(quoted in ref. 3), August Weismann[4], Edmund Wilson[5] and Hugo de Vries[6], among others.

The early origins of molecular biology discussed by Gunther Stent[7] and others emphasise the desire to apply laws much like those of physics to biology. In this regard, Erwin Schrodinger's book *What is Life?*[8] was influential. Fifteen years before the publication of Schrodinger's book, the well-known biologist Edmund Wilson wrote a book with a similar intention entitled *The Physical Basis of Life*[9].

Whereas a preoccupation with physics may have motivated the so-called "phage group"[10] there was a separate origin for the application of physicochemical methods to studies of the structures of biological molecules[11]. W. Astbury, an X-ray crystallographer, clearly played a major part in this, and indeed was the first to coin the term molecular biology[12]. In addition, it is not generally realised that in 1949 Sven Furberg, a Norwegian graduate student in the laboratory of J. D. Bernal, was the first to propose a helical structure for DNA, albeit single-stranded, on the basis of X-ray studies on nucleosides[13].

We thus conclude that it is somewhat difficult to set a precise date for the origin of molecular biology, but we presume that by April 25, 1953, molecular biology had already come of age.

Yours faithfully,

FRANKLIN H. PORTUGAL

Viral Carcinogenesis Branch,
National Cancer Institute,
National Institutes of Health,
Bethesda, Maryland 20014

JACK S. COHEN

Reproduction Research Branch,
National Institute of Child Health and Human Development,
National Institutes of Health,
Bethesda, Maryland 20014

1 Watson, J. D., and Crick, F. H. S., *Nature*, **171**, 737 (1953).
2 Spencer, H., *Principles of Biology*, 2, 8 (Appleton, New York, 1867).
3 Coleman, A., *Proc. Am. Phil. Soc.*, **109**, 143 (1965).
4 Weismann, A., in *Essays upon Heredity and Kindred Biological Problems* (edit. by Poulton, E. B., Schonland, S., and Shipley, A. E.), 8 (Clarendon Press, Oxford, 1889).
5 Wilson, E. B., *The Cell in Development and Inheritance*, 358 (Macmillan, New York, 1900).
6 De Vries, H., *Intracellular Pangenesis*, 6, 48 (Open Court, Chicago, 1910).
7 Stent, G., in *Phage and the Origins of Molecular Biology* (edit. by Cairns, J., Stent, G., and Watson, J. D.), 3 (Cold Spring Harbor, 1966); *Science*, **160**, 664 (1968).
8 Schrodinger, E., *What is Life? The Physical Aspects of the Living Cell* (Cambridge University Press, Cambridge, 1944).
9 Wilson, E. B., *The Physical Basis of Life* (Yale University Press, New Haven, 1928).
10 Delbruck, M., in *Phage and the Origins of Molecular Biology* (edit. by Cairns, J., Stent, G., and Watson, J. D.), 9 (Cold Spring Harbor, 1966).
11 Kendrew, J. C., *Scient. Am.*, **216**, 141 (1967).
12 Astbury, W. T., *Nature*, **190**, 1124 (1961).
13 Furberg, S., thesis, London University (1949); *Acta chem. Scand.*, **6**, 634 (1952).

DNA synthesis in plants

SIR,—Buchowicz[1] reports "that incorporation of thymidine into DNA of germinating wheat seeds begins only after some preliminary activation of RNA synthesis is completed, implying an RNA-dependent DNA synthesis".

I do not agree with this conclusion. Indeed, it has only been demonstrated that RNA synthesis precedes DNA synthesis[2,3] and that inhibition of protein synthesis between 0 and 9 h results in a complete suppression of DNA synthesis. These essential proteins are probably coded for by preformed mRNA[4,5]. Thus, it is not at all evident that DNA synthesis is dependent on RNA in this way. Thymidine is not incorporated into DNA before a lag period in germinating wheat because, as in other plants, the phosphorylating enzymes are lacking in dry seeds[6,7]. They become detectable a few hours before the onset of DNA synthesis[7,8]. In contrast, uridine can be phosphorylated by extracts of dry seeds[8,9].

