more likely that they will not be able even to pay the tax, for gathering which the Government will, most probably, use the same methods of persuasion that it used in gathering requisitioned grain. Under these circumstances, it seems inconceivable that the policy of compromising with the peasantry, which the Soviet Government had announced, will prove more than a measure on paper.

The general situation in the province is similar to that in other parts of Russia: utter apathy and indifference on the part of the peasantry toward organizations and elections, since the Communists always force their own majorities.

For example, last month there was a coöperative congress. In spite of all the efforts on the part of the Communists, the majority at this Congress was anti-Communist, consisting of the peasants. Then the Communists brought to the congress forty-five city representatives; and when even that did not give them a majority, they arranged for the *collegium* of the local food administration to have the right to vote. Only then were they able to get a majority of 71 against 68 of their opponents. Naturally, they elected their own candidates. The peasants left the congress, cursing the Communists. And this is what the Communists call free and autonomous coöperation, based upon the confidence of the masses!

All public life is at a standstill. Only official meetings take place and official celebrations at which the people appear by government order.

CONTROL OF THE LIFE-CYCLE. III

BY JULIAN HUXLEY

From *The English Review, March–June*
(Independent Liberal Monthly)

The reason that the tissues of the adult do not grow is not that they have lost all power of growth. When an adult muscle is injured, the injury can be repaired. In order to accomplish this, the muscle-cells near the point of injury lose their characteristic striated structure, which enables them to contract, and become de-differentiated. In this condition they multiply; and when enough young muscle-tissue has been produced, the new cells differentiate again, and assume the striated adult structure. It would seem as if the power of reproduction and the power of working efficiently cannot exist together in such a complicated tissue as muscle. An analogy will illustrate this. We have seen that an axolotl can be transformed into its adult state by means of thyroid. Now, if thyroid be given to a female during the egg-laying period, the egg-laying stops within a day or two, and the transformation begins. To carry on both egg-production and metamorphosis together is too great a task for the organism.

Something roughly parallel to this occurs in cancer. Each kind of cancer is produced from one particular type

of tissue. In every cancer, the special structure characterizing the cells of the normal tissue has been partially lost, and with it the power of working in the normal way; but meanwhile a power of growth over and above any possessed by the normal tissue has been gained, and the greater the difference of the cell from the normal in appearance and working, the greater is the excess power of growth, and the more malignant the cancer.

In very malignant growths, as in some spontaneous cancers of the mouse, the cancer may continue growing, like a parasite, at the expense of the animal that is both its host and its parent, and finally suck it dry, as the stolon of Perophora was sucked dry by the healthy individual. In the competition with the body, the tumor tissues, simply because they are growing, and so working faster, get first call on the available food. Some tumors take their origin from fatty tissues; these may continue to grow and to be full of fat after every fat-globule — that is to say, every particle of reserve food-supply — has disappeared from the tissues of the rest of the animal. The tumor may be well nourished, the rest of the animal literally starving.

Nothing could better illustrate that balanced competition between parts which we have already discussed in connection with metamorphosis. It is important to note that in such a system the balance should be capable of being tilted either way. Normally, the cancer wins; but if we knew how, we could so damage the cancer that the body would win, and would absorb the growth. This is what happens in successful cases of radium treatment. Occasionally a tumor will disappear spontaneously; in such cases, too, the cancer has perhaps been damaged in some way; but it may be that the cancer has not been damaged at all, but that the body has been stimulated; for a raising of the level of the body-tissues' activities would alter the balance in exactly the same way, so far as result is concerned, as would a depression of the activities of the cancer.

Once more, the bodily fact has a mental counterpart. Obsessions, complexes, and fixed ideas, whatever their origin, are always parts of the mental structure which have emancipated themselves from the proper harmony of the mind, and established themselves as dominant. They draw into themselves an undue portion of the nervous energy, and starve the other parts of the mind, finally causing a complete upset of the mental organization and total inability to carry on its normal work.

Harmony of the parts in subordination to the needs of the whole is one of the conditions of existence for higher types of life. Cancerous growths and mental obsessions show what terrible results can follow when a part becomes insubordinate.

Now at last we are free to return and consider the problem of old age and the prolongation of life. All single-celled organisms, which typically reproduce by dividing into two equal halves, have, as we have seen, in a sense, no death — no inevitable death, that is to say, of their substance. Unless accident overtakes it, the substance of one individual is simply turned into the substance of two fresh individuals. There is a constant stream of living substance which moulds itself into a succession of individuals; and when we speak of the period of life, all we mean is the period of time for which one of these characteristic moulds or individuals lasts. The form perishes, but the substance need never die.

In the minute and simple bacteria, with their large surface in proportion to bulk, this period is very short, and division may even take place once every

half-hour. There being 48 half-hours in the day, this means that, given abundant food, 2^{47} [two to the forty-seventh power] bacteria could be produced from one original parent in the 24 hours — a number which, if I were to expand it, would be, equally with the distances dealt with by astronomy, beyond ordinary comprehension.

In larger single-celled organisms, such as Paramecium, which feeds on bacteria, division will take place two or three times a day. When we reach the multicellular organisms, we find the rule to be that a part of the tissues is inevitably doomed to death, reproduction here being the property of only one kind of tissue, the reproductive or germ-cells, and no longer possible after the lapse of a certain period of time. But even this is not universally true. In all higher plants, for instance, there exists a special tissue, the so-called cambium, which remains perennially young, and is always engaged in forming new layers of bark and of wood in the old parts; further, it has the power of forming new buds from which new shoots grow out. Some plants, like the banana, appear to have altogether lost the power of reproducing sexually, by seed, and must be propagated entirely by slips and cuttings. Here there is a compromise. If we choose, we can save any particular part of an old plant from death by taking it for a cutting; but the part we leave behind will eventually die. Again, in the famous baobab tree, the Indian fig, new stems are continually formed by down-growths from the branches. These root in the ground, themselves form new branches, and these in their turn new stems. By this means a grove of trees is formed which is in reality but one compound tree — a gigantic colonial vegetable. When properly protected from goats and other browsing animals, such a grove continues growing outwards in a circle, like a fairy-ring of toadstools. One in the Calcutta Botanical Gardens had some years ago reached the size of eleven acres, and was still growing. In the centre of the grove, however, the old stems begin to decay, and finally rot away. So that, although the grove, as a grove, has the power of apparently unlimited growth, parts of it become old and die.

Here we see illustrated the very important fact that the accumulation of old tissue may of itself lead to death. In the baobab, as indeed in trees generally, this seems to be due to accidents — to lightning, to the holes of wood-boring insects, to cracks caused by strains, and so forth. Any one kind of defect opens the door to another, and so with time the agents of death are summed, not arithmetically, but geometrically. Through an insect burrow, for instance, fungi, the agents of decay, find entry, and the whole region becomes affected and dies. If we could preserve the tree from all such accidents, there is no reason to suppose that it need ever die from internal causes, until, it might be, the weight of its crown became too great for its trunk to support. The five thousand years of the giant sequoias show us how long this particular contingency may be delayed.

These examples will have prepared us to find that in animals our preconceived ideas will perhaps not turn out after all to be right.

Let us first turn to the results of a new and adventurous field of research, that known as tissue-culture. Less than twenty years ago, the American worker Harrison discovered that it was possible to take a small portion of a growing chick-embryo out of the egg, and to cultivate it in a drop of nutritive liquid, such as the fluid of the blood. All the operations had of course to be carried out with the utmost care to prevent infection — with the same precautions

of sterilization, in fact, as are taken for any human operation.

Later Carrel, the surgeon, to whom a Nobel Prize was afterwards awarded, took up the problem, and, by developing the technique, obtained new results. After a few days a piece of tissue in a drop of culture-fluid will cease to grow. It has exhausted the available food-supplies. This was got over by the method of transplantation, the tissue being cut into pieces, washed, and transferred to new fluid. Later, the interesting discovery was made that the addition to the culture-fluid of a certain quantity of 'embryonic extract,' that is to say, of fluid obtained from the tissues of chick-embryos, had the most marked effect upon the health and especially on the growth of the strain of tissue.

In this way it has been found possible to continue growing the cells of a single original piece of tissue (from a chick), not merely for weeks or months, but for years. When progress was last reported, the period was seven years; and the experiment was still being continued.

The cells of the tissue show no sign of ageing, and their rate of multiplication continues unchecked long after the same tissue in a living animal would have sobered down to slow reproduction or to no reproduction at all. From the evidence now at hand, it would seem that tissues cultivated thus outside the body are probably immortal—or, if you prefer a less high-sounding epithet, that, even in the tissues of a higher animal, continued existence and growth need not involve limitation of growth, senescence, or death. In other words, the growth-limitation, senescence, and death of tissues which do take place in the higher animals are due somehow to the way the parts are related together in the organism, not to anything in the parts themselves. This leads us back once more to the idea of a balance — either a balance between the different parts, or a balance between the different types of chemical processes in one or more of the parts.

As so often, knowledge of the lower forms helps us to analyze the higher. The continued reproduction of a protozoön, or single-celled animal, by division is in all essentials similar to the reproduction of the original cell of the body, the fertilized ovum, to form the millions or billions of cells which make up the adult, save that the protozoan cells separate from each other.

Now in a great number of such protozoa there occurs at intervals an interesting process which we know as conjugation. It is the forerunner of sexual reproduction, for at conjugation two cells come together and exchange portions of their substance. It has been maintained that the life of a species of protozoön is divisible into a series of cycles, each terminating with conjugation. Each, therefore, would resemble the cycle of cell-reproduction seen in the growth and ageing of the body of one of the higher animals, except that in a higher animal the cells stay bound together, in the protozoön they remain separate. On this view, death of the whole race of the protozoön is inevitable unless sooner or later conjugation takes place. Somehow or other this is supposed to have a rejuvenating effect.

In the last few years, however, various American workers have shown that by a properly balanced diet, strains of protozoa can be kept for years, instead of for a few months as was previously supposed, without conjugation, and the presumption is getting stronger and stronger that it *need* never occur at all.

It would seem as if, in the course of generations, the vital processes of the cells often become, in some way or other, unbalanced, and that this condition will lead to the dying-out of the race unless it can be corrected by that mingling of one cell with another which

occurs at conjugation; this is exactly paralleled by the ability of mice or rats to live well for a certain time on certain single proteins, but to end by a sudden decline and death long before the usual period. But, by careful regulation, the strain of protozoa can be prevented from getting unbalanced; and in this state the cells appear to have an unlimited power of reproduction, the strain of living matter to have an unlimited potential existence. The dying-out of a strain of protozoa is due to the upsetting of a balance.

Progressive change, leading inevitably to old age by alteration of this inner balance, is seen over and over again in animals. Among the simpler multicellular forms it has been studied most thoroughly in the Planarian flatworms, by Professor Child, of Chicago. Planarians are common inhabitants of ponds and streams, curious thin and leaf-like organisms which glide slowly along the stones and water-weeds, feeding for the most part on dead animal matter, faintly sensitive to light, with a very simple and lowly type of nervous system and general organization. Many of these can reproduce, like protozoa, by fission, so that here, too, so long as fission continues, the substance is potentially immortal, and it is but the form that dies. But Child has shown that even the form, the single individual, need not age and die. If one of these animals is kept without food, it does not simply lose weight, lose power and health, and rapidly die, like a starving dog or man, but is able, owing to its very simplicity of organization, to live upon itself. A starved flatworm gets smaller and smaller, but remains perfectly healthy and active until it becomes extremely minute, dying only when it has gone back to about the size at which it hatched from the egg. If fed at any time while still active, it will once more start normal growth.

Some twenty years ago it had been noticed that such starved and miniature worms reassume the shape and proportions of really young individuals. More recently, Child has shown that they resemble them, too, in their behavior and the great activity of their chemical processes. In a word, they are not only small, they not only look young, but, in the only sense in which we can attach a real meaning to the word, they *are* young once again. 'Can a man enter a second time into his mother's womb and be born?' asked Nicodemus; here is a fact almost as startling.

Following this up, Child divided a batch of worms into two lots. One he kept in normal conditions, with abundant food. For the other he fixed in his mind definite limits of size. When they reached the upper limit, he let them starve; when they fell to the lower limit, he fed them again, and so on. During the time the experiment was continued, this second lot was successfully kept within these limits. The individuals never divided, never showed signs of ageing, and by all the tests that could be thought of, were in the same general condition at the end as at the beginning. The other lot meanwhile passed through eighteen generations, a period which, if translated into human terms, would represent over five centuries.

To the question which we posed at an earlier stage, the question whether age is only a question of external time, or is determined by inner factors, by the way the animal is and has been working, we may now, I think, give a definite answer. Real age is determined internally. We measure it by the lapse of years, for convenience; but the only true old age is physiological. Many men and women of seventy are really younger, in the right and proper meaning of the word, than many men and women of sixty.

Unfortunately, however, these experiments, important as they are, do not show us directly how to prolong human life. The *elixir vitæ* was sought by alchemists throughout the Middle Ages. It does now definitely seem to have been found — but alas! only for flatworms (with an *ersatz*-imitation, as we saw before, for fruit flies)! In one case, it is intermittent starvation; in the other, low temperature. But neither intermittent starvation nor cold will prolong human life. We are so constructed that we cannot live upon our own tissues, nor can our temperature be altered. It may be some consolation to remember that it is just because our brain is so complex, our mental activity so intense, that we cannot submit to starvation; also that if by any chance our temperature could be reduced, all our activities and all our motions, of pleasure and delight as well as of pain and discomfort, — all, in fact, that gives life its value, — would be so reduced in intensity that we could scarcely recognize them.

No: we must accept the fact that our level of existence, so high above that of the simpler animals, is possible only in a delicately balanced system, and that, if we tilt the balance comparatively slightly, the only existence that counts — one of physical and mental activity — is no longer possible to us. Our chief aim must be to preserve and to extend this state of balance that we call healthy maturity.

It will be recalled that adding tethelin from the pituitary body to the diet extended the life of mice. It is probable that this was due to a change of the balance. The tissues of the body can be broadly divided into the cellular tissues, which are those doing active work, — glands, nerves, muscles, blood, — and the supporting tissues, which make a framework for the rest of the body — bone, cartilage, and the connective tissue that binds all the others together. The supporting tissues are in a sense parasitic on the rest — they are passive, the others active. In old age, the connective tissues always accumulate; there is a greater proportion of them in the old than in the young. It looks as if the processes of life gradually slow down, and, as they slow down, it is easier for supporting tissue to be formed. To use once more our simile of a river, as the current slows, the sediment it carries with it will no longer help erode and deepen the channel, but will be deposited, and the channel will begin to silt up; and yet these two opposite tendencies, of erosion and silting-up, will be due only to a difference in the rate of the current. The effect of tethelin seems undoubtedly to be to stimulate the growth of the cellular tissues; they thus get an advantage in the internal competition of the parts of the body, and so the final preponderance of the supporting tissues — which means an ever-increasing burden on the active cellular parts — is postponed. It may be mentioned that two of the biological authorities on senility, Minot and Child, agree broadly with this view. Minot sees the cause of old age in differentiation, which leads to accumulation of structure, and Child in slowing of metabolism, which he believes to be behind differentiation.

BRITISH ATHLETES AND THEIR CRITICS

BY HORACE HUTCHINSON

[Mr. Hutchinson was a prominent figure in the earlier days of English golf and is well known as a writer on sports. Since his article was written, the Oxford and Cambridge track team has been defeated by Harvard and Yale, and an English tennis team has won from an American.]

From *The Westminster Gazette, July* 1
(Old Liberal Weekly)

America has won the polo. America has won the golf. America has won the war. We know that America has won the war, for she has said so. As one of her own admirable humorists has written, 'I know he is a gentleman, for he told me so himself, and a man would not tell a lie about a little matter like that.' After all, it is not quite fair to say that America claims to have won the war. No reasonable American claims it, and there are absurd people, in every country. A friend of mine lately returned from America told me that he had been, while in that country, to hear an American lecturing on the characteristics of American humor. One of the characteristics that the lecturer dwelt on was its love of exaggeration. By way of one instance, he cited the American who told his friends that the fish were so large where he went angling that they commonly used whales for bait; by way of another instance, he quoted the American saying, 'We won the war.' And an American audience received it well.

But whatever America won or did not win, it is certain that we, of Britain, are not just now winning much, and my present object in writing is to argue that the principal reason why we are not winning in such contests as the polo match, the golf, the lawn-tennis, and the cricket test-matches is a reason that we have not great cause to be ashamed of. The reason is that we did win the war. Far be it from us to claim that alone we did it, to deny stricken and gallant France and Belgium. Italy, moreover, has a right to her own share, and Rumania and Japan. But for what we did we may take our due, and we know only too grievously the price we paid for the doing, the loss of the splendid young manhood. Who will say that the four who would, had the war not come, have been our team this year at Hurlingham, may not, one and all, be lying in the soil of France, of Mesopotamia, of Gallipoli? Such a toll of athletic youth has been exacted of us as never before, and can we expect, is it reasonable, that we should be as rich in athletic manhood as if that toll had not been taken? Surely not. It is just because we won the war, and won it at such price, that we are relatively so poor; and it is only justice to ourselves that we should recognize the glorious reason of our poverty.

America had her losses; America did her share, and a share that we should be criminally ungrateful if we failed to appreciate generously, in the war's winning, but her sacrifice is scarcely to be accounted for by the measure of ours. Let us see these things in their true light, though we are Britons and, so, with an inveterate habit of regarding