bacterial cell wall. Not all deoxyribonucleic acid is present as genes: What is the status of the common generalization that all genes are deoxyribonucleic acid? *A priori* this seems unlikely. Similarly, regions of high metabolic activity are often rich in ribonucleic acid: Are regions of protein synthesis characteristically richer still? It is surprising that there seems to be so little deoxyribonucleic acid–ribonucleic acid interconversion, and that actions such as the stimulation of polysaccharide and enzyme synthesis have been found so seldom.

Prof. A. Gustafsson (Stockholm) spoke on regularities and intentional control of mutation processes in plants.

From comparative experiments on barley, using X-rays, neutrons and specific chemical compounds as mutation-inducing agents, Gustafsson and his collaborators conclude that chromosome breakage and consequent X_1 sterility can be induced in barley by certain specific compounds: (1) without visible mutations of the chlorophyll apparatus, for example, 8-ethoxycaffein, (2) probably with such mutations, for example, ethylene oxide and mustards. Some agents, for example, nebularine, do not cause chromosome breakage, rearrangements, or X_1 sterility, but may increase mutation-rates considerably and cause fundamental changes in the mutation spectrum.

Chromosome breaks induced by strongly ionizing neutrons do not differ from those induced by X-rays. Random breaks, re-attached to form translocations, rarely produce noticeable changes in morphology, anatomy or ecology, but such translocations are highly instrumental in the genetical isolation of plant populations.

Plant-breeding in its genetical aspects rests on a profound knowledge of genes and chromosomes, the importance of heterochromatin and euchromatin, chromosome number, heterozygosity, gene recombination and mutation control. Mutations, whether spontaneous or induced, are generally regarded as arising at random. Gustafsson feels that this is not so. The mutation spectrum varies with the type of species and mutagenic agent used. The time does not seem far off when we shall be able to induce chromosome rearrangements and gene changes independently from one another, and control or direct the mutation process so that mutations of distinct loci, including those of high-productivity effects, are intentionally produced.

Prof. A. Müntzing (Lund) discussed chromosomes in relation to species differentiation and plant breeding.

Some species, although morphologically indistinguishable from one another, are isolated reproductively. Lewis's work on *Clarkia* has shown how a study of the differentiation of populations within a species can lead to an understanding of the mechanism of speciation in that group, and the part played by chromosome re-arrangements at the intra- and inter-specific levels. The salivary gland chromosomes of *Drosophila* have provided a means by which the nature of this chromosome differentiation can be studied in detail. In only a few cases has it been adequately demonstrated that the difference between two species is genic only and that chromosomal rearrangements have not occurred. Change in chromosome number to give an aneuploid series may result from fusion or breakage of chromosomes with diffuse centromeres.

Prof. Müntzing also spoke of the part played by polyploids in plant breeding and the value such plants had. Cytological analysis had shown the origin of many polyploid cultivated species and how they could be resynthesized, so that fresh genetic material could be incorporated into existing varieties. New polyploids have also been made and found to be of value in plants such as rye, clover, turnips and fruit trees. By the use of wheat plants lacking a pair of homologous chromosomes (nulliscomics) it has been possible to determine on which chromosome various genetic factors are situated and also to transfer whole chromosomes, bearing genes for disease resistance, to other varieties.

Prof. C. D. Darlington (Oxford) discussed the means of communication in the cell. These are to be inferred from chemical, genetical and radiation experiments and from comparative developmental studies. The co-operation and competition of nuclei had been revealed by classical experiments the meaning of which was now becoming clear in genetic and chemical terms.

The co-operation of gene activities and the co-ordination of chromosome movements both required communication along the chromosomes themselves. Evidence in relation to nucleoli, heterochromatin, and especially centromeres, showed that this communication was sometimes canalized along the chromosomes, a property which was variable and physiologically controlled. The inference of position effects from breeding experiments could thus be greatly extended. Further gene activity and integration could be seen as conditional not only on the local character of the cytoplasm but also on its cyclical changes. These cyclical changes in turn were co-ordinated in two normal systems (mitosis and meiosis) in every species. The relations of these normal systems were made clear by the abnormal systems which have now been described in many species and could be provisionally interpreted in terms of deoxyribonucleic acid and protein relations. With these cytological inferences the main concepts of genetics and embryology were consistent but they appeared in a new and larger perspective.

