirement I seriously took up painting as an outside activity and have really worked at it. I also allowed myself to be drawn into a certain amount of public activity such as club directorships, museum boards, etc. Others would prefer different types of activities, but I am sure it is necessary for an individual to deliberately plan and become involved in activities outside his ordinary profession in order to help him with his retirement."

Henry A. Blair is still occupied about as usual at the University of Rochester with some teaching, research and administering for the Atomic Energy Commission its fellowship program in Industrial Medicine.

Chauncey D. Leake, Director Special Research Studies at the University of California, San Francisco Medical Center is busy editing, reviewing, running Drug Information conferences and other conferences for the New York Academy of Sciences, the Aspen Institute for Humanistic Studies, writing, lighting the Bohemian Grove dramatic productions, and travelling. "On approaching retirement, get busier than ever before!"

James A. Greene has retired and is living at 3614 Ocean Drive, Corpus Christi, Texas, 78411. He is occupied with fishing, golf, gardening, traveling, reading and learning oil and water color painting.

Henry T. Ricketts has just retired. He will continue some clinical work in the University as well as editorial jobs.

George O. Gey is continuing scientific activities more strenuously than ever. "I spend my free time fishing anywhere and everywhere there is an opportunity to give a lecture on our chosen topics which attempt to describe the special habits and nature of tumor and normal cells and especially as seen in vitro. I enjoy the many consultations with young eager Fellows working here in my laboratory whose questions often cover the contemporary waterfront and, also, the many interviews with established cell physiologists who constantly reaffirm our great ignorance of basic physiological processes and especially as they relate to dynamic morphology, preservation of function and differentiation, and, of course, our ignorance of established differences between normal and tumorous cells of isogenic origin."

Charles A. Winter retires in October 1967 and is considering the possibility of accepting an appointment for at least half-time work in either an academic setting (physiology or pharmacology) or in an independent lab.

Robert A. Kehoe recently spent three months in Santiago, Chile as a consultant to the Pan American Health Organization, in developing a program of research and graduate education in Occupational Health, in the Institute of Occupational Health and Air Pollution in the University (a joint Chilean governmental and Pan American activity). He has several years of hard work ahead in getting out a monograph which will cover his work for the past forty years on the problems associated with lead in the environment of man.

Percy Dawson who was elected to the society in 1900 reports in his colorful style, "The work on the autobiography goes slowly, but I am almost ready to bet that I will finish this first (and only) draft before I am extinct. Up to the present I have refused to consider the subject of reader and publisher, lest ideas and notions regarding these should damage my objectivity. But now I am beginning to consider this matter though I do not dwell much upon it. As I think I told you before, this manuscript along with my other manuscripts will go to the Archives of the University of Wisconsin."

Peter V. Karpovich expects to retire next February. He is not seeking any position, administrative or teaching or even research. His back still bothers him on occasion.

W. A. Selle will not retire for two years. He is Professor of Biophysics and Lecturer in Physical Medicine at UCLA. He is engaged in research on osteoporosis at Long Beach General Hospital, where he is consultant in Physical Medicine.

M. L. Tainter thinks he will retire in two years at age 70. He is carrying a full load of work and enjoying it.

Evelyn Anderson is with the Space Administration and will probably be there for a couple more years. After that she wants very much to go into the practice of geriatrics. Such a career might be pursued either in California or in the South Pacific. Both places are attractive for living.

Elaine P. Ralli is in charge of the Out Patient Departments of the City of New York and is trying to improve the medical care to the indigent poor. She is concerned with clinical problems, with care of patients and with nutritional investigation.

A. R. McIntyre advises "Don't retire, simply find a new job - Peace Corps or anything."

V. F. Lindeman will retire in 1968 when he plans to give up active research and teaching. For the past year he has been collaborating in writing a couple of textbooks for use in the elementary schools.

Ernst Simonson retired from the University of Minnesota in 1966 and was appointed Director of Medical Electronic Research at Mount Sinai Hospital. He has an NIH grant for reviewing Russian cardiovascular literature and another for writing a comprehensive monograph on performance and fatigue. Unfortunately, there was a fire at the research building at Mount Sinai Hospital where his office is located. The fire started directly beneath his office and most of his reprints for the monograph were damaged or destroyed. He was honored at a banquet on September 28, 1967 by many of his colleagues.

Edmund Jacobson is busy writing up years of unpublished material in journals and monographs.

