impression made upon the sensible structure of the blood-vessels, and not from their direct application to the brain itself."—(*Essay*, p. 60.) The proofs adduced in support of this theory are, first, "the extreme susceptibility of the inner coat of a vein, when exposed to the action of a poison," as shown by the experiment related at page 26: secondly, that woorara acts on the brain as quickly when injected into the femoral, as when thrown into the carotid artery: thirdly, that woorara, applied to the cut surface of the cerebrum, caused no symptoms of poisoning: fourthly, that by establishing a complete double circulation between the carotids of a poisoned and of a sound dog, the latter does not become affected.

Of all these "proofs," however, the only important, though not unobjectionable one, is the first. The second and third are merely negative; their object being to show that poisons do not act by pervading the structure of the part, and to the fourth I have before offered some objections.

In conclusion, then, I would observe, that while Messrs. Morgan and Addison have thrown some doubt over our previously received notions on the operation of medicines, they cannot be admitted to have established their own hypothesis; and further experiments are still required to settle this doubtful question.

6. *Operation of Medicines by Nervous Agency.*

Messrs. Morgan and Addison contend, "that all poisons, and perhaps, indeed, all agents, influence the brain and general system, through an impression made upon the sentient extremities of the nerves, and not by absorption and direct application to the brain." Müller, on the other hand, asserts, "that before narcotic poisons can exert their general effects on the nervous system, they must enter the circulation."

Difficulties are met with by exclusively adopting either of these opinions. The operation of some medicines seems to be best explained by supposing the previous absorption of these agents, while that of other substances appears to be most satisfactorily accounted for by presuming they affect the nerves independently of absorption.

Proofs that some substances act independently of absorption.—Several circumstances lead us to infer that, in some instances, substances act on the general system without necessarily undergoing absorption.

a. The instantaneous operation of some Poisons.—One drop of pure hydrocyanic acid, says Magendie, placed in the throat of the most vigorous dog, causes it to fall dead after two or three hurried inspirations. If the nose of a rabbit be introduced into a receiver filled with hydrocyanic acid vapour, the animal drops dead instantly. Sir Benjamin Brodie once happened to touch his tongue with the end of a glass rod which had been dipped in the essential oil of bitter almonds; scarcely had he done so, before he felt an uneasy, indescribable sensation at the pit of the stomach, great feebleness of limbs, and loss of power to direct the muscles, so that he could hardly keep himself from falling. These sensations were quite momentary. In the cases now quoted the rapid action of the poisons seems almost incompatible with the idea of their absorption. Müller, however, thinks otherwise, and asserts they are explicable on the theory of absorption by imbibition. "The rapid effects of prussic acid," he observes, "can only be explained by its pos-

sessing great volatility and power of expansion, by which it is enabled to diffuse itself through the blood more rapidly than that fluid circulates, to permeate the animal tissues very quickly, and in a manner independent of its distribution by means of the blood, and thus to produce the peculiar material changes in the central organ of the nervous system more quickly in proportion as it is applied nearer to it."—(*Op. cit.* p. 247.)

b. The effects being disproportionate to the facility for absorption.—Orfila (*Toxicologie Générale*) says, that alcohol acts with much less energy when injected into the cellular texture, than when taken into the stomach; and as the power of absorption is greater in the former than in the latter part, he concludes that the remote action of alcohol must be produced by the agency of the nerves. Opium, on the contrary, is supposed to operate by absorption, because it is more active when injected into the cellular texture of the thigh than when taken into the stomach.

c. Dilution diminishing the remote effects.—The effect of dilution on the action of medicinal and poisonous agents oftentimes assists us in determining the mode by which the remote effects take place. Thus if we apply a strong mineral acid to the stomach, great disorder of the general system is produced; but if we dilute the acid previous to its exhibition, little disturbance in the system is observed. Now as dilution facilitates absorption, it is improbable that the constitutional disorder caused by swallowing strong mineral acids depends on their absorption. On the other hand, Dr. Christison (*op. cit.*) has shown that oxalic acid, considerably diluted, quickly enters the blood, and causes speedy death: hence it is presumed to kill in consequence of absorption.

d. Effect of Mechanical Injury.—Mechanical injuries sometimes give rise to effects on remote parts similar to those caused by the action of certain medicines or poisons. Laceration of the stomach produces similar constitutional disorder to that occasioned by the strong acids.

