(*65*) have discussed the evidence for carcinogenic activity of unburned tobacco in producing oral cancers. Wynder (*66*) has reported some evidence that alcohol consumption increases a smoker's susceptibility to laryngeal cancer. The evidence regarding the etiologic role of smoking in gastrointestinal disease is highly controversial (*67, 68*).

Case and Lea (*69*) found an association between chronic bronchitis and lung cancer in World War I pensioners. Unfortunately, smoking histories were not available. However, Joules (*70*), Palmer (*71*), Oswald and Medvei (*72*), and Abbott and associates (*73*) found that chronic bronchitis was closely associated with heavy smoking (see *74*). Lowe (*75*) found that heavy smokers were significantly more common among tuberculosis patients than among control patients.

P) For references to the voluminous literature on this condition, see Allen, Barker, and Hines (*76*).

References

1. F. H. Muller, *Z. Krebsforsch.* 49, 57 (1939).
2. E. Schairer and E. Schöniger, *ibid.* 54, 261 (1943).
3. W. F. Wassink, *Ned. Tijdschr. Geneesk.* 92, 3732 (1948).
4. R. Schrek *et al.*, *Cancer Research* 10, 49 (1950).
5. E. L. Wynder and E. A. Graham, *J. Am. Med. Assoc.* 143, 329 (1950).
6. C. A. Mills and M. M. Porter, *Cancer Research* 10, 539 (1950).
7. R. Doll and A. B. Hill, *Brit. Med. J.* 1952II, 1271 (1952).
8. R. B. McConnell *et al.*, *Lancet* 1952II, 651 (1952).
9. D. A. Sadowsky *et al.*, *J. Natl. Cancer Inst.* 13, 1237 (1953).
10. E. L. Wynder and J. Cornfield, *New Engl. J. Med.* 248, 441 (1953).
11. M. Koulumies, *Acta Radiol.* 39, 255 (1953).
12. M. L. Levin, *N.Y. State J. Med.* 54, 769 (1954).
13. L. Breslow *et al.*, *Am. J. Public Health* 44, 171 (1954).
14. W. L. Watson and A. J. Conte, *Am. J. Surg.* 89, 447 (1955).
15. S. J. Cutler, *J. Am. Statistical Assoc.* 50, 267 (1955).
16. P. Stocks and J. M. Campbell, *Brit. Med. J.* 1955II, 923 (1955).
17. E. L. Wynder *et al.*, *New Engl. J. Med.* 255, 1111 (1956).
18. R. Doll and A. B. Hill, *Brit. Med. J.* 1954I, 1451 (1954).
19. E. C. Hammond and D. Horn, *J. Am. Med. Assoc.* 155, 1316 (1954).
20. R. Doll and A. B. Hill, *Brit. Med. J.* 1956II, 1071 (1956).
21. E. C. Hammond, *CA* 6, 156, 163 (1956).
22. J. Berkson, *Proc. Staff Meetings Mayo Clinic* 30, 319 (1955).
23. J. Cornfield, unpublished address before the Am. Chem. Soc., 24 Feb. 1956.
24. R. Korteweg, *Brit. J. Cancer* 10, 282 (1956).
25. M. L. Levin, in *Proc. Third Natl. Cancer Conf.* (Lippincott, Philadelphia, 1957).
26. A. M. Lilienfeld, *Public Health Repts. (U.S.)* 72, 51 (1957).
27. W. Haenszel *et al.*, *Public Health Monogr. No. 45* (U.S. Dept. Health Educ. and Welfare, Washington, D.C., 1956).
28. W. Haenszel and M. B. Shimkin, *J. Natl. Cancer Inst.* 16, 1417 (1956).
29. E. C. Hammond, unpublished address before the Am. Statistical Assoc., 27 Dec. 1955.
30. W. C. Hueper, *Public Health Monogr. No. 36* (U.S. Dept. Health Educ. and Welfare, Washington, D.C., 1955).
