

pupils outside their specialized subjects and to stimulate them to think, then little harm can be done by the syllabus. But if, as seems likely, this general knowledge is to be included in the new examination as an examination subject, then the syllabus should be condemned outright. Its use would merely intensify the deplorable tendency, which those of us concerned with scholarships and the Higher School Certificate know only too well, of learning whole passages and whole problems by heart on the chance of getting a question on them in the examination. To suggest that there are boys who, not knowing any biology before, could really assimilate in approximately eighty 45-minute periods the contents of this syllabus and retain a coherent idea of its range is asking too much of the imagination.

H. GRAHAM CANNON

STRUCTURE OF THE RESTING NUCLEUS IN *MARASMIUS ANDROSACEUS* FRIES.

By DR. J. A. MACDONALD
University of St. Andrews

HOLLANDE¹ considered that living protoplasm in general consisted of filamentous, hyaline tubes with numerous clusters, made up of two punctiform corpuscles, distributed over their surface; and that the nucleus had a comparable structure. Hollande and Hollande² made similar findings for Bacteria and Cyanophyceæ. Drennan³, studying human blood, described granules which moved freely in the serum and which were of different kinds, as they reacted differently to stains and varied in size and degree of motility. Sparrow and Hammond⁴ noted Feulgen-positive bodies in the cytoplasm of the meiotic prophase stages of microsporocytes in eleven different flowering plants. These bodies appeared to originate in the nucleus or at the nuclear membrane. They regarded the positive Feulgen reaction together with high absorption at 2537 Å. and 2650 Å. as proof that the bodies contained desoxyribose nucleic acid, and strong absorption at 2804 Å. as an indication that protein also was present. Calvet, Siegel and Stern⁵, as a result of electron optical observations, reported that the resting nuclei of calf thymus lymphocytes, treated with lanthanum acetate, showed nucleoprotein ultrafibrils of approximate thickness 80–100 Å. These appeared banded. They concluded that the banded appearance was probably due to the coiling of a fine thread to form long helices and that the spirals might be formed by individual desoxyribonucleoprotein molecules in combination with lanthanum ions. Malvesin-Fabre⁶ found, in the living nuclei of *Arum italicum*, that there were chromocentres which continuously changed their form and appearance and that the nucleus showed continuous activity in the resting stage. Ritchie⁷, working on fixed and stained basidia of *Amanita cesaria*, found extra-nuclear inclusions, frequently near the base of the basidium, which were readily stained with hæmatoxylin and were Feulgen-positive. He regarded them as chromatic in nature.

The recent papers cited above show that there is an accumulating body of evidence which points to

the existence in the cells of many plant and animal groups of: (1) chromatic bodies in the cytoplasm; (2) a fibrillar structure for the protoplasm; (3) a high degree of activity associated with the so-called resting nucleus.

In an account given to Section K at the recent meeting of the British Association at Brighton, I described observations made on the mycelia of *Marasmius androsaceus* Fries. and put forward a theory on the structure of the resting nucleus in this basidiomycete. Many of the general points raised are referred to in a paper to be published elsewhere⁸. In view of the evidence referred to above, it seems desirable to put on record the principal points in my account which refer to nuclear structure.

Growing hyphæ were studied with the use of agar films supported on coverslips⁹, using phase-contrast methods. Apparatus of the type recommended by Burch and Stock¹⁰ was used in this laboratory, pending the arrival of the outfit manufactured by Cooke, Troughton and Simms; but observations have been checked on the latter type of instrument at the Strangeways Laboratory, Cambridge, through the courtesy of the director, Dr. Fell, and of Dr. Hughes. Fixed and stained preparations have also been made using half-strength Flemming's fluid¹¹ and a number of non-osmic fixatives^{12,13}, of which Belling's modification of Navashin has been the most successful. Heidenhain's hæmatoxylin¹¹ and the Feulgen stain have been used; the former counterstained with Light Green¹¹ and the latter with Fast Green¹⁴ when desirable.



Fig. 1

The living hyphæ contain paired, grey structures, round or oval in outline, corresponding in size and position with the heterokaryotic pairs of nuclei so often seen and figured in stained preparations of basidiomycete mycelium. In addition, there are numerous moving dark granules scattered throughout the cytoplasm. There is an area of marked concentration of these granules nearer the hyphal tip than the more advanced member of the pair of grey bodies and a similar area behind that which is farther away from the tip. Between the two grey bodies there is also a region of concentration of granules, though this is less pronounced than the first two. Some of the granules are associated with cleared areas in the cytoplasm and are paired (Fig. 1). They may move relative to each other, but their association is maintained. In the Basidiomycetæ generally, clamp-connexion formation is associated with the division of the two nuclei of the heterokaryon. In *Marasmius androsaceus* Fr., as a clamp connexion begins to form, the two grey bodies position themselves so that one is in the developing hook of the clamp connexion and the other at or near it in the parent hypha. The cytoplasmic activity in general and that of the granules in particular becomes concentrated very near or on the grey bodies (Fig. 2).

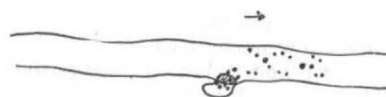


Fig. 2

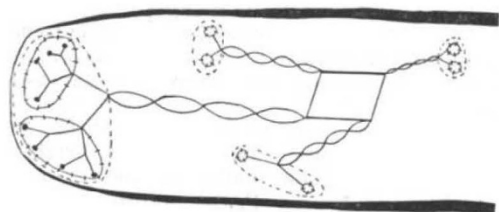


Fig. 3

The latter then divide in two, and cross-walls are laid down in parent hypha and clamp connexion. Spindles have not been seen in living material. A study of fixed preparations stained with: (a) hæmatoxylin or (b) Feulgen stain showed: (a) (1) when the grey bodies are not near the clamp connexions, that is, are not approaching or in process of division, they do not stain deeply and can be distinguished clearly from the general cytoplasm only if Light Green is used as a counterstain. Paired granules staining deeply with hæmatoxylin are to be seen in the cytoplasm. Sparrow and Hammond⁴ comment on the frequency of cells showing a correlation between lightly stained nuclei and a large volume of cytoplasmic bodies (Feulgen reaction). (2) When the grey bodies are near clamp connexions which are forming, they stain darkly. They may have a mottled appearance, suggesting that granules are present on their surface. Deeply stained granules are no longer visible in the cytoplasm. (b) (1) The grey bodies are Feulgen-negative and there are pairs of Feulgen-positive granules in the cytoplasm. The grey bodies counter-stain with Fast Green. This indicates the nucleolus in higher plants¹⁴. (2) Near the time of division, the grey bodies are in part Feulgen-positive, in part stainable with Fast Green. The Feulgen-positive granules are missing from the cytoplasm.

The above observations show that, if the conventional idea of the resting nucleus is accepted, there is extra-nuclear chromatin present in the vegetative cells of *Marasmius androsaceus* Fr. The fact that the Feulgen-positive cytoplasmic granules are often paired is regarded as evidence in favour of the theory that they represent either the two complete chromatids, or equivalent aggregates of chromatin-containing material from the two chromatids of a chromosome, loosely attached together. The fact that these Feulgen-positive granules are widely distributed in the cytoplasm, yet are drawn towards and finally become closely associated with the Feulgen-negative grey body, at the time of nuclear division, is believed to be strong evidence in favour of a theory that the nucleus in the 'resting' condition consists of a Feulgen-negative shadow nucleus to which the chromosomes or parts thereof are attached by means of threads of variable length, composed of protein molecules (possibly polypeptide in nature). The extensible or retractable nature of the protein chain visualized is such that it would make it possible for the active material in any chromosome to be carried to that part of the cell where its activity is required at any given time. Thus the laying down of new wall material, in the terminal 10–20 μ of the hypha to which growth is confined, would be carried out by the activity of a pair of granules in the tip and remotely controlled only by the shadow nucleus which is situated about 120 μ from the tip and thus well outside the growing region. At the approach of nuclear division, shortening of the molecule chains, by bringing granules and

shadow nucleus together, would produce the stainable nuclear entity usually depicted in association with clamp connexions. Fig. 3 is a theoretical diagram illustrating the organisation of a resting nucleus with four chromosomes.

It is hoped that the existence of the molecular chains may be susceptible of proof with the electron microscope, and some preliminary investigations have been carried out on this problem.

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² Hollande, A. C., and Hollande, G., *Arch. Zool. Exp. et Gén.*, **84** (9), 375 (1944).

³ Drennan, M. R., *Clin. Proc.*, **3** (4), 171 (1944).

⁴ Sparrow, A. H., and Hammond, M. R., *Amer. J. Bot.*, **34** (8), 439 (1947).

⁵ Calvet, F., Stegel, B. M., and Stern, K. G., *Nature*, **162**, 305 (1948).

⁶ Malvesin-Fabre, G., *C.R. Soc. Biol.*, **135**, 590 (1941).

⁷ Ritchie, D., *Bot. Gaz.*, **109**, 521 (1948).

⁸ Macdonald, J. A., *Proc. Roy. Soc. Edin.* (B) (in the press).

⁹ Macdonald, J. A., *Trans. Brit. Mycol. Soc.*, **31**, 92 (1947).

¹⁰ Burch, C. R., and Stock, J. P. P., *J. Sci. Instr.*, **19** (5), 71 (1942).

¹¹ Gwynne Vaughan, H. C. I., and Barnes, B., "Structure and Development of the Fungi" (1937).

¹² La Cour, L., *Bot. Rev.*, **3**, 241 (1937).

¹³ La Cour, L., *Bot. Rev.*, **13**, 216 (1947).

¹⁴ Hillary, B. B., *Bot. Gaz.*, **102**, 225 (1941).

A NOTATION FOR THE LEWIS AND LUTHERAN BLOOD-GROUP SYSTEMS

BY means of a grant from the World Health Organisation, the following were able to meet to discuss a notation for the Lewis and Lutheran blood-group system: P. H. Andresen, Universitetets Retsmediciniske Institut, Copenhagen; S. T. Callender, the Radcliffe Infirmary, Oxford; R. A. Fisher, Department of Genetics, Cambridge; R. Grubb, Bakteriologiska Institutionen, Lund; W. T. J. Morgan, Biochemical Department, Lister Institute, London; A. E. Mourant, Ministry of Health, Lister Institute, London; M. M. Pickles, Pathological Department, Radcliffe Infirmary, Oxford; R. R. Race, Medical Research Council, Lister Institute, London. The appended report has been prepared.

"For both the Lutheran¹ and Lewis² blood-group systems the symbols L_1 and L_2 have been used^{3,4}. The Lewis system is being actively investigated at the present time, and the need for distinctive symbols has become urgent.

In agreeing to use the following notation we are adhering, so far as the genes and genotypes are concerned, to present usage in plant and animal genetics. In human genetics there is as yet no systematized genetical notation in use, though Ford has suggested such a notation for the $A_1 A_2 B O$ blood groups⁵. The notations we have chosen conform with that of Ford.

System	Lewis	Lutheran
Genes	Lea Leb	Lua Lub
Genotypes	$LeaLea$ $LeaLeb$ $LebLeb$	$LuaLua$ $LuaLub$ $LubLub$
Phenotypes	$Le(a+b-)$ $Le(a-b+)$ $Le(a-b-)$	$Lu(a+)$ $Lu(a-)$
Antibodies	anti- Lea anti- Leb	anti- Lua

No distinction is made between the symbols for the genes and those for the antigens.