Agency of the Nervous System.—Between the individual parts of the organism there exist certain relations or connexions, which Adelon (*Physiologie de l'Homme*, t. 4me, p. 200,) has arranged in three classes,—the mechanical, the functional, and the sympathetic. It frequently happens that one organ in the performance of its functions exercises a mechanical influence over another. Thus the motions of the respiratory muscles have an important influence over the circulation of blood within the chest. By the contraction of the muscles of the fore-arm, pressure is made on the deep-seated veins, and the passage of blood through them thereby obstructed. These, then, are evident and clear cases of a *mechanical relation* between certain organs. We have also numerous instances of what have been called *functional relations;* but one example will suffice: the liver cannot secrete bile if the supply of arterial blood, or of nervous energy, be cut off: hence it is evident that the function of the liver depends for its performance on the proper execution of the functions of the arterial and nervous systems. But there is a class of relations which cannot be referred to either of the preceding heads, and which have been called the *true sympathies*, or the *sympathetic relations*. Thus if we titilate the mucous membrane of the nose, sneezing is produced; if the soft palate, vomiting.

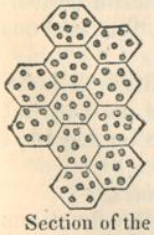
The phenomena hitherto called sympathetic have been denominated by Dr. Marshall Hall (*Memoirs on the Nervous System*, 1837,) *excito-motory*. They must not be confounded with those of sensation and

volition, from which they are quite distinct. They are effected by nervous fibres and a nervous centre. The fibres are of two kinds, one termed *incident excitor*, the other *reflex motor*. The centre is the grey matter of the true medulla oblongata and medulla spinalis, from which the nervous fibres arise.—(See *Grainger's Observations* on the *Structure* and *Functions* of the *Spinal Cord*, 1837.) The mode of action of these parts is this: when a physical agent is applied to any of the external or internal surfaces of the body, an impression is made on, and carried by, the incident excitor nerve to the grey matter, constituting the nervous centre of the system; and this part, by its peculiar power, excites contraction through the medium of its reflex motor nerves. Electricity has been suspected to be the secret agent effecting these communications.

When the nostrils are stimulated, the fauces irritated, or cold water dashed upon the face, filaments of the fifth pair of nerves are the incident excitors; when carbonic acid, or a drop of water, comes in contact with the larynx, and when the dust of ipecacuanha is inhaled into the bronchia, with the effect of inducing asthma, filaments of the pneumogastric nerve are the incident excitors. In all these instances filaments of the pneumogastric are the reflex motors, by means of which the actions of sneezing, vomiting, sobbing, closure of the larynx, and asthma, are produced. "It is singular," observes Dr. Hall, (*Lectures on the Nervous System*, p. 156, note,) "that ipecacuanha, taken into the stomach, should excite vomiting, and, inhaled into the bronchia, should excite spasmodic asthma, equally, as it would appear, through the pneumogastric nerve." Belladonna applied to the eyebrow causes dilatation of the pupil: the incident excitors concerned in this process are the fibres of the portio major of the fifth,—while the reflex motors are derived from the third or oculo-motor nerve. In cases of poisoning by this substance, difficulty or impossibility of deglutition has been observed,—another effect of its action on the excito-motory system.

