of the mechanistic, materialistic tendencies of certain scientists expressed in the Latin proverb "tres physici, duo athei," *i.e.*, out of 3 scientists 2 are atheists. This attitude leads one to formulate a scientific philosophy, a religion without revelation. These bear an innate contradiction in themselves, for science and philosophy and religion rest on different mental attitudes.

Recently, according to press reports, a leader of the Radical Democratic Party had accused Modern science, especially in supposed findings of 20th century Physics of giving birth to what he called a religious revivalism and a kind of neo-mysticism. The lecturer wished to assure the leader and those who may share his opinion that scientists in our days and especially religious scientists including Catholics do not intend to spread any sort of scientific mysticism as in their own interest of their own religious beliefs they just want to keep their scientific activities free from any non-scientific elements.

Scientists like J. Jeans who expressed the view that there is a supreme intellect beyond the universe were doing so not as scientific but as thinking men, free to express their views. They of cource based their considerations on real scientific findings. These findings however give only the background picture. The comments were made by the spectators, Jeans, Eddington, etc. not with scientific methods but with philosophical or theological reflections. Scientists like Haldane, Hogben and Prenant expressed views contrary to the Christian religion. Whilst they may be free to hold them, these anti-religious views are just as nonscientific as the so-called religious revivalism and neo-mysticism of Jeans, etc.

There was a danger to-day, said Dr. Wolsky, of politically controlled science but in an atmosphere of free science one need have no fear. If properly pursued it can never interfere with religion. Similarly, Catholic religious truth has its proper domain. All we want is to expose it clearly and explain it to the modern mind and to the millions who never had the chance to hear about it. We need freedom and tolerance. If this is granted, science and religion will strive side by side as parallel paths of truth which like parallels according to the Euclidean postulate meet in the Infinite, in the eternal truth of God.

## METABOLIC MECHANISMS OF UNSTRIATED MUSCLE

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THERE are several metabolic mechanisms in unstriated muscle as shown by the effect of asphyxia, glucose, iodoacetic acid, etc., on the mechanical response of unstriated muscle.

*Anaerobic mechanisms.* When unstriated muscle from frog's or dog's stomach is asphyxiated, there is a stage of hyperexcitability before the response declines. This effects the response to alternating and direct currents, acetylcholine, potassium and tone. Tone may thus increase immediately on asphyxiation; this has to be distinguished from the later increase of tone.[1, 2]

The asphyxial excitability is of two kinds. One kind is increased by iodoacetic acid and depressed by glucose (0·1-0·2 p.c.); removal of glucose enhances the effect of asphyxia. This resembles the asphyxial hyperexcitability in the central nervous system which is increased by hypoglycaemia.[3] The second kind of asphyxial hyperexcitability is increased by glucose and depressed by iodoacetic acid as happens in the carotid body.[3] These two mechanisms are therefore antagonistic.

The inhibitory action of glucose on one kind of asphyxial hyperexcitability is succeeded by an opposite action, both these actions being abolished by iodoacetic acid. This indicates that the glycolytic mechanism at first suppresses the nonglycolytic one and then takes over from the latter.

The anaerobic utilisation of glucose appears to happen in two ways. When glucose is added to an asphyxiated muscle, there may be an immediate increase in response followed by a decline to a steady state or the response increases gradually to that state. There are two possible explanations for this. The first explanation is that the hyperexcitability on addition of glucose may be due to a substance, which is metabolised with glucose, but is soon exhausted. The second explanation is that asphyxia renders the muscle more sensitive to the action of glucose, this being due to the opening of reserve channels for its utilisation. This second explanation is supported by two facts. First, the inhibitory effect of oxygen on asphyxial hyperexcitability in glucose is readily shown. Secondly, iodoacetic may

at first increase the response.[4] The opening of reserve channels of metabolism probably accounts for the asphyxial hyperexcitability.