Franklin C. McLean reports that since January 1, 1966 he has been a Visiting Professor, on salary, in the Department of Histology of the College of Dentistry, University of Illinois. He is continuing scientific activities in a favorable environment, and has recently completed the 3rd edition of the book on "Bone" by McLean and Urist. "My present mode of life is ideal from my point of view. While I am doing little work on scientific problems I have daily contact with the fields of my interest, and am free to do anything I wish. My only advice to those approaching retirement is to keep working. I am 79 this year, and am following my own advice."

John W. Bean has four years before the compulsory termination which is 70 at the University of Michigan.

Julia Herrick has accepted an invitation to become Senior Research Scientist on the staff of the Interscience Research Institute in Champaign, Illinois. Although the Interscience Research Institute is independent of the University of Illinois she hopes to develop good relations with physiologists in the Department of Physiology at the University of Illinois.

Alexander Hollaender gave up the directorship of the Biology Division of the Oak Ridge National Laboratory on January 1, 1967, but is staying on as a full-time member of the staff of the Biology Division as a Senior Research Adviser. He will concentrate a good part of his efforts on cooperative work which he has initiated in Latin America and which is now being extended to the Far East. He is helping to develop the teaching of modern biology in Pakistan and India, and he has just made contracts with people in Djakarta to develop an international institute of tropical biology at Bogor, Indonesia.

Otis O. Benson, Jr. is Staff Director for Biosciences and Bioengineering in the Southwest Research Institute. He and his wife went recently to an international medical meeting in Lisbon where he gave a paper on "Biomedical Engineering." He counsels those about to retire "to stay active in vocational areas of interest and in which they have competence. There is a direct relationship between satisfaction and competence. I must add that a continued inflow of that 'green stuff' is needed in these days of spiraling inflation - as one mundane fact of life."

Paul E. Howe is in good health; he keeps in touch with scientific activities through Science and technical journals - Biochemistry, Nutrition, Indian J. Nutrition and Dietetics.

Louis N. Katz is retiring September 1st but will continue as Emeritus in the Cardiovascular Institute and will serve as a consultant to Dr. Fishman, who has succeeded him. He will continue a research program with R. Pick on "The Influence of Environmental Stress on Experimental Atherosclerosis." He is writing a text book on Heart Disease with E. Silber which he hopes to have published in two years. He has commitments to the Chicago Heart Association to organize an International Symposium on Atherosclerosis in the Fall of 1968. He is maintaining an active interest in the International Program of the American Heart Association and in the International Cardiological Society (and Foundation). He has accepted a Visiting Professorship at the University of Chicago beginning this Fall, to be responsible for the regular course on respiratory, renal, and cardiovascular physiology.

K. K. Chen teaches full time at Indiana University Medical School, is writing papers from accumulated data and is soliciting contributions from the drug industry for the XXIV International Congress of Physiological Sciences. He recommends making plans as what to do before retirement, keeping busy during retirement and saving sufficient money long before retirement.

Stanley Reimann has 200 pages written for another book and is contemplating a paper back based on his last one on normal growth and cancer. He gets great satisfaction in knowing how many friends he has and in meeting former students and discovering they're getting along well. "Make sure you have some interests other than your profession. I have music and cabinet work."

E. J. Van Liere recommends continuing to do creative work as long as possible. He is continuing his research on altitude physiology and

has just completed a book, "Medical and Other Essays." He still believes that there should be a statutory age of retirement and that heads of departments, deans, vice-presidents and presidents should step down at age 65, but should be allowed to teach or do research until they are 68 or even 70.

Emmett B. Carmichael has discontinued experimental work but is still editing "The Alabama Journal of Medical Sciences" with the new title of consultant to the editorial board. He is president of the American Institute of Chemists for 1967-1969. The hobby that gives him most satisfaction and pleasure is writing biographical sketches about Alabama physicians and chemists; he publishes two to four annually. He conducts the Alabama Science Talent Search under the auspices of the Gorgas Scholarship Foundation, Inc. "My advice for those who are approaching retirement is for them to make plans to keep active and busy at time-consuming projects. I believe that at least one activity should be physical in nature such as gardening, hiking (walking), golf, etc."

