are, symptoms and appearances arise which differ from those which characterize sleep. (2) During sleep the brain is in a comparatively bloodless condition, and the blood in the encephalic vessels is not only diminished in quantity, but moves with diminished rapidity. (3) The condition of the cerebral circulation during sleep is, from physical causes, that which is most favourable to the nutrition of the brain tissue; and, on the other hand, the condition which prevails during waking is associated with mental activity, because it is that which is most favourable to oxidation of the brain sub­stance, and to various changes in its chemical constitution. (4) The blood which is derived from the brain during sleep is distri­buted to the alimentary and excretory organs. (5) Whatever in­creases the activity of the cerebral circulation tends to preserve wakefulness; and whatever decreases the activity of the cerebral circulation, and, at the same time, is not inconsistent with the general health of the body, tends to induce and favour sleep. Such circumstances may act primarily through the nervous or through the vascular system. Among those which act through the nervous system may be instanced the presence or absence of impressions upon the senses, and the presence or absence of exciting ideas. Among those which act through the vascular system may be men­tioned unnaturally or naturally increased or decreased force or frequency of the heart’s action.”

Dr William A. Hammond and Dr Silas Weir Mitchell (b. 1830) repeated and extended Durham’s observations, with the same general results (1866), and Ehrmann, Salathé (1877), François Franck (1877) and Mosso (1881), by more refined methods of observation arrived at the same general conclusions. Angelo Mosso (b. 1846) in particular applied with great success the graphic method of registration to the study of the movements of the brain and of the circulation during sleep. He made observa­tions on three persons who had lost a portion of the cranial vault and in whom there was a soft pulsating cicatrix. They were a woman of thirty-seven years of age, a man of thirty-seven years and a child of about twelve years. By special arrangements, Mosso took simultaneous tracings of the pulse at the wrist, of the beat of the heart, of the movements of the wall of the chest in respiration, and of the movements of the denuded brain. Further, by means of the plethysmograph—an instrument of Mosso’s own invention—he obtained tracings showing changes in the volume of the hand and forearm; and he succeeded in showing that during sleep there is a diminished amount of blood in the brain, and at the same time an increased amount in the extremities. He showed further that there are frequent adjust­ments in the distribution of the blood, even during sleep. Thus a strong stimulus to the skin or to a sense organ—but not strong enough to awaken the sleeper—caused a contraction of the vessels of the forearm, an increase of blood pressure, and a determination of blood towards the brain; and, on the other hand, on suddenly awakening the sleeper, there was a contraction of the vessels of the brain, a general rise of pressure, and an accelerated flow of blood through the hemispheres of the brain. So sensitive is the whole organism in this respect, even during sleep, that a loudly spoken word, a sound, a touch, the action of light or any moderate sensory impression modified the rhythm of respiration, determined a contraction of the vessels of the forearm, increased the general pressure of the blood, caused an increased flow to the brain, and quickened the frequency of the beats of the heart. These observations show how a physiological explanation can be suggested of the influence of external impressions in modifying the dreams of a sleeper. Further, Mosso found that during very profound sleep these oscillations disappear: the pulsatory movements are uniform and are not affected by sensory impres­sions, and probably this condition exists when there is the absolute unconsciousness of a “ dead ” sleep. By such methods as have been employed by Mosso, three movements of the brain have been observed—(1) *pulsations*, corresponding to the beats of the heart; (2) *oscillationsi* or longer waves, sometimes coincid­ing with the heart beats, or more generally consisting of longer festoons, carrying each a number of smaller waves, and believed to correspond generally to the respiratory movements; and (3) *undulations,* still longer and less marked elevations and depressions, first clearly observed by Mosso, and believed by him to indicate rhythmic contractions of the vessels of the pia mater and of the brain. This view is in keeping with the observa­tions of Franz Cornelius Donders (b. 1818), Adolf Kussmaul (b. 1822), Tenner and others on changes of calibre observed in the cerebral vessels, and with the experiments of many physio­logists, showing that the vessels of the pia mater, like other vessels, are controlled by the vaso-motor system of nerves. It may therefore be considered certain that during sleep there is an anaemia, or partially bloodless condition, of the brain, and that the blood is drawn off to other organs, whilst at the same time this anaemic condition may be modified by changes in the circulation or in the respiratory mechanism caused by position, by sensory impressions or by sudden changes in the state of repose of the muscles. The examination of the retina (which may be regarded as a cerebral outwork) by the ophthalmoscope during sleep also shows a comparatively bloodless condition. Such are the facts; the deficiency in the way of a theoretical explanation is that physiologists cannot satisfactorily account for the anaemic condition causing unconsciousness. Sudden haemorrhage from the brain and nerve-centres, or a sudden cessation of the supply of blood to the brain, as occurs in syncope (failure of the heart’s action—a faint), no doubt causes uncon­sciousness, but in these circumstances there is a tendency to convulsive spasm. Such spasm is usually absent in sleep, but sudden jerks of the limbs may sometimes be observed during the time when there is the confusion of ideas preceding the passage into sleep.

During sleep the amount of carbonic acid eliminated is very much reduced, indicating that molecular changes in the tissues do not occur to the same extent as in the waking state. This is also shown by the fact that less heat is produced. Hermann von Helmholtz (b. 1821) states that the amount of heat produced by a man weighing 67 kilogrammes (147∙4lb) is about 40 calories per hour during sleep, as against 112 calories per hour while awake. This diminished production of heat may be largely accounted for by the quiet condition of the muscles of locomotion, but it also indicates diminished tissue changes throughout the body. In profound sleep the bodily temperature may fall from ∙6° to ∙2° Fahr. In consequence of diminished oxidation changes during sleep, it is not improbable that excess of nutrient matter may then be stored up in the form of fat, and that thus the proverb "He who sleeps dines ” is based on a correct appreciation of the fact that sleep tends to produce plethora or obesity.

Whilst it is easy to state that sleep is caused by fatigue of the nervous system, it is more difficult to explain what the precise changes are that produce the state of unconsciousness. Various hypotheses have been advanced, but it cannot be said that any one is wholly satisfactory. Aware that the fatigue of muscle is associated with the accumulation of sarcolactic acid, Thierry William Preyer (b. 1841) surmised that the activity of nervous matter might be interfered with by the accumulation in the nerve- centres of some such acid, or of its soda salt (lactate of soda), but this view has not been supported by the results of experiment, as the injection into the blood of a dose of lactate of soda has not produced sleep. Pflüger has observed that frogs deprived for a considerable time of oxygen passed gradually into a state resembling profound sleep, and he has advanced the theory that there is no organ of the body so quickly affected by deprivation of oxygen as the brain. According to Eduard F. W. Pflüger (b. 1829), the phenomena of life depend on a dissociation of living matter, and in particular the activity of the cerebral substance connected with psychical states depends on dissociation changes in the grey matter. To excite the dissociation, however, oxygen is necessary. The oxygen unites with certain of the compounds set free by the dissociation, forming, amongst other substances, carbonic acid. If such matters as these that unite with oxygen arc in sufficient amount to use up all the oxygen, the grey matter of the brain suffers from a deficiency of oxygen (or from its absence), and also from the accumulation of carbonic acid. According to such a theory, cerebral activity depends on cerebral respiration, and sleep is a kind of cerebral asphyxia. Some such condition is not improbable, but it must be stated that the evidence at present in support of it is meagre. Possibly, in attempting to account for the phenomenon of sleep, too much importance has been attributed to the changes occurring in the