

An inaugural dissertation on the vitality of the blood : submitted to the examination of the Rev. John Ewing ..., the Trustees and Medical Faculty of the University of Pennsylvania, for the degree of Doctor of Medicine / by John Martin.

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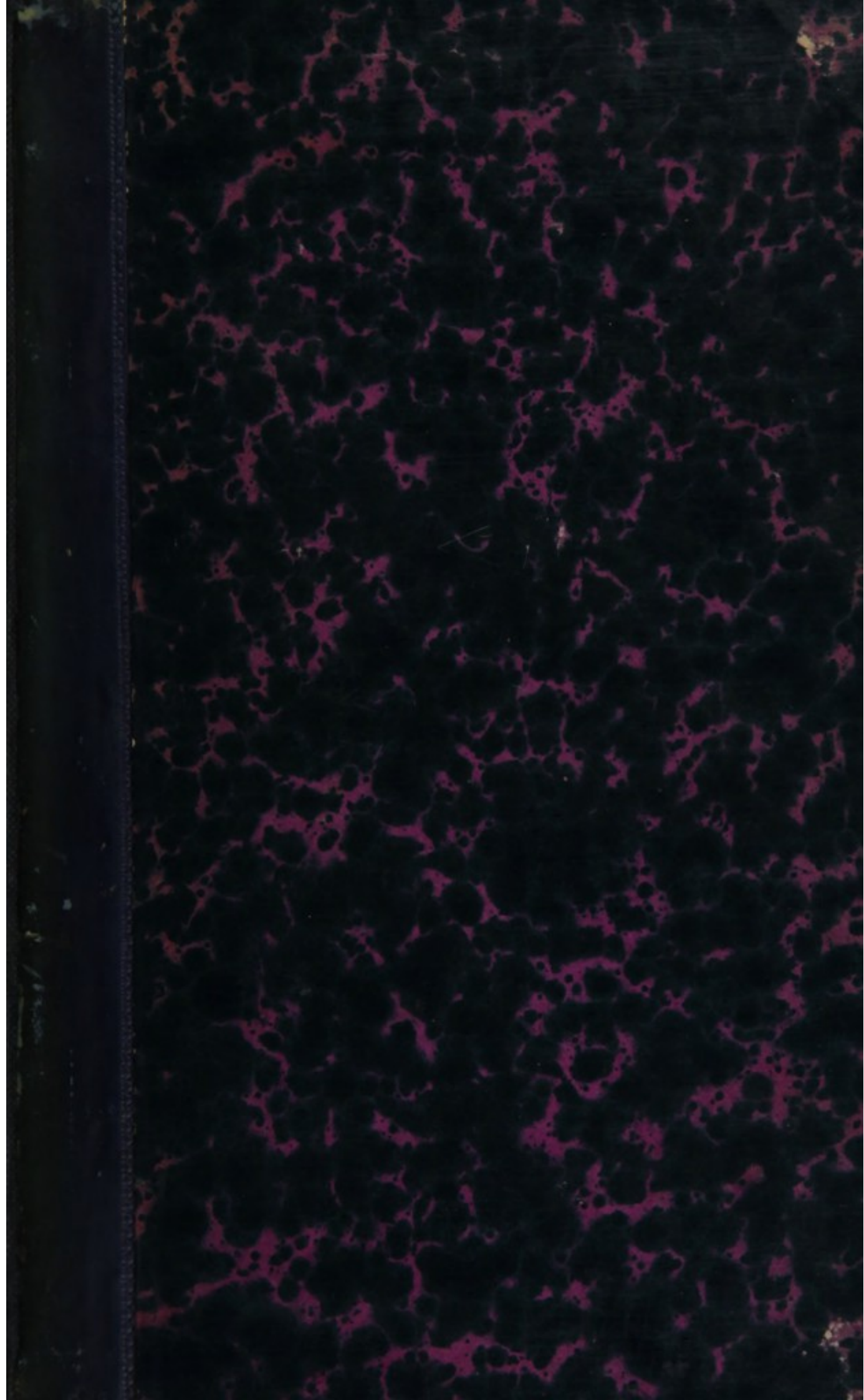