Tone producing substances relieve asphyxial arrest[1,2]. This action is atagonised by glucose, indicating that the above substances release a nonglycolytic mechanism. Tone producing substances may also hasten asphyxial arrest; it is presumed therefore, the suppressed mechanism is a glycolytic one. In the brain potassium suppresses the formation of latic acid during asphyxia.[3]

There is a glycolytic mechanism in acid solutions as shown by relief of asphyxial arrest by glucose. There is also a nonglycolytic mechanism for acid solutions as shown by the functioning of the muscle in the presence of iodoacetic acid[1,2]. The mechanism for acid solutions is not the same as that for alkaline solutions, as shown by the fact that asphyxial arrest is relieved by change of reaction. This can be done alternately several times, suggesting that the alkaline mechanism rests in acid solutions and *vice versa*. Ordinarily in an asphyxiated muscle poisoned with iodoacetic acid no recovery takes place unless oxygen is admitted. Iodoacetic acid diminishes but does not abolish the response on change of reaction, suggesting that rest only partly accounts for the recovery on change of reaction. Change of reaction has thus also a stimulating effect due to its tone producing properties. Glucose has an inhibitory effect also in acid solutions, showing that the glycolytic mechanism for acid solutions is antagonistic to the nonglycolytic one.

*Aerobic mechanisms.* Cyanide does not entirely abolish activity, which is further decreased by stoppage of oxygen supply, indicating that there are two aerobic systems, one involving cytochrome and the other involving a cyanide resistant substance, possibly a resistant cytochrome. The aerobic mechanisms are also divided into glycolytic and nonglycolytic which are antagonistic as shown by the inhibitory effect of glucose. Both the aerobic systems are antagonistic to the anaerobic ones as shown by the inhibitory effect of oxygen[1,2]. Sodium lactate and salts of fatty acids, such as sodium acetate, propionate, butyrate improve the response suggesting their utilisation[2]. After asphyxiation the muscle becomes more sensitive to oxygen indicating opening of reserve oxidative channels.

*Inhibition.* The responses of unstriated muscle are divided into two classes, inhibition and contraction[4,5,6,7]. That inhibition is active is shown by increase in oxygen consumption,[9] and its abolition by asphyxia and restoration by glucose. The anaerobic mechanism for inhibition is antagonistic to that for contraction as shown by the fact that asphyxia while decreasing inhibition may increase contraction. The aerobic mechanisms for both may also be antagonistic as shown by the fact that after asphyxiation, oxygen may increase tone, but diminish inhibition. Both inhibition and contraction may be subserved by the same mechanism aerobically as well as anaerobically, as shown by the identical effect of glucose in asphyxia and oxygen subsequently. The aerobic mechanism for inhibition may be antagonistic to the anaerobic one, as shown by the inhibitory effect of oxygen.

That relaxation of muscle may also be passive is shown by decrease in oxygen consumption of the relaxed musle[9], and absence of *rigor mortis*.

*Contraction.* The contractions of unstriated muscle are divided into four groups as produced by nervous stimulation, electric current, drugs such as adrenaline and acetylcholine and ions such as potassium and barium. Their susceptibility to asphyxia suggests that they are subserved by different metablic mechanisms[1,3]. Thus the susceptibility to asphyxia varies in the following order:—Nervous stimulation > electric current > drugs > ions.

The aerobic mechanisms of twitch and tone may be different[1,2]; this is shown by the fact that after asphyxiation, introduction of oxygen may increase tone and decrease twitch or they may be subserved by a common mechanism. The anaerobic mechanism for tone and twitch may be different as suggested by the following experiments: (1) addition of glucose to an asphyxiated muscle may increase tone and decrease twitch, (2) asphyxia may increase twitch though tone may be unaffected or actually decrease.

Though there are several metabolic mechanisms in unstriated muscle, they appear to be related and the metabolic compartments are not watertight. Thus oxygen may not have an inhibitory effect after asphyxia suggesting that the anaerobic mechanism functions aerobically also. Similarly both tone and twitch may be simultaneously increased by oxygen or glucose. The antagonism between the various metabolic mechanisms prevents utilisation of energy simultaneously from

two sources. When one source is opened, the other is closed, thus exercising economy in the expenditure of energy.