Mr. Grainger is of opinion, that the ganglions of the sympathetic form a part, though to a certain degree an isolated one, of the excito-motory system; and that their action is excited like that of the spinal cord.—(*Op. cit.* p. 136, *et seq.*) He has also suggested (*op. cit.* pp. 131-2, 155-6-7,) that the motions displayed by plants and the lower animals are excited, and not voluntary; and that even in plants it may be effected by a structure analogous in its office, though differing in its physical characters, to the true spinal system of animals. Hitherto, however, no one has been able to demonstrate a nervous system in vegetables. Dutrochet (*Recherches anatomiques et physiologiques sur la structure intime des Animaux et des Végétaux*, 1824,) indeed asserts, that the small points, or spots, observed on the cells and vessels of plants (figs. 17 and 18,) are analogous to the nervous globules of animals; he calls them *nervous corpuscles*, and regards them as the scattered elements of a diffused nervous system. That globules are found in vegetables in the situation described by Dutrochet no one can deny; but the grounds on which he asserts them to be nervous are very slender. The researches of Leeuwenhoek, Prochaska, Fontana, Sir Everard Home, Bauer, the brothers Wenzel, and Dr. Milne

Fig. 17.

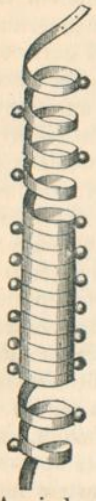


Section of the medulla of the *Mimosa pudica*, shewing the globular bodies adhering to the sides of the cells.

Edwards, he observes, have shewn that the nervous system of animals is composed essentially of agglomerated globular corpuscles.

If we examine, by the aid of a simple microscope, the pulpy matter of which the œsophageal ganglia of the great or vineyard snail *(Helix pomatia,)* or of the red slug *(Limax rufus,)* is made up, it is seen to be composed of agglomerated globular cells, on the sides of which are numerous globular or ovoid corpuscles (fig. 19.) In form and chemical properties, says Dutrochet, these corpuscles agree with those found in plants. Moreover, in the lower tribes of animals (the *Acrita*) we observe no nervous filaments; the nervous system consisting merely of the diffused or scattered corpuscles (as in the *Hydra* or fresh-water polype, fig. 20, and in *Vorticella Convallaria*, fig. 21; thus presenting another analogy between the nervous corpuscles of animals and the globular bodies of plants.

Fig. 18.



A spiral vessel, as found in the stems of *Solanum tuberosum*, and *Cucurbita Pepo*, with the adhering globules.

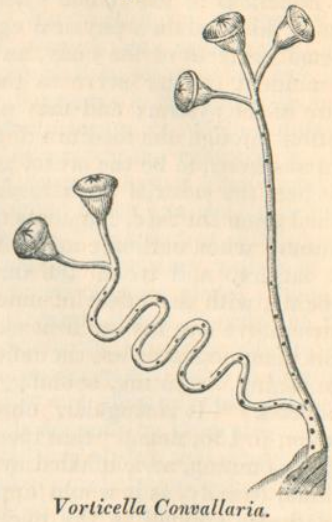
Fig. 19.

Globular cells of the œsophageal ganglia of *Helix pomatia* and *Limax rufus*.

Fig. 20.

Magnified view of the arm of a *Hydra*, (fresh-water polype) shewing the nervous corpuscles.

Fig. 21.



Vorticella Convallaria.

On these grounds, then, Dutrochet assumes that the little globules sticking to the cells and vessels of plants, and which are nothing but particles of amylaceous, ligneous, or resinous matter, are to be regarded as the scattered elements of a diffused nervous system.

7. *Parts affected by the remote action of Medicines.*

The remote effects of medicines consist of alterations in the functions of one or more organs more or less distant from the parts to which these agents were applied. Although an alteration of function presupposes an organic change, yet the latter is not always obvious.

A medicine may affect a distant organ directly or indirectly. The stupor caused by opium is presumed to arise from the direct influence exercised by this drug over the cerebrum, since it cannot be otherwise