J. F. McClendon is writing a book on native American Folk Medicine. He has the scientific names of 1250 species of native American plants used by Indians for drugs and sources of vitamins, and some information of Mexican Curandras and similar people of Colombia, South America. He spent 1889-1904 between Austin, Texas and Guadalajara, Mexico and wrote a Master's thesis on adaptations of Yuccas and Nolinias to the desert. "I tried to make my living collecting Mexican tropical animals but gave it up after three months. In 1895 I read Darwin and in 1907 was fired for believing in evolution. In 1906 I heard a preacher at the Academy of Natural Science, Philadelphia, rise up during a lecture by J. Percy Moore on "The Descent of Man" and announce to the audience that it was a damned lie. It caused me to ask myself "Why did St. Paul need a physician?" I believe St. Paul was a fiery evangelist starting out to convert the world and used St. Luke M.D. as a press agent because the other Christians could not read and write."

W. W. Tuttle has consulting appointments that keep him busy.

Lucien Brouha is recuperating at his home in Sutton, Vermont from major surgery. Elizabeth writes that he is back on his feet but is progressing slowly.

Arthur H. Steinhaus held a distinguished service professorship in physiology at the Chicago College of Osteopathy for one year. He then accepted an invitation to join the staff of the Human Energy Research Laboratory at Michigan State University. He has become convinced that physiology should serve three functions. First, to perpetuate itself that is the field of research and the teaching of teachers of physiology. Second is to serve mankind through the profession of medicine and third is to serve mankind through the profession of education. He suggests that retired physiologists turn their attention away from medical problems to education and see how they might serve mankind through this important field. This is not primarily a call for research in this area, but rather to point out the need of interpreting the present knowledge in a form that would be significant for education.

Charles B. Puestow is Chief of Surgical Service at Hines and hopes to remain so for a few years. His greatest satisfaction comes from the administration of their residency training program. He counsels surgical residents working for an advanced degree. "I do not think I could retire completely and be happy." Indicative of the regard these residents have for him the Hines Surgical Association was renamed in 1963 the Charles B. Puestow Surgical Society. Two hundred members of the Society held a dinner in his honor on June 10 and unveiled a portrait that will be hung in Hines Hospital.

William A. Hiestand has been incapacitated for five years with multiple sclerosis.

Harry G. Armstrong has moved from his Virginia farm to San Antonio. He is recuperating successfully from removal of an aneurysm of the abdominal aorta. "Those facing retirement should never make the mistake of thinking that a life of idleness is ever 'fun' for more than two months after which it becomes a tragedy."

Leigh E. Chadwick retired from the University of Illinois in June 1966 and settled in an all-year home at Blue Hill Falls, Maine. He is busy translating from German books and papers such as a summary by Von Frisch of a book on "The Language and Orientation of Bees"... that recounts... the development of his views about bee communication.

Hubertus Strughold plans to keep active after retirement. He is busy with lectures and writing having almost finished three books, "Mars Environmental Medicine", "Bioastronautics and the Solar Planetary System", and "Your Body Clock in this Jet and Space Age." Next year he will help celebrate the Golden Anniversary of Aerospace Medicine.

Ann Minot went to Vanderbilt in 1926, and in time became professor of biochemistry in medicine. She was put on Emeritus basis about five years ago and is still working fulltime including one lecture course. Her research projects include one in orthopedics and another in pathology on a study of physiological and biochemical factors predisposing to fat emboli formation. "I... pass on the advice of my 96 year old mother who says 'Keep at work at something that interests you and which needs doing and you won't grow old so fast.' Personally I think it about as unphysiological to quit a forty-year habit of working as it is to quit smoking after a similar length of time - so I am doing neither."

Frederick R. Miller is in a nursing home. A Public Trustee administers his estate.

Alfred C. Redfield reports that life goes well with him. Since retiring in 1956, he has been investigating natural phenomena. He has been applying a physiological way of thinking to problems in ecology. He lives in Woods Hole with access to the MBL Library and to the service departments at the Oceanographic Institute and enjoys the companionship and council of the younger men there. "My advice to those approaching retirement is to read an essay on retirement written by Henry James who for many years ran TIAA. His point was to start planning for it many years in

advance, to develop an interest or hobby which will keep you occupied and happy and not to think you will make any money out of that book you are probably planning to write - do not hesitate to take up something a little different or something which will take ten or fifteen years to accomplish. And above all, do not remain dependent on the kindness of the institution to which you have been attached."

Wilhelm Raab is in excellent health and is continuing his scientific activities under an NIH grant.