The author is indebted to Prof. C. D. Darlington (Oxford) and to Mr. K. M. Goodway (University College of North Staffordshire) for assistance in the preparation of this account. H. D. Springall

---

BRITISH WELDING RESEARCH ASSOCIATION

OPEN DAY AT THE ABINGTON LABORATORY

In our present society, which is committed to the pursuit of technology in support of a material standard of life, research associations and similar bodies form an essential communication between fundamental science and industry. This theme was developed by the Minister of Supply, Mr. R. Maudling, when proposing the toast of the British Welding Research Association at the annual luncheon and open day held at the Association's laboratory at Abington, Cambridge, on July 24. The Minister went on to encourage the production of memoranda containing the essence of sound practice supported by scientific investigation, the commencement of which in the case of the Association in fields such as brazing and the construction of arc-welded machinery has been made possible by application of Foreign Operations Administration funds from the United States. In

the ensuing replies the work of Sir William Larke, spanning from the inception in 1936 of the Welding Research Council on through the formative years of the Association, was warmly acknowledged on the occasion of his retirement as president.

As in former years, an exhibition of work in progress was arranged. Illustrative examples of current metallurgical work were housed in the partly completed new laboratory, since the metallurgical staff is being transferred from Park Crescent, London, to Abington this autumn.

Success in the production of strong and ductile fusion welds in high-strength aluminium alloys by means of the tungsten-arc process depends strongly upon the provision of filler material of correct composition when diluted with parent material. Performance with different compositions may be shown by means of a cracking test, in which shrinkage restraint is varied along a butt weld by means of symmetrical slots of graded length transversely cut into the parent plate at intervals along the weld. The test plate thus has the appearance of a fishbone, and with unsatisfactory conditions longitudinal weld-cracking occurs in the region of greatest restraint. The fusion welding of cylindrical fatigue specimens with the use of filler rods developed in this way was demonstrated.

In the case of the self-adjusting arc process, the arc is struck between the end of the filler rod and the plate, and the rod is advanced at a fixed speed to neutralize its own fusion. This process, although markedly successful by virtue of the results achieved and the simplicity of the control equipment, leads to some limitation in the ranges of voltage and current which may be successfully used, irrespective of the diameter of the filler wire through which the current is passed. Investigations undertaken co-operatively by the Electrical Research Association and the British Welding Research Association have shown experimentally that there are three different characteristics of arc operation and metal transfer, depending upon arc voltage. Thus, at low voltages discrete droplet transfer leads to irregular metal deposits unsuitable for welding. Above this voltage, in the practical working range, a spray transfer operates. At even higher voltages the spray transfer is accompanied by such high metal velocities that a strongly scouring action occurs in the molten pool, and unwanted complete penetration of the plate may take place. Nevertheless, in the working range, the somewhat lower spray-transfer velocity may be put to good use when welding in positions other than the horizontal. From the point of view of arc characteristics, the change from droplet to spray transfer is interesting because of the sudden change of current accompanying it.

The use of carbon dioxide as a shielding gas for arc welding of ferrous materials is of much topical interest, and typical welds made with this process were on view. In the case of other welds made with a mixture of argon and oxygen as shielding gas, unwanted porosity has been found and is thought to be associated with a reaction between carbon in the steel and gas which is either trapped or dissolved. Such porosity ought to be avoidable with sufficient added silicon in relation to carbon present in the fused metal. The manner of estimation of the requisite silicon content of the filler material was demonstrated.

Successful welding of metals such as titanium and zirconium is dependent upon the exclusion of reacting gases such as oxygen and nitrogen, for which these metals have great affinity. Welds of high quality for standardization purposes may be made in a completely closed argon chamber. In the apparatus which was shown, a sufficient degree of purity of the arc atmosphere is ensured by the production of high vacuum before flooding with argon.