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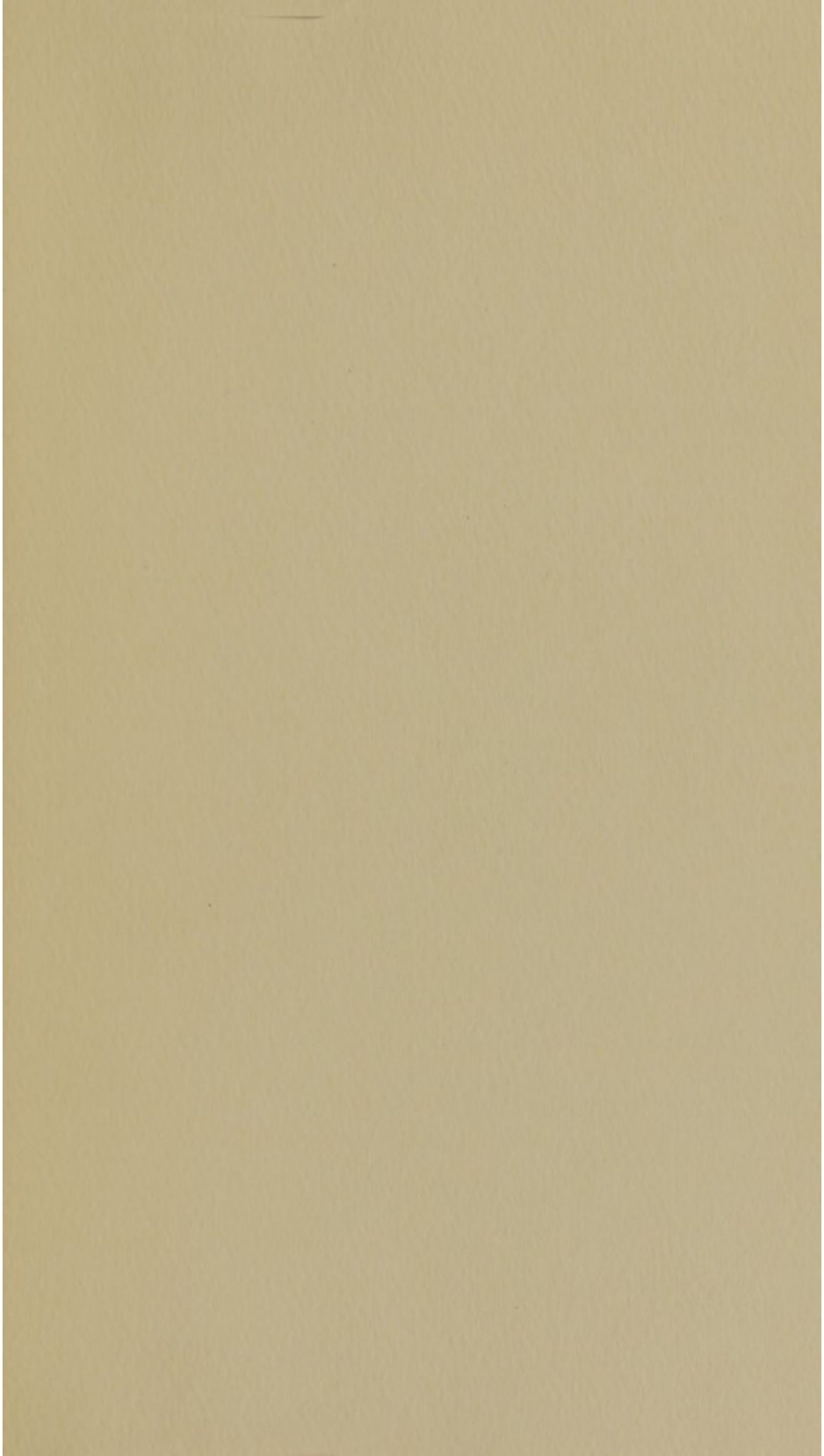
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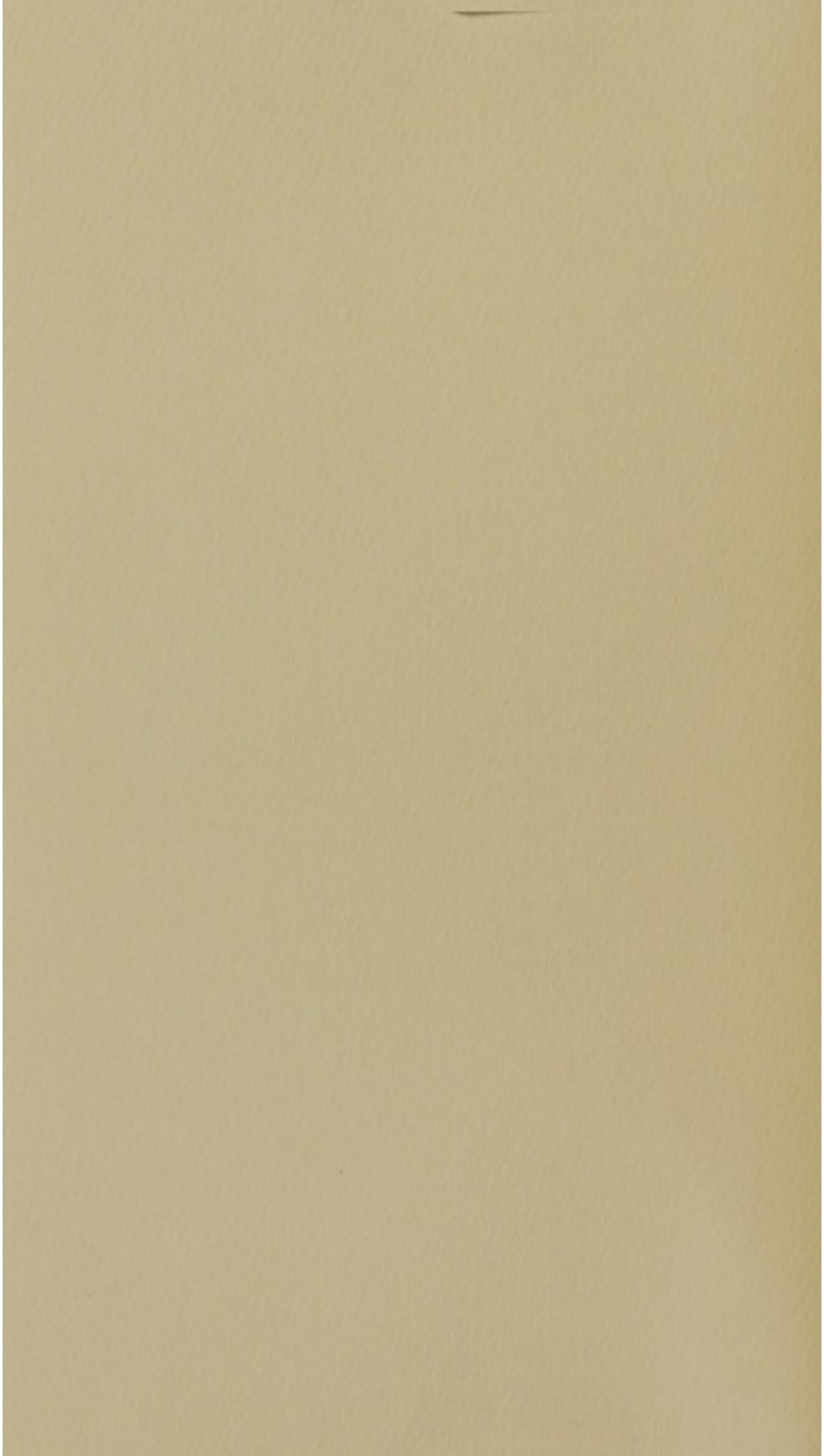
Section,