C. A. Smith spends summers at his Camp Idlehours on Mascoma Lake near Enfield, New Hampshire, where he as many challenges to his multiple skills with the tools of carpentry, plumbing, painting, and woodsmanship. He advises starting as a youngster in developing a wide variety of interests and skills.

Sydney W. Britton comments on the invigoration he derives from wandering over the face of the earth, getting so much nearer to human history and heritage such as that provided by a recent three-months' wandering through Mexico, including Yucatan. "...in the duller weather or between seasons we delve into literature, rhapsodize in music, work hard at gardening..."

Ernst Gellhorn published a book on Principles of Autonomic-Somatic Integrations last March and the summer issue of Perspectives in Biological Medicine has an article of his own on Tuning of the Nervous System. He has time to think and enjoy nature, music, and reading. He still is waiting for the arrival of the mellowness of old age.

E. F. Adolph, emeritus professor of physiology at the University of Rochester, spends full time there in research on the ontogeny of physiological regulations. He finds great satisfaction in living among scientists who are seething with ideas and deeds.

Arturo Rosenblueth is director and head of the department of physiology of the Centro de Investigacion y de Estudios Avanzados del Instituto Politecnico Nacional in Mexico City. He is in good health and is leading a full, happy life spending most of his time continuing his scientific activities.

Wilder Penfield reports that his health is good. His only scientific activity has been to write some further elaborations of the evidence collected up to 1960, on the neurophysiology of man. "My satisfaction, and that of Mrs. Penfield, comes from living our lives and keeping pace as nearly as we can with what is happening in the world. I have devoted my time to writing, having finished a book which took me five years - "The Difficult Art of Giving; The Epic of Alan Gregg." While waiting for that to appear, I have written a very small book called "Man and His Family," McClelland and Stewart, Toronto. His advice is "choose your second career, choose it early in life, but when you start on it, start as a beginner. It's a wonderful thing to be climbing upward..."

Ruth Conklin is in excellent health except for some neurogenic im-

pairment of hearing. She returned to Vassar for one semester of part-time work in 1965. She helps in social action: Women's Job Corps and member of Social Action Committee of State Conference of United Church of Christ. She has a large house where she is hospitable to a good many people including a Philippine graduate student and a friend with terminal carcinoma. "Those approaching retirement should establish contacts with people outside their field, particularly young people, so that they develop other interests and are not at a loss when their regular employment stops."

H. B. van Dyke is in excellent health and is continuing full-time activities combining teaching and research as Visiting Professor of Pharmacology in the University of Malaya under the sponsorship of the China Medical Board of New York, Inc. Since his retirement in 1963, he has been Visiting Professor in Taiwan 1963-1964 and since then Visiting Professor in the University of Malaya. Full-time research during part of the year and a combination of teaching and research during the remainder of the year give him special satisfaction. . . . "Those approaching retirement should if possible continue their present activities." His comment on the "retirement crisis" (see *Science* 7 July, 1967): "As far as I am concerned there is no such thing as a retirement crisis."

Rafael Dominguez is Director of Doctors Hospital in Cleveland Heights, Ohio. In his spare time he is trying to finish several experiments begun while still in pathology research at St. Luke's Hospital in Cleveland. He finds it impossible to be idle; he has not lost his interest in mathematics and devotes to it practically all of his free time.

Clarence A. Mills is in good health and feels that he is doing some of his life's best work on the effects of varying lunar-solar gravitational forces upon the earth and its inhabitants. A retired university scientist, he is disappointed in having been cut off from such university faculty facilities as artistic illustrations, use of special laboratory and mechanical equipment, typing and secretarial services, and (most important of all) practically complete inaccessibility of grant funds. This enforced isolation from such faculty privileges has constituted a very real "retirement crisis." This entails a waste of highly specialized and highly important mental abilities still of real potential value to humanity.

Baird Hastings is in excellent health. In September 1966 he became Member Emeritus of the Scripps Clinic and Research Foundation. He is now Research Associate in Neurosciences of the Medical School of the University of California at San Diego. He is learning a field new to him (the nervous system) and is helping Robert Livingston with his Neuroscience Study Plan, surrounded by faculty and students who are engaged in all phases of oceanography and marine biology, as well as the ordinary pursuits of a university. The feature of his situation is that he likes most being in an environment of youth. The atmosphere reeks with the future; there is no smog of the past. His advice is, "Don't retire - just change your field of activity. But, if you are used to having a secretary, don't try to get along without one!"... "Go fishing whenever and wherever you can. I work six days a week and go fishing on Sunday. It is an ageless profession."