Although it would be undesirable to claim that metallic titanium had not previously been cut successfully with an oxygen jet, predictions of feasibility were made by a member of staff of the Association as a result of earlier fundamental work on combustion in gas cutting. This was strikingly confirmed by experiment, and expectations of a high optimum cutting-speed, five times that for steel, were realized. Surface embrittlement, which was expected to arise from gas contamination, was not found to be as serious as anticipated, probably because of the high speeds. A practical demonstration of such cutting on moderately heavy sections was witnessed by visitors.

With regard to engineering activities, a further building frame was on view, after test to the point of plastic collapse by investigators under Prof. J. F. Baker, from the Department of Engineering in the University of Cambridge. This particular frame contained two stories, and illustrates the progress which has been made in bringing more complex constructions within the scope of load calculations for plastic collapse. The Association has gained much benefit from its financial support of this work.

Experimental stress analysis of elements of welded pressure vessels continues to fulfil an industrial requirement. The very thick pressure vessel containing circular nozzle openings, a model of which was shown last year, is shortly to be installed. The addition of reinforcement to reduce stress concentrations at its openings has been demonstrated theoretically to be unnecessary, and economy would ensue if this could be proved experimentally. At the opposite extreme, accumulated theory suggests that reinforcement may have to be substantial for large circular openings which are likely to be in use in thermal reactor vessels, because of the low ratio of shell thickness to diameter in such cases.

Stress analysis of vessels with openings has also been supplemented by pulsating pressure fatigue tests, from which the former work has been well vindicated. Fracture in some of the cases shown was directly associated with the calculable stress concentrations due to the openings themselves, rather than to unpredictable local stress concentrations induced through sharp changes of section at weld profiles.

In the fatigue laboratory, further results were presented from tests of high-quality butt welds in mild steel made by various welding processes. Recent work has also been addressed to a definition of the influence on fatigue strengths of various weld faults. Although, in the case of pipe butt welds, reductions of strength from all faults may be observed, the overriding effects of cracking and lack of penetration have been readily demonstrated. In comparison, the influence of moderate amounts of totally enclosed porosity appears to be reasonably small.

Determination of the fatigue resistance of all but the smallest welded shafts may be extremely slow if it is necessary to use a rotating-bending testing machine. In this respect, a resonance machine with a single unbalanced rotating mass, co-axial with the fixed shaft, enables an increased speed of testing to

be used, with the same stress cycle and a reasonably small power-input. It is later hoped to build an apparatus of greater load capacity than that which was on view.

In the pulsating pressure fatigue testing of welded joints in thick steel tubes, fluid pressures of many tons per square inch must be applied. A machine for this purpose, developed at the University of Bristol, was shown in use. A characteristic of the machine is the reduction of fluid volume to the greatest possible extent, whereby the energy stored at each pulsation may be reduced to low values.

Although the use of ultrasonic inspection for weld flaws may increase markedly in future thick welded constructions, it has first been necessary to achieve reliable calibration with regard to the strength of echoes. In this respect, the use of standard reference blocks was demonstrated, by means of which an apparatus may be quickly calibrated. Equal attention is now being given to attenuation of pulses by virtue of different surface contours in contact with the ultrasonic probes, in conjunction with various fluid coupling agents.

During the past year, experimental work on the brittle-fracture strengths of welded mild-steel plates has been continued with the 700-ton tension test rig, which was on view together with the fractured specimens. It is now believed that the role of residual stress in promoting fracture is better understood. While these stresses have no embrittling influence of themselves, it has been shown in the presence of a notched weld parallel to the direction of tension, and notch brittle parent material, that the static strengths of wide plates may be reduced to low values, such as are normally present in structures. When the residual stresses are removed, yield point stresses may be consistently sustained before fracture takes place. Thus, it is now believed that the beneficial effect of stress-relieving of welded structures may be more readily assessed.

UNIVERSITY AFFAIRS IN GREAT BRITAIN, 1954–55

CONTRARY to the past few years, the "Returns from Universities and University Colleges in receipt of Treasury Grant for the Academic Year 1954–55", issued by the University Grants Committee*, show an increase of 1,103 in the number of full-time students; the latest figure is 81,705, compared with 80,602 in 1953–54, 81,474 in 1952–53 and 83,458 in 1951–52, and it is expected that the numbers in 1955–56 will show a further and greater increase, as it is known that there were 3,378 more full-time students in the autumn term of 1955 than in that of 1954. In the English universities, full-time men students increased by 395 and women by 500; for Wales, the corresponding figures were 46 and 17; and for Scotland, 61 and 84. There were 4,987 full-time and 2,010 part-time students from overseas within the British Commonwealth and 3,617 full-time and 1,594 part-time students from foreign countries; for 1953–54 the corresponding figures were 4,607 and 1,819 for the Commonwealth and 3,373 and 1,379 for foreign countries. There was no significant change in the distribution of full-time students among the faculties; but there were small increases both for science and technology: from 21·1 to 21·2 per cent for the former, an increase from 16,971 to 17,327, and from 12·4 to 12·9 per cent for the latter, an increase from 10,036 to 10,586. Full-time advanced students of pure science increased by 45 to 3,335, those of technology by 74 to 1,455, of agriculture by 17 to 307, and of veterinary science by 6 to 18, while those of medicine decreased by 49 to 813. Of the full-time advanced students, 2,835 (or 23·2 per cent) were working for the teacher's diploma. Of the full-time students, 64,778 were reading for a first degree, 4,099 for a first diploma and 12,212 were engaged in research or other advanced work, the corresponding figures for 1953–54 being 63,560, 4,350 and 12,166.

The proportion of assisted students was 72·9 per cent compared with 71·9 per cent in 1953–54; for England as a whole it increased from 74·2 to 74·9 per cent, but for Scotland it increased from 56·8 to 59·5 per cent, and for Wales decreased from 88·5 to 86·6 per cent. The dependence on parliamentary grants was practically unchanged, the £25,059,434 received from this source representing 70·4 per cent of the total income compared with 70·5 per cent in 1953–54. Of the recurrent income, 10·7 per cent came from fees, 4·1 per cent from endowments, 3·2 per cent from local authority grants and 1·1 per cent from donations and subscriptions, the corresponding figures for 1953–54 being 12·0, 4·3, 3·6 and 1·6 per cent, respectively. Universities were asked to show separately for the first time in 1954–55 income from grants for research and income receivable under research contracts: for England the former amounted to £1,079,307 and the latter to £685,615; for Wales the corresponding figures are £17,787 and £8,213, and for Scotland £115,308 and £45,683. The ratio of staff to students again improved, the full-time teaching staff being now 9,810, compared with 9,514 in 1953–54. The distribution of this increase among staff is: professors, 43; readers, assistant professors and independent lecturers, 36; senior lecturers, 41; and lecturers, 176.

Of the full-time students, 63,068 were in England (15,121 at Oxford and Cambridge, 18,201 at London and 29,746 at other universities and university colleges), 4,494 in Wales and 14,143 in Scotland. Except at Liverpool and at Reading, where there were decreases of 1 and 10, respectively, the increase in students was distributed over all the universities and colleges, but only at Oxford (150), Southampton (137), Durham (139), Leeds (128), St. Andrews (114) and Cambridge (104) did the increase exceed a hundred, though the increase by 95 to 719 at the Manchester College of Technology was the highest proportionate increase. The proportion of full-time students residing in colleges and halls of residence increased to 28·4 per cent; and, of these 23,243 students, 8,262 were at Oxford and Cambridge, 11,838 at other English institutions and only 1,261 in Wales and 1,882 in Scotland. The proportion of men in residence was 24·2 per cent, and of women 41·3 per cent, while 34,548 students (42·3 per cent) were in lodgings and 23,914 (29·3 per cent) at home, compared with 40·9 per cent and 31·0 per cent, respectively, during the previous year. Of the 22,463 students admitted for the first time during 1954–55 (an increase of 1,310 on 1953–54), 20,946 were reading for a first degree and 1,517 for a first diploma; of those reading for a first degree, 1,233

* Universities Grants Committee. Returns from Universities and University Colleges in Receipt of Treasury Grant for the Academic Year 1954–1955. (Cmd. 9800.) Pp. 50. (London: H.M.S.O., 1956.) 2s. 9d.