I wish to draw your attention to my interpretation of Dr Buchowicz's results. A prerequisite to check whether the cytoplasm may be an early site of nuclear DNA synthesis is to obtain a cytoplasmic fraction free of nuclear contamination. I have frequently obtained significant ^{14}C-thymidine labellings in similar 'cytoplasmic fractions' with radish seedlings, but all the electron microscope controls I have performed have revealed that nuclei were broken in the 1,000*g* pellet, and that successive 15,000*g* and 27,000*g* pellets still contained chromatin. The difficulty of isolating unbroken plant nuclei is well known amongst plant biochemists, and this is the reason why I believe that most of the radioactivity detected by Dr Buchowicz in his cytoplasmic fraction is of nuclear origin.

The higher specific activity of the cytoplasmic fraction can be explained if we assume that newly synthesised, short, DNA fragments are probably more easily released from broken nuclei than highly polymerised DNA from chromatin. One way to check whether the cytoplasmic fraction is free of nuclear contamination would be to assay this fraction for nuclear enzymatic activities such as RNA polymerase.

Yours faithfully,

M. DELSENY

Laboratoire de Physiologie Végétale,
ERA 226,
Centre Universitaire,
F 66 000 Perpignan, France

1 Buchowicz, J., *Nature*, **249**, 350 (1974).
2 Rejman, E., and Buchowicz, J., *Phytochemistry*, **10**, 2951 (1971).
3 Chen, D., Schultz, G., and Katchalski, E., *Nature new Biol.*, **231**, 69 (1971).
4 Mory, Y., Chen, D., and Sarid, S., *Plant Physiol., Lond.*, **49**, 20 (1972).
5 Chen, D., Sarid, S., and Katchalski, E., *Proc. natn. Acad. Sci. U.S.A.*, **60**, 902 (1968).
6 Delseny, M., Got, A., Julien, R., and Guitton, Y., *C. r. Acad. Sci., Paris*, **277**, 2361 (1973).
7 Wanka, F., Vassil, I. K., and Stern, H., *Biochim. biophys. Acta*, **85**, 50 (1964).
8 Delseny, M., and Julien, R., *9th Int. Cong. Biochem., Stockholm*, Abstract B 3m47 (1973).
9 Wanka, F., and Walboomer, J. M., *Z. Pflanzenphysiol. Bd.*, **55**, 458, (1966).

DR BUCHOWICZ REPLIES: I was interested to learn that Dr Delseny had observed similar labelling of cytoplasmic DNA in radish seedlings.

The possibility of nuclear contamination of the 'cytoplasmic fraction' has not been overlooked in my letter[1]. Instead, it was found insignificant, as the cytoplasmic radioactivity dropped when the possible source of contamination, radioactivity of nuclear DNA, increased. The comments concerning the dependence of DNA synthesis on thymidine kinase activity are obviously important. Nevertheless, the DNA synthesis would proceed without the participation of thymidine kinase (deriving TMP from UMP reduction and methylation) if not limited by other factors. It is known, however, that other precursors as well as thymidine are not incorporated into DNA at early germination stages, in spite of the fact that enzymes catalysing UMP synthesis[2] and reduction[3] are active. It seemed, therefore, justified to point out that the initiation of DNA synthesis in awakening wheat embryo may depend on the appearance of a newly synthesised RNA fraction.

Institute of Biochemistry and Biophysics,
Warsaw, Poland

1 Buchowicz, J., *Nature*, **249**, 350 (1974).
2 Mazus, B., and Buchowicz, J., *Phytochemistry*, **11**, 77 (1972).
3 Müller, H., Wahl, R., and Follmann, H., *9th Int. Cong. Biochem., Stockholm*, abstract 187 (1973).