Charles D. Snyder, 66 years a member of the Society, celebrated his 96th birthday April 30. He is in good health, "all vital organs are in first class condition." He has turned his attention to the Demographic Distribution of Cultural Achievements and also to playing the New York stock market so successfully that he regrets not having done so earlier. His wife, a good companion, is an invalid so he feels he should stay at home with her.

Percival Bailey is in fair health; he is writing his autobiography.

Hal Davis, in excellent health, is continuing full time scientific activities. He enjoys freedom to work on what interests him including rounding out projects that were begun long ago. He advises, "Stay healthy if possible; stay interested in any case!"

A. V. Hill, one of the Society's honorary members, has returned to live in Cambridge after 47 years away from it. His health is very good, except for proprioceptors in his legs, which don't function well. His last experiment was made at University College, London, on 28 May. Now he will spend a year or two in fitting bits of information together obtained during the last 2-1/2 years and writing a book on the result. "I approached retirement in 1951, since when I have done quite a lot of things, always bearing in mind the rule to get out before anyone wants you to. Perhaps the last words could be considered advice, but I use them only when I have to insist on giving things up. I remember arguing once with Lloyd Berkner about giving up being Secretary General of ICSU and finally settled it by saying, 'Look here Lloyd, I'm 70 years old and am damned well going to do what I like' ... Whether you would describe these as 'pregnant comments' I don't know. I once laughed at Jo Barcroft for one of his Irish bulls. He replied that the Irish bulls had one great virtue - that is was always pregnant."

COMMISSION ON MOLECULAR BIOPHYSICS
Symposium on
INTERACTIONS BETWEEN SUB-UNITS
OF BIOLOGICAL MACROMOLECULES

To be held at
Cambridge, England
24 - 27 June, 1968

Program Outline

Monday, June 24	Muscle and other motile systems
Tuesday, June 25	Viruses I Structure and electron microscopy Viruses II Disaggregation and Assembly
Wednesday, June 26	Viruses III Structure and Assembly of T.M.V.
Thursday, June 27	Oligomeric enzymes and multi-enzyme complexes

Persons wishing to attend should apply to Dr. K. C. Holmes, Laboratory of Molecular Biology, Hills Road, Cambridge, for the application forms which will be sent when available.

THE COMMISSION ON CELL AND MEMBRANE BIOPHYSICS

The Commission on Cell and Membrane Biophysics is proposing to hold a Symposium on Permeability Problems at Jerusalem, Israel from 2nd to 9th July, 1968. The topics to be discussed will be:

1. Transport problems arising in animals and plants under arid conditions.
2. Transport across epithelia.
3. Water transport in biological systems.
4. Physical chemistry of charged membranes.
5. The theoretical interpretation of tracer fluxes.

Persons interested are invited to submit nominations for attendance at this Symposium before 1st December, 1967. It would be helpful if lists of names could be sent both to:

Professor A. Katchalsky
Weizmann Institute of Science
Rehovoth, Israel

and to

Dr. R. D. Keynes
A. R. C. Institute of Animal Physiology
Babraham, Cambridgeshire
England

SYMPOSIUM
ON
TECHNICAL AND BIOLOGICAL PROBLEMS IN CYBERNETICS

An international symposium on Technical and Biological Problems in Cybernetics will be held in Erivan, Armenia, USSR in October 1968.

Approximately 100 papers, in total, are being solicited, 20-25 from the United States. In the United States emphasis will be placed on bio-medical aspects of the symposium in order to avoid duplication with United States participation in the All Union IFAC Congress.

The subjects will be grouped in the following problem areas:

1. Characteristics of bio receptors, their analogues; engineering applications.
2. Characteristics of higher nervous activity and its modelling (brain, neural nets, neurons).
3. Adaptive bio processes and systems.
4. Organizational principles of bio systems and their evolution.
5. Common man and machine operation, including psychological links.
6. Application of cybernetics to artificial bio structures (heart, lung, kidney, limb, etc.).
7. Application of computers in bio problems.

Papers should be submitted to Arthur Iberall, General Technical Services, Inc., 8794 West Chester Pike, Upper Darby, Pa. 19082, or to James Reswick, Case Institute of Technology, Cleveland, Ohio 44106.

In order to allow adequate time for American review and Russian translation, the deadline for submitting papers is February 1968 - there will be no exceptions for late papers.

JANE ANNE RUSSELL (WILHELMI)

February 9, 1911 - March 12, 1967



Jane Anne Russell (Mrs. Alfred E. Wilhelmi) died of cancer on March 12, 1967 after having given one of the most extraordinary exhibitions of grace and courage one can imagine. She had been ill for four years and had been quite sure she was mortally so for nearly two but in spite of this burdensome knowledge she continued to work, with her customary skill and enthusiasm and utterly without self-pity, until the end. Shortly before her death a friend found her surrounded by manuscripts submitted to the American Journal of Physiology, a journal which she served with great distinction as Section Editor for endocrinology and metabolism.

Jane was a native Californian, the daughter of vigorous pioneer parents. She was born on an isolated homestead in the place now known as Watts. Her outstanding performance as a student at the public high school in Long Beach was a good prognostic sign of many honors to come. At Berkeley, where she worked part-time in Dr. Sundstroem's laboratory in order to help support herself, she graduated first in her class and was awarded a gold medal. (This is the sort of information that one could never elicit from Jane.) There is a kind of musical beauty in the fact that the last graduate student who studied with her worked on the role of the adrenals and pituitary in the adaptation of rats to low partial pressures of oxygen, a problem in which she became interested as a Berkeley undergraduate in Sundstroem's laboratory.

Following her graduation in 1932 she became a Ph.D. candidate in the famous institute of Experimental Biology at Berkeley where H. M. Evans, P. E. Smith and others had done their exciting work on the pituitary gland. Jane's thesis problem was on the effects of anterior pituitary extracts on carbohydrate metabolism, a subject on which she was an acknowledged world authority for the rest of her life. Slowly and carefully she built the concept that growth hormone functions as a physiologic antagonist to insulin, that it probably plays an important role in the conservation of glucose during starvation and that it works acutely in the homeostatic regulation of blood glucose. All of these brilliant inferences were made from the application of simple analytical methods in beautifully designed experiments. She was delighted to see her theories resoundingly confirmed by the outstanding studies of Glick, Roth, Berson and Yalow on the fluctuations in serum growth hormone on starvation and in hypoglycemic states.

It is a measure of Jane Russell's capacity for growth that, after having begun her career when blood glucose and tissue glycogen analyses and R. Q. estimations were among the most powerful tools of the metabolic physiologist, she lived to write a most penetrating and insightful essay on the subject of the use of isotopes in the study of intermediary metabolism. She was a pioneer in the application of statistical methods in the analysis of biologic data and, in her capacity as editor, she insisted on proper experimental design and sound statistical analysis. This most gentle of women could not bear to see the science she loved violated by fuzzy thinking, a convoluted prose style or mathematical incompetence.

Though she wore her massive erudition lightly, Jane Russell was an inspiring teacher who had a great capacity for communicating her enthusiasm to grateful and appreciative students. She could scarcely have been otherwise, for she was devoted to her subject and she had great affection and respect for her students. She was enormously proud of her graduate students and of their accomplishments and, though she was not medically qualified, she understood the special needs and anxieties of medical students and sympathetically tried to show them the relevance of endocrinology to life and disease. For this they were grateful, and, when she completed her last lecture after having insisted on continuing though her vertigo prevented her from seeing her notes, they presented her with a large bouquet of red roses. Surely, this accolade must have pleased her even more than receiving the Ciba and (with Alfred) the Upjohn awards of the Endocrine Society.

Jane knew the special happiness of research as a family enterprise, for her skills and knowledge were happily complementary to those of her well loved husband. Even when they were not working on precisely the same problem the work of each gained from discussion with the other. The remembrance of their pride in one another will continue to be a source of pleasure to their many friends.

It is a little difficult to imagine Jane the skilled seamstress, virtuoso sweater knitter, champion gardener and Siamese cat lover as a member of the august Board of the National Science Foundation. She moved quietly but easily among the most prestigious scientific brass and was not easily awed by the highest ranking official of a Space program or the head of an elaborate atomic energy installation. She had an intelligence that was like a beautifully discriminating chromatography column which was able to make quick and sure separations of genuine from counterfeit, product from package, and, yes, message from medium. Her brilliance and courage were only components of a warm and generous person who was happy to share what she had and what she knew.

Physiology and her friends, though they may miss her, will remember her with gratitude and affection.

Jay Tepperman