1. Singh, I., and Singh, S. I., *Curr. Sci.*, 1947, **16**, 259. 2. —, *Proc. Ind. Acad. Sci.*, 1948, **27**, 127. 3. Best and Taylor, *The Physiological Basis of Medical Practice*, London, 1945. 4. Singh, I., *J. Physiol.*, 1938, **92**, 62. 5. —, *Ibid.*, 1939, **96**, 367. 6. —, *Ibid.*, 1940, **98**, 155. 7. —, *Ind. Journ. Med. Res.*, 1942, **30**, 629. 8. —, and Singh, S. I., *Proc. Ind. Acad. Sci.*, 1948, **28**, 51. 9. Rao, M. S., and Singh, I., *J. Physiol.*, 1940, **98**, 12.

# IN MEMORIAM[1]

## THOMAS NELSON ANNANDALE

ON the 10th April 1949, some past and present members of the Zoological Survey of India assembled at the Scottish Cemetery, Calcutta, to pay their respectful homage to the sad and loving memory of Dr. Thomas Nelson Annandale, the founder-Director of the Survey, who died on the 10th April 1924, twenty-five years ago. Wreaths, flower bunches and loose flowers were laid on the grave and those present stood in silence for some time remembering his brilliant career in India, his erudite learning, his love for the staff and his manifold kindnesses and courtesies to many. It was decided by those, who knew Annandale personally, that every year on this day they should assemble and pay their homage to his memory with floral tributes.

The Royal Asiatic Society of Bengal, with which he was closely associated throughout his period of service in India as Anthropological Secretary, Vice-President, and as its President in 1923, perpetuates his memory by a triennial award of the Annadale Memorial Medal on a person who has made the most important contribution, during the previous five years, to Anthropology in Asia and the first award was made of Dr. Fritz Sarasin in 1928 in honour to Dr. Annandale's lifework in physical anthropology. Thereafter the award has been made alternately for physical and cultural anthropology. The Society has also a sepia portrait and an oil painting of Annandale in its rooms. In appealing for funds to perpetuate the memory of Annandale, the Council of the Society paid to him the following tribute:—

> "Dr. Annandale occupied the foremost place in the ranks of Indian Zoologists. His scholarly research work earned for him meritorious recognition from the premier scientific Society in the world. His enthusiasm for the cause of scientific education in India was abiding. In him was combined the rare distinction of a scholar, erudite and industrious, and a personality, modest but engaging."

It is also in the programme of the Society "that the balance of income of the Annandale Memorial Fund be suitably invested until the accumulated amount is sufficient, after paying for the triennial award, to provide Rs. 250 a year, to be utilised for a biennial Anthropological Lectureship.

Annandale was the last Superintendent of the Indian Museum and this office he held from 1907 to 1916. He succeeded Col. Alcock and relinquished the office on becoming the first Director of the Zoological Survey of India. The Trustees of the Indian Museum have also perpetuated his memory by putting up a brass tablet in the premises, the inscription on which reads as follows:—

> "In memory of Thomas Nelson Annandale, C.I.E., M.A., D.Sc., Driector, Zoological Survey of India, Superintendent and Secretary to the Trustees, Indian Museum. Born 1876, died 1924. Erected by the Trustees as a token of their esteem."

Lt.-Col. R. B. S. Sewell, C.I.E., F.R.S., Cidevant Director, Zoological Survey of India, at the request of the undersigned wrote a review of Annandale's work in India which is being published in the *Records of the Indian Museum*. It brings out very clearly how Annandale was far ahead of his times, for to him any taxonomic work involved correlation of the fauna " with the climate, the geographical position and geological formation, the vegetation and the composition of the water of each district surveyed." He was of the opinion that "No one formula can express, much less explain, evolution." He very often told the writer that it was his intention to write a book on "Evolution" during leave which he intended to take when death snatched him away from us. His later writings show the magnitude of the loss suffered by the scientific world through his early death, for he had intended to incorporate the whole of his investigations and wide experience in his contemplated publication on "Evolution."

S. L. HORA.

[1]An Obituary Notice of Nelson Annandale by the late Dr. S. W. Kemp appeared in the *Records of the Indian Museum*, 1925, **27**, 1-28.