31. P. Kotin, *Cancer Research* 16, 375 (1956).
32. A. M. Baetjer, *Arch. Ind. Hyg. and Occupational Med.* 2, 505 (1950).
33. A. M. Lilienfeld, *Cancer* 9, 111 (1956).
34. E. L. Wynder *et al.*, *Cancer Research* 15, 445 (1955).
35. L. R. Holsti and P. Ermala, *Cancer* 8, 679 (1955).
36. G. E. Moore and F. Bock, *Surgery* 39, 120 (1956).
37. K. Sugiura, *Gann* 47, 243 (1956).
38. N. Nelson *et al.*, unpublished data.
39. A. H. Roffo, *Bol. inst. med. exptl. estud. cancer* 20, 103 (1943).
40. W. H. Woglom, *Arch. Pathol. Lab. Med.* 2, 709 (1926).
41. A. Gellhorn *et al.*, *Proc. Am. Assoc. Cancer Research* 2, 109 (1956).
42. R. L. Cooper and A. J. Lindsey, *Brit. J. Cancer* 9, 304 (1955).
43. J. Bonnet and S. Neukomm, *Helv. Chim. Acta* 39, 1724 (1956).
44. R. Latarjet *et al.*, *Bull. der Cancer* 43, 180 (1956).
45. E. L. Wynder and G. Wright, *Proc. Am. Assoc. Cancer Research* 2, 159 (1956).
46. S. Z. Cardon *et al.*, *Brit. J. Cancer* 10, 485 (1957).
47. E. L. Wynder, *Brit. Med. J.* 1957I, 1 (1957).
48. A. Lacassagne *et al.*, *Compt. rend. acad. sci.* 244, 273 (1957).
49. O. H. Robertson, *Physiol. Revs.* 21, 112 (1941).
50. C. C. Macklin, *J. Thoracic Surg.* 31, 238 (1956).
51. A. C. Hilding, *Ann. Otolol. Rhinol. and Laryngol.* 65, 116 (1956).
52. R. C. Mellors *et al.*, *Proc. Am. Assoc. Cancer Research* 2, 132 (1956).
53. H. Black and L. V. Ackerman, *Ann. Surg.* 136, 44 (1952).
54. O. Auerback *et al.*, *New Engl. J. Med.* 256, 97 (1957).
55. S. C. Chang, unpublished Ph.D. dissertation, Washington Univ., St. Louis, Mo. (1956).
56. S. C. Chang and E. V. Cowdry, *Proc. Am. Assoc. Cancer Research* 2, 10 (1955).
57. R. Pearl, *Science* 87, 216 (1938).
58. M. Gertler and P. D. White, *Coronary Heart Disease in Young Adults* (Harvard Univ. Press, Cambridge, Mass., 1954), p. 16.
59. J. P. English *et al.*, *J. Am. Med. Assoc.* 115, 1327 (1940).
60. L. M. Bargeron, Jr., *et al.*, *Circulation* 15, 251 (1957).
61. F. W. Davis, Jr., *et al.*, *Am. Heart J.* 51, 165 (1956).
62. J. Travell *et al.*, *Federation Proc.* 16, 341 (1957).
63. A. M. Lilienfeld *et al.*, *Arch. Internal Med.* 98, 129 (1956).
64. H. L. Friedell and M. D. Rosenthal, *J. Am. Med. Assoc.* 116, 2130 (1941).
65. G. E. Moore *et al.*, *J. Am. Geriatrics Soc.* 1, 497 (1953).
66. E. L. Wynder *et al.*, *J. Am. Med. Assoc.* 160, 1384 (1956).
67. T. I. Bennett, *The Stomach and Upper Alimentary Canal in Health and Disease* (Heinemann, London, 1925), pp. 18, 87, 168.
68. O. A. Trowell, *Lancet* 1934I, 808 (1934).
69. R. A. M. Case and A. J. Lea, *Brit. J. Preventive Social Med.* 9, 62 (1955).
70. H. Joules, *Brit. Med. J.* 1954II, 1259 (1954).
71. K. N. V. Palmer, *Brit. Med. J.* 1954I, 1473 (1954).
72. N. Oswald and V. C. Medvei, Lancet 1955II, 843 (1955).
73. O. A. Abbott *et al.*, *Thorax* 8, 116 (1953).
74. P. W. Clough, *Ann. Internal Med.* 45, 319 (1956).
75. C. R. Lowe, *Brit. Med. J.* 1956II, 1081 (1956).
76. E. V. Allen *et al.*, *Peripheral Vascular Disease* (Saunders, Philadelphia, 1946), p. 403.