Blood

No.

21377





AN
INAUGURAL DISSERTATION
ON THE
VITALITY OF THE BLOOD;
SUBMITTED
TO THE EXAMINATION
OF THE
REV. JOHN EWING, S. T. P. PROVOST;
THE
TRUSTEES AND MEDICAL FACULTY
OF THE
UNIVERSITY OF PENNSYLVANIA;
FOR THE DEGREE OF
DOCTOR OF MEDICINE.

BY JOHN MARTIN,
OF DELAWARE.

.....Anima cujusque carnis in sanguine est.

Levit. xvii. 11.

PHILADELPHIA:
PRINTED BY ROBERT CARR.

.....
1802.

OF THE FLOOD;

TO

DOCTOR EBENEZER A. SMITH,

OF

WILMINGTON, DELAWARE,

THE DISSERTATION

ON THE NATURE AND CAUSES OF

IS PRESENTED:

AS A MARK OF

RESPECT AND ESTEEM

FOR THE MANY FAVOURS

CONFERRED UPON HIS

SINCERE FRIEND,

AND GRATEFUL PUPIL,

THE AUTHOR.

TO
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VITALITY OF THE BLOOD.

SECTION I. OF THE VITALITY OF THE BLOOD.

THE opinion of a vital principle in the blood is by no means modern; it has been entertained by men of distinction in all ages. Dr. Harvey has thrown out some hints which lead to this conclusion. A similar hypothesis, however, prevailed long before his time; Hippocrates and Galen, made the heart the seat of the vital principle, and Sennertus expressly says, that the heart and arteries form and contain the vital power. Since the time of Dr. Harvey the same opinion has been maintained by many authors of eminence. Willis says, sanguinis animatio, in totum solum placenta phlogistonum, sed indubitanter sanguis corporis totumque placenta animat. Hoffman makes use of the same

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* Instit. Med.

† De. Mot. Musc.

argument, and elsewhere says, in plain terms, that the blood contains the principle of life.* The sentiments of Huxham are of a similar nature.† This opinion, having those great men for its supporters, gave rise to no controversy, untill revived and advocated by the late Mr. John Hunter,—since then, it has been a subject on which persons of the most enlarged powers of mind are divided.

In the following dissertation, though in some respects I may differ from Mr. Hunter, I shall, notwithstanding, endeavour to support his doctrine so far as it tends to establish the life of the blood in common with the solids. The order I shall observe will be :

I. To shew that animal substances, apparently inorganic, and destitute of motion, have a vital principle.

II. To define what is to be understood by life in the blood, and endeavour to make it appear that it has a vital principle.

III. To shew that it neither circulates,

* Tom. I.

† Essay on Fever.

nor preserves the life of the body by acting as a stimulus, i. e. as other stimuli act when applied to parts possessing irritability.

To commence the consideration of the first head, I shall state an objection made to a living principle in the blood, by an ingenious modern author,* who says that "it seems to be against all the laws of nature, that any fluid should be endowed with life." From this it would appear that the great difficulty in reconciling the belief of a vital principle in the blood, is owing to its fluidity. Life being erroneously supposed to consist in the exercise of certain functions of an active nature, to the performance of which, organization is considered necessary, and from our not being able to discover organization in the blood, it has been deemed inanimate.

The only just difference, however, which can be discovered betwixt a solid and fluid, consists in a greater capacity of motion in the parts of the one, than in

* Mr. John Bell.

those of the other, and as we have observed living bodies in both states, it may be said, "that there is not a more intimate connection between life and a solid, than life and a fluid." The opinion, that organization is necessary to life, proceeds from an incorrect idea entertained of its nature. Instead of life being an effect, as is supposed, it is a cause, and cannot be said to depend upon organization or motion, as these are merely its consequences. That animal substances have life, when neither of these effects are observable, must be admitted, supposing, therefore, that the blood is inorganic, it can be no objection to its vitality. The embryo in its early state, and many animals of the lowest order, as polypi, have neither visible organization nor motion, yet it is certain they have life in a perfect degree. Although the phenomena of life, depending upon the same cause may differ, it is to be observed, that all living matter is governed by one general and peculiar law, which is a power of resisting, to a certain degree, the action of those causes which

tend to its destruction ; if we can make it appear that animal substances, having neither visible organization nor motion, possess this power, which in every instance must be the effect of life, we shall be induced to infer, that the blood, though apparently inorganic, may also possess life.

That such substances have a power of resistance different from inanimate matter must be evident. The egg, which comes under this description, resists the action of heat, even when raised to a considerable degree. To shew which, we may observe, that during the process of incubation, when situated in a heat of 103°. Farenheit, for three, and in some instances, six weeks, yet the yolk, and that part of the albumen which has not been expended on the growth of the animal, continue sweet until the last, while if it be not converted into a living animal, putrefaction is the consequence. We find from some of Mr. Hunter's experiments,* that this sub-

* Hunter on the blood.

stance also possesses the power of resisting the action of cold. After freezing and thawing an egg, it was placed in a cold mixture (about 0 of F.) with one newly laid, the difference in freezing was seven minutes and a half, the fresh egg requiring so much longer time. In another experiment, two eggs under similar circumstances, were placed in a cold mixture, (15 above 0.) the thawed egg soon fell to 32. and froze, while that which was fresh, although reduced to 29. and a half, continued fluid twenty-five minutes after the dead one, when it rose to 32. and congealed. That the egg, an animal substance apparently inorganic, does possess properties different from inanimate matter, is evident, and except they are admitted to proceed from a vital principle, we shall be unable to account for its power of resisting the action of heat, during incubation, which is peculiar to living matter—for we find when deprived of the principle upon which this power depends, and placed in a warm situation, that putrefaction necessarily takes place, as in dead animal matter

of a different kind. The two experiments prove that a certain degree of cold has the effect of annihilating that principle, which at first resisted its action, as it is observable that those substances, after being once frozen, loose their resisting power and freeze in a much less time than was necessary at first, which would not be the case, if in the first process their vital principle had not been destroyed. It has been further ascertained by Mr. Hunter, that frogs and eels, when subjected to the same experiment with the fresh egg, are affected in a similar manner, the living principle of each, permitting their heat to be diminished two or three degrees below the freezing point, resists further decrease, but in this exertion its powers being expended, they then freeze (like other dead matter) and on thawing, are found to be dead.

From these facts it is evident, that fluid animal substances possess a vital principle, not only in an equal degree with the less perfect animals, but that the same phenomena result from the action of the

same cause on this principle in each, we are therefore naturally led to conclude, that fluidity can be no objection to a vital principle in the blood. Will those who believe in a nervous fluid, deny the vitality of the blood upon the principle of fluidity? Will vitality be denied to the seminal fluid, a principal agent in the process of generation? Or will those who believe that the gastric juice imparts living properties to dead matter, in the process of chylication, deny its vitality upon the principle of fluidity? If so, it may be truly said with Mr. Bell, that *it seems to be against all the laws of nature, that any fluid should be endowed with life.*

Having, I think, sufficiently shewn that a want of organization or fluidity can be no objection to a vital principle; according to the second division, we shall now define life in the blood to be that peculiar principle, by which it and the living animal solids are united. With a view to illustrate this definition, and shew that it has a vital principle, I shall state a few of

Mr. Hunter's leading arguments, and endeavour to remove the most plausible objections that have been brought against them, by certain authors of eminence. Mr. Hunter observes,* that the blood "unites living parts when effused between them, as certainly as the yet recent juice of the branch of one tree unites it with that of another." This is said by Mr. Bell, to be effected merely by "the living fibres and living vessels of both." In answer to this objection, it may be observed, that the consequence necessarily arising from the action of dead matter, on the living animal solids, is suppuration, which is a process that has a tendency to throw off this matter, or if it be so situated that nature is unable to effect it, no union of parts will take place. So that if the blood be not alive, when in contact with living parts, it would always produce suppuration, or as effectually prevent an elongation of the vessels, as a piece of bougie or any substance of a similar na-

* Medical Com. Vol. 2.

ture, when used with that intention. But as it is effused in every wound, and none of these phenomena proceed from its presence alone, we must suppose that it has a vital principle in common with the solids. Supposing it be admitted, that the blood is inanimate, and that it is from being confined to the vessels, which are its only proper receptacles, that it produces none of the effects of dead matter. If this be the case, it may be observed that, when effused in wounds and fractures, it is in an error loci, and ought, upon this principle, to produce the same serious consequences which would necessarily result from the action of so much inanimate matter of a different kind, in a similar situation. But as it is governed only by the laws of living matter, and in such cases becomes the bond of union, it is evident that Mr. Hunter's argument affords a strong proof in favour of its vitality.

Mr. Hunter has proved by "injection, that the coagula of blood, in the extremities of arteries after amputation, become vascular." Mr. Bell says, "that nothing

is more common, than clots of blood, or depositions of the coagulable part, becoming highly vascular by vessels shooting into them from surrounding parts," but does not consider it as a proof of their vitality. To this objection it may be replied, that, altho' we admit that the vessels may elongate, yet we can by no means suppose they have a power to pass into inanimate matter, for if, in place of the coagula of blood, we introduce into wounds and the extremities of arteries, animal jelly or vegetable gluten, substances from appearance most similar to the coagula of any other, they will not fail to act as dead matter, while every attempt to inject vessels shooting into them, being unsuccessful, evidently shews a difference between blood and common matter.

Mr Hunter says, that "contraction is the life of the solids, and if we can find any thing like it (by which he means coagulation) we shall call it the living principle of the blood." Contraction of the solids and coagulation of the blood, when separated from the body, are considered

by Mr. Hunter, as effects arising from the operation of an undiminished living principle in each, excited into action by stimuli. On this particular I beg leave to offer a different explanation. Contraction and coagulation, proceeding from the same cause, may more properly be considered as effects which arise from a partial diminution of the living principle of both. We cannot justly suppose that the muscles and blood when detached from the body, should retain life in such perfection as before their separation. To what cause are we to attribute this diminution of life, if it be not from separation and the action of stimuli? What, in such circumstances are we to consider as certainly characteristic of diminished vitality, if it be not contraction and coagulation? As these are the first and regular phenomena which take place in the muscles and blood, in a healthy state, before decomposition, they may be considered as the first symptoms of death, and as denoting the previous existence of an equal degree of vitality in each. But that the life of both may be in

a diminished state without those appearances taking place, must be admitted, as in disease, or death induced by the sudden and violent action of certain hurtful powers, thereby reducing them below what may be denominated the contracting and coagulating points. Considering therefore, fluidity as the natural state of the blood, and that it is in this state only, of use to the healthy system, every change it undergoes may be supposed as morbid, and tending more and more to the destruction of its vital principle. But to return, Mr. Bell in objection says, "he can find no harmony betwixt the occasional, voluntary, regulated contractions, of the living solid, and this sudden irretrievable, inorganic, coagulation of the blood." That the blood when in the body, and under similar circumstances with the solids, has not a power of contracting without coagulating, we are by no means certain. It is a fact which every person of observation must be acquainted with, that when the body is exposed to cold, the solids contract independent of the will. Is it not probable, that a

similar effect is induced at the same time, and by the same cause in the blood? It is generally supposed, that when the surface of the body is exposed to a great degree of heat, the superficial vessels at that time contain a larger quantity of blood than usual, the consequence being a painful and uneasy sensation, (independent of the heat) arising from the great turgescency of the vessels. When the body is exposed to a great degree of cold, the blood is then supposed to be determined in an unusual quantity to the deep seated vessels as in the other case it was to the superficial. If similar causes were present, they should produce similar effects, and we ought to experience the same uneasiness in one instance as in the other, which is not the case. It is but reasonable therefore, to conclude that there is no unusual determination to the deep seated vessels, but from the application of cold a contraction is produced in the blood upon the same principle that it is in the solids. It is no just objection to the vitality of the blood, that when separated from the body, it has not

the power of alternate relaxation and contraction when stimuli are applied, similar to the muscular fibre; the only proper reason which can be assigned for the different effects, is that they proceed not from a different principle, but from the same principle being united with a different arrangement of the same matter. If the power of relaxation and contraction be made a necessary characteristic of life, we should have this principle confined to the muscular system alone, and it might be asserted that all the other parts of the body which have not this power, are also inanimate; but this is far from being the case, therefore, the want of this power in the blood, can be no proof against its vitality.

Mr. Bell compares the coagulation of blood to the coagulation of animal substances, which are generally considered as inanimate, for says he, does not jelly coagulate; and what is it but a part of the blood? does not glue congeal, dissolve, and congeal again, yet what is it but an animal jelly?" Mr. Bell certainly has not adverted to the different principles upon

which these phenomena take place in the two substances, or he would not have drawn the analogy he did. It is well known that jelly coagulates from a diminution of heat, for by renewing this, its fluidity is restored, and it is observable when exposed to the action of the air for any length of time, if that heat to which its fluidity is owing be continued, no coagulation will take place, which clearly proves that heat is the cause of its fluidity. On the contrary, the coagulation of blood depends upon a different cause, when separated from the body, and once coagulated, it cannot again be rendered fluid, unless by chemical means or the natural process of putrefaction. It is certain also, that its heat is as great when it coagulates in the living system, as when it is in a state of fluidity and motion. That a diminution of heat has no effect in coagulating blood, is a fact which cannot be denied, for fresh blood after being frozen, may again be rendered fluid by thawing. The blood of amphibious animals is fluid, although in a natural state it is below the

temperature of the atmosphere, and if it be extravasated, its heat is always increased, before coagulation takes place. Hence it must be evident that jelly coagulates from a diminution of heat, while as we have already observed, the coagulation of blood is owing to a partial destruction of its vital principles, and not a diminution of heat.

We have seen that fluid animal substances, in consequence of their living principle, possess to a certain degree a power of resisting the action of heat and cold, if we can find that the blood has this power also, we may justly infer a living principle in it. To establish this, Mr. Hunter says, "that it is always of the same temperature, altho' the body be exposed to the most opposite extremes of heat and cold it can bear." This argument is objected to by Dr. Ferriar,* who says that "its heat is derived from the solids, as it has not the power of retaining it when separated from the body, but is

* Manchester Memoirs.

gradually reduced to the temperature of the atmosphere." That the blood should lose this power when separated from the body is but natural. A muscle under the same circumstances, will not retain its resisting or preservative properties for a greater length of time than the blood ; yet it is certain that both have life, and as long as they retain it, possess the same properties, but being separated from the source whence they derive this principle gradually lose that portion which they possessed, and of course its depending properties. How are we to account for the power which the blood has, of resisting the action of heat, when in the body, if it be not supposed to proceed from a vital principle ? Those who deny the vitality of the blood must admit that putrefaction is peculiar to that matter only, which has once possessed life, that this process will not take place without the presence of oxigene and heat, that the blood when in the body, has this necessary degree of heat and quantity of oxigene, yet it does not putrefy ; whereas if it be separated from the

body and this degree of heat and quantity of oxigene applied, putrefaction will be the consequence, though it may be kept in constant agitation. Why does it not putrefy when in the body? Or why does it putrefy when separated from the body? With a view to ascertain that the blood has a power of resisting the action of cold, I made the following experiment. After freezing a portion of healthy blood, the vessel containing it, was immersed in warm water, by which it was thawed and brought to the same temperature, with an equal quantity of the same kind, fresh drawn.—These two portions, being in similar vessels, were placed in a freezing mixture, made of ice and salt, the thawed blood soon fell to 32° and became solid, while the fresh was reduced two degrees lower, where it continued some time, then rose to 32° and congealed. That the blood when in the body, has a principle which resists the action of heat, and of course prevents putrefaction, must be evident, for we find, that when separated from the body, putrefaction, is the consequence, which ne-

cessarily proceeds from a loss of the principle upon which this power depends. We also observe, from the experiment just related, that cold has an effect of destroying a principle in the blood, which at first resisted its action in a similar manner to the fresh egg—as it is certain, that after being frozen, it loses this power, and congeals like dead matter of a different kind. Were we destitute of another argument to prove its vitality, this would be sufficient.

Mr. Hunter's last argument is, that "it preserves life in different parts of the body, and in paralytic limbs." This it does, says Dr. Ferriar, by conveying nourishment and acting as a stimulus. The last part of this objection we shall pass by, as it will be seen in another place that it does not act as a stimulus. In answer to the first it may be observed, that the solids and fluids are always changing, that there is a constant deposition to, and absorption from the solids. Physiologists generally admit this deposition to be made from blood by the minute extremities of the arteries, according-

ly, if it is not supposed to be alive, the particles deposited from it should be, and ought to act, as dead matter, unless we can make it appear that they do not take on vitality until after deposition, and even granting this, they ought in the first instance, before assuming vital properties, to have produced the effects of inanimate matter. But, as the reverse is the fact, we are disposed to think that they are alive before deposition, which being admitted, proