Cancer Conference in London in 1928 that the possibility of a mutation of the nucleus of the somatic cells began to be considered seriously. It was suggested by Loeb, Teutschlaender, Strong, and Mavor, but no definite theory was propounded, as most investigators were more concerned with the pros and cons of the infective theory of Gye. Ten years ago, Theodor Boveri, the zoologist, put forward the theory that cancer is due to abnormal mitosis—tetrapolar mitosis—of the cell nucleus resulting in an abnormal number of chromosomes. He had got the same idea, as he attributed tumour formation to genetic changes in the cell nucleus, but this theory was not generally accepted, because the tumour cell, according to his theory, must have a wrong number of chromosomes. There is considerable evidence that the nucleus of the ordinary tumour cell contains the correct number of chromosomes, and that tetrapolar mitosis is at any rate quite uncommon in tumour cells. The whole subject has been much confused by the fact that tumour cells are often found with all sorts of abnormal nuclear structure, but there is every reason for believing that the ordinary tumour cell is quite normal as regards its chromosomes, and that gene mutation and not multipolar mitosis is the primary factor in tumour genesis. More recently, in 1930, R. J. Ludford gave an excellent résumé of the whole subject, but it did not receive the attention it deserved.

The strongest argument for believing that this theory of tumour genesis is the true one is that it is possible, by means of it, to explain all the different phenomena that have been observed in tumours and their behaviour. No other theory has made it possible to interpret all the observed facts about tumours, and as the facts are seen to fit in and come into line, as it were, the inference becomes very strong that the theory is correct. How it will help in solving the problem of the cure of tumours, which to us as doctors is of more importance, remains to be seen. At first sight it looks as if it will not help at all. But experience in medicine and surgery has taught us that when the cause of a disease is known we are in a fair way to discovering how to prevent or cure it. Cause and effect are a natural sequence, and if we know the cause it cannot but help towards the ultimate goal of full control over this great class of diseases which we call tumours, and which hitherto we have been so comparatively helpless in attacking successfully.

SUMMARY

1. The essential difference between a normal cell and a tumour cell is one of behaviour, not of apparent structure. The tumour cell grows faster than the normal cell.
2. There are two kinds of reproduction—that which produces a new individual, and that which results in the replacements of injured or worn-out cells in our tissues.
3. All cells, both germ cells and somatic cells, breed true to their parent cells, and this breeding is controlled by the genes in their nuclei.
4. Changes or mutations of the genes in the nuclei may occur, and, when they do, the daughter cells will always breed true to the mutation.
5. Tumours are the result of a mutation of the genes controlling division of somatic cells.

BIBLIOGRAPHY

- Bauer, K. H.: *Mutationstheorie der Geschwulst-Entstehung*, Berlin, 1928.
- Bierich, R.: *Proc. International Cancer Conference*, 1928, p. 61.
- Boveri, T.: *The Origin of Malignant Tumours*, 1929.
- Bullock, F. D., and Curtis, M. R.: *Journ. Cancer Research*, 1924, viii, No. 4.
- Ewing, James: *Proc. International Cancer Conference*, 1928, p. 1.
- Fibiger, J.: *Journ. Cancer Research*, 1919, iv, 367.
- Fisher, R. A.: *The Genetical Theory of Natural Selection*, 1930.
- Gye, W. E., and Purdy, W. J.: *The Cause of Cancer*, 1931.
- Handley, W. Sampson: *The Genesis of Cancer*, 1931.
- Herlitz, C. W., Jundell, J., and Wahlgren, F.: *Durch Ultravioletbestrahlung*, etc., *Acta Paed.*, 1931, x, 321.
- Leitch, A.: *Proc. International Cancer Conference*, 1928, p. 22.
- Loeb, L.: *Ibid.*, 1928, p. 48.
- Ludford, R. J.: *Imperial Cancer Research Fund, Ninth Report*, 1930, p. 121.
- Magnus, Werner: *Die Entstehung der Planzengallen verursacht durch Hymenopteren*, 1914.
- Mavor, J. W.: *Journ. Exp. Zool.*, 1924, xxxix, No. 2, 381.
- Morgan, T. H., Bridges, C. B., and Sturtevant, A. H.: *The Genetics of Drosophila*, *Bibliographica Genetica*, lii, 1.
- Mottram, J. C.: *Journ. Exp. Biol.*, 1930, vii, 4, 370.
- Rous, P.: *Journ. Exp. Med.*, 1913, 416.
- Roussy, G.: *Proc. International Cancer Conference*, 1928, p. 14.
- Shaw, J. J. M.: *Lancet*, February 6th, 1932, p. 221.
- Strong, L. G.: *Journ. Cancer Research*, 1929, xiii, No. 2, 103; *Ibid.*, 1926, x, 219.
- Teutschlaender, J.: *Proc. International Cancer Conference*, 1928, p. 43.

A NOTE ON THE OPERATIVE TREATMENT OF FACIAL PALSY

WITH AN ACCOUNT OF SOME ANIMAL EXPERIMENTS

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The experimental inquiry on which the following notes are based was carried out by Dr. Arthur B. Duel and myself at Laurelwood, Dutchess County, New York State, during the years 1930 and 1931. A full account of the experiments is printed in the *Archives of Oto-Laryngology*, January, 1932.

Each anastomosis operation was combined with the removal of the facial nerve from the aqueduct of Fallopius. Sometimes, on gentle traction on the central end of the divided facial nerve, 3 cm. of the nerve came away. This was followed by escape of cerebro-spinal fluid from the aqueduct. The object in view was to prevent the union of the divided ends of the facial nerve, which would vitiate the clinical results. The stimulation of the facial area of the Rolandic cortex, and of the nerves in the posterior fossa of the base of the skull, was undertaken as

a routine in the final examination of each experimental animal.

The grafting of the hypoglossal, descendens noni, or glosso-pharyngeal nerve to the facial nerve in man is followed, as recovery takes place, by associated movements during eating and swallowing. Whether such movements ever disappear we do not know, but while they last they are disfiguring and distressing to patients during meals. When, in our baboons, one of the above nerves was united to the facial, associated movements were observed during the fourth month from the date of the experiment, and they continued without remission till the animal was killed. When a sensory nerve—for example, auriculo-temporal—was grafted to the facial nerve no associated movements were expected and none were observed. The spinal accessory nerve was not employed in the anastomosis experiments because, in the many cases we had observed in man, the contraction of the muscles of the face was associated with the contraction of the sternomastoid and trapezius muscles. This is a great disability. Further, there is deformity of the neck, and maybe drooping of the shoulder. The contraction of the muscles of the face dissociated from that of the shoulder muscles, the movement most desired, is seldom if ever attained, even many years after operation.

GENERAL CONSIDERATIONS

There can be no question about the disability attending an anastomosis operation, or about the imperfections present in many cases that were hailed as good recoveries in the past. After all, it is an unnatural thing to anastomose one nerve to another when the ideal surgical method of bringing the two ends of a divided nerve into contact, either directly or by means of a nerve graft, is both feasible and practicable. We therefore removed portions of the facial nerve from the Fallopian aqueduct, and substituted for the portion of the nerve taken away an equal length of some other nerve. For example, we have used the descendens noni nerve, the intercostal nerve, the intercostal-humeral nerve, and the external respiratory nerve of Bell from the axilla. We prefer to take the nerve graft from the nerve of Bell in the axilla; there is something rather pleasing about curing Bell's palsy with Bell's nerve!

The graft operation in the Fallopian aqueduct causes recovery from facial palsy far more rapidly than any anastomosis operation, and cannot, of course, be followed by associated movements. My colleague Dr. Duel writes me that he has already done in his hospital clinic twelve nerve-graft operations for facial palsy, and that the earlier cases are all on the way to complete recovery.

Many severe cases of facial palsy recover only in part after prolonged medical treatment by massage and electricity, and they are often the victims of a spontaneous spasm or tic movement. These spontaneous spasms have been observed in a few of the baboons, both after anastomosis operations and after nerve-graft operations. They are not uncommon when an experimental animal is under light anaesthesia. The nerve impulses, the cause of the spontaneous spasm, originate at the level of the corpus striatum and not in the cortex. They are described under the term "paleo-kinetic," in contradistinction to impulses arising in the cortex, which are called "neo-kinetic." The spontaneous tic spasm is more prone to occur after an anastomosis experiment than after a nerve-graft operation.

We believe that early operation and perfection in the technique of the nerve-graft operation are the pathways which lead to the avoidance of spontaneous spasm of the recovering face muscles.

The following account gives three examples of the experimental results.

ANASTOMOSIS OPERATIONS

Case I

Baboon, operated on August 17th, 1930; glosso-pharyngeal facial end-to-end anastomosis (right side), facial nerve removed from aqueduct of Fallopius.