H. N. Russell, Astronomer

The death of Henry Norris Russell on 18 February marks the passing of one of the most brilliant minds that has flourished in the modern scientific world. A scientist of truly remarkable breadth, he was for many years the leading theoretical astronomer in this country and a pioneer in the use of atomic physics for the analysis of stars.

Russell's astronomical career began, as it ended, at Princeton University, where he spent 62 of his 79 years. He entered Princeton with the class of 1897 and was graduated with the highest scholastic record of his generation. During the quarter of a century when Latin honors were awarded to high-standing seniors, he was the only Princeton undergraduate whose record was so outstanding that he was graduated *insigni cum laude*. His Ph.D. degree was obtained at Princeton 3 years later, under C. A. ("Twinkle") Young, his famous predecessor at the Princeton Observatory. After 2 years in Cambridge, England, he returned to Princeton University, where he rose rapidly up the academic ladder and became professor of astronomy in 1911, at the age of 33. The following year, he became director of the Princeton University Observatory, succeeding Young.

During his early years as an astronomer, Russell engaged in a number of programs, largely in such classical topics as stellar parallaxes, photographic positions of the moon, and celestial mechanics. In 1912 he turned to the analysis of stellar spectra, a subject in which he remained active throughout his career. The famous diagram of stellar luminosity against surface temperature, originated

by Hertzsprung, was used so extensively by Russell in his physical analyses of stars and in his theories of stellar evolution that this basic plot is generally referred to as the "Hertzsprung-Russell diagram." In the same year he published his analysis of the light curves of eclipsing variable stars. These double stars, whose light varies periodically because one star eclipses the other, had been known for some time, but no simple method existed for interpreting the observed light curves quantitatively. With a characteristic genius for handling complicated data, Russell devised a convenient and useful method for extracting full information from such observations. The method did not long remain untried. "For then," as Russell later used to remark, "the Lord sent me Harlow Shapley." This young Ph.D. candidate at Princeton, who was destined to become Russell's best known student, applied Russell's techniques to 87 double stars as his doctoral thesis. With the advent of photoelectric techniques, the observations are now much more accurate than they were 45 years ago, and more refined methods have been developed for certain types of binaries. However, Russell's method remains the standard one for a first interpretation of any eclipsing-variable light curve.

During World War I, Russell, like so many other scientists, became involved in military research. During the decade following the war, much of his time was spent in preparing a textbook on astronomy, in collaboration with his colleagues, R. S. Dugan and J. Q. Stewart. The first volume of this work was a revision of Young's *Manual of Astronomy,* but the second volume, dealing with modern astrophysics and stellar astronomy, was, for the most part, new. A great deal of effort went into the preparation of these two volumes. Virtually nothing was taken on faith, and much original research was carried on to provide material for the book. An indication of the thorough care that went into this textbook for undergraduates is the fact that, for almost three decades, "Russell, Dugan, and Stewart" remained a standard reference work, despite enormous advances in most astronomical fields.

It was, perhaps, the preparation of this general textbook that gave Russell the extraordinary knowledge of astronomy that was so characteristic of his mature years. An astronomer in any field could count on Russell's intelligent interest and helpful comments.

In 1924 he embarked on a research problem that was destined to take much of his time during the rest of his active life. In that year he published his first paper on the analysis of atomic spectra, a subject in which he became interested because of the pivotal importance of spectroscopy in astrophysics. During the next 10 years he published 25 papers in this new and exciting field of basic physics. A pioneer in this field, he originated, with Saunders, a theory for the coupling between spin and orbital momentum in atomic electrons. He took great delight in unraveling complicated spectra and in determining the atomic energy levels involved.

The years 1928–29 may be regarded as the apex of Russell's professional career. He was then just over 50 years of age and at the peak of his powers. Although immersed in the task of spectroscopic research, he carried on several other important analyses at about this time. His analysis, with Adams, of stellar spectra, appeared in 1928, and his great work, *On the Composition of the Sun's Atmosphere,* appeared in 1929. In these papers he used the Saha ionization equation to determine the pressure and chemical composition of stellar and solar atmospheres. He concluded, in variance with accepted beliefs, that hydrogen was overwhelmingly the most abundant element in the solar atmosphere. For many elements his values of relative abundances are still the best available, and his assertion of the great abundance of hydrogen has now, after a prolonged controversy, been accepted as one of the most basic facts of cosmology. During this same period he also published an analysis of the rotation of the line of apsides in eclipsing variables, in which he pointed out a very important method —in fact, the only observational method —for obtaining the density distribution in stars.

During his later years, Russell continued active research in all these fields. In addition, he maintained his lively interest in stellar evolution and planetary origin. His little monograph, *The Solar System and Its Origin,* did not present any new and sweeping theory but was of great help in clarifying the field and stimulated several of his students to productive work in this area.

On so outstanding a scientist, honors were showered from all sides. Medals were awarded him at various times by the Royal Astronomical Society (England), by the French Academy, by the National Academy of Sciences, by the American Academy of Arts and Sciences, and by the Astronomical Society of the Pacific. Honorary degrees were awarded him by Yale, Harvard, and Princeton universities, among others. He was a member of many learned societies and past president of several. In 1946, Mexico presented him with its highest award for foreigners, the Order of the Aztec Eagle.

There are few men now living who remember Russell as a young man. Those who knew him in his later years remember him for his unbounded energy and his enthusiasm for ideas. It is characteristic of the man that he would frequently be so carried away in his graduate lectures that he would talk enthusiastically for an additional hour or two, carrying his fascinated audience into exciting new realms of research. He brought this same keenness and enthusiasm to all the many experiences in his full and active life—to his extensive travels, his wide reading of both prose and poetry, and his happy hours with his grandchildren. He would keep small children engrossed for hours with the paper boats, balls, birds, and animals that he constructed with facility, his long, dexterous fingers folding and creasing the paper with unerring speed. His knowledge was encyclopedic; it included facts and theories not only in all branches of science but also in such varied subjects as the Bible and the wild flowers of New Jersey.

A deeply religious man, he was convinced that there was no basic conflict between science and religion. For several years he organized among the graduate students regular discussions of the interrelations between science and religion and published a little book on the subject, *Fate and Freedom.* Through his vast and cogent writings, through his many and vital discussions with colleagues and students, and through the sheer force of his personality and giant intellect and their impact on all who knew him, the influence of Henry Norris Russell will continue through many generations to come.

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