The glosso-pharyngeal nerve, exposed till the petrous ganglion came in sight, was divided just before its two terminal branches (motor and sensory) entered the muscle in front. The central end was turned backwards, and united to the peripheral end of the facial nerve, which had been severed at the stylomastoid foramen.

Examination of the animal 357 days after the operation, at rest, during eating, and when angry, showed equal movement in the occipito-frontales. The right palpebral fissure was smaller than the left. Winking was synchronous and equal in range. Movements of the nose were equal on both sides. Mouth fissure was normal, and lip movements equal in extent. Associated movements during swallowing were noted as follows: retraction of right ear, partial closure of right eyelids, and right angle of mouth pulled backwards. There was no spontaneous spasm.

With the animal anaesthetized, faradic and galvanic current gave an equal response of all muscles on both sides of the face. Under light anaesthesia there was a spontaneous twitch of the muscles of the right upper and lower lips and the angle of the mouth was pulled backwards. No spontaneous spasm was observed, except when the animal was lightly

anaesthetized. The spontaneous spasm was synchronous with spasm of the eyelids. There was also a tonic contraction of the muscles of the posterior third of the right side of the tongue, which appeared to be synchronous with the "winking spasm." Stimulation of the facial area of left Rolandic cortex gave a normal response in the muscles of the right side of the face.

When the brain was removed and the nerves in the posterior fossa of the base of the skull stimulated, the right facial nerve gave no response. The right glosso-pharyngeal nerve gave good contraction of the muscles of the upper and lower lips and retraction of angle of mouth. With stronger current the right eyelids closed.

Stimulation of right glosso-pharyngeal nerve at lower border of jugular foramen (petrous ganglion exposed) caused contraction of all muscles of the right side of the face.

The above is an excellent example of an anastomosis operation with the usual associated movements.

Case II

Baboon operated on August 23rd, 1930; auriculo-temporal facial end-to-end anastomosis (right side), facial nerve removed from aqueduct of Fallopius.

The auriculo-temporal nerve was exposed on the zygoma above and in front of the auditory meatus. It was followed underneath the attrahens auriculam muscle, and divided at the upper border of this muscle. The central end was turned downwards, and united to the peripheral end of the facial nerve, which was severed at the stylomastoid foramen.

Examination 345 days after the experimental operation, with the animal at rest, eating, and when angry, gave the following results.

The eyelids winked together equally; the nose was straight. The right food pouch was used: mouth normal. When teeth were shown the pull of the left upper lip was a little stronger than the right. There was no spontaneous contraction spasm or any associated movements.

With the animal anaesthetized, the faradic and galvanic current gave an equal response on both sides in all muscles. Under light anaesthesia there was a spontaneous twitch of the muscles of the right upper and lower lips synchronous with the winking spasm. These spasmodic movements did not take place except under light anaesthesia. Stimulation of facial area of the left Rolandic cortex caused normal contraction of all muscles of the right side of the face.

When the brain was removed and nerves were stimulated in posterior fossa of the base of the skull, the right facial nerve gave no response and the right fifth nerve caused contraction of all muscles of the right side of face.

The auriculo-temporal is a small sensory nerve. Nevertheless, its anastomosis with the facial nerve resulted in recovery from complete facial palsy in this experiment. No associated movements are possible.

NERVE-GRAFT OPERATION IN FALLOPIAN AQUEDUCT
(RIGHT SIDE)

Case III

Baboon operated on September 16th, 1930. Seven millimetres of the facial nerve in Fallopian aqueduct were replaced by 7 mm. of the descendens noni nerve. After 160 days there was no sign of deformity of face when the animal was eating an apple. Under anaesthesia faradic and galvanic current gave an equal response in muscles of the right and left sides of the face—including occipito-frontales.

Examination 325 days after operation showed complete recovery of the right side of the face with no spontaneous spasm.

No spontaneous spasm when under anaesthesia; equal response to faradic and galvanic stimulation on right and left sides of face. Stimulation of the facial area of left Rolandic cortex produced contraction in all muscles of the right side of the face. Stimulation of right and left facial nerves in the posterior fossa, after removal of brain, produced equal and full contraction of muscles of the right and left face.

This experiment is an example of the rapid and complete recovery from facial palsy when a nerve graft is substituted for a similar length of the facial nerve in the aqueduct of Fallopius. Moreover, no associated movements are possible, and in this case no spontaneous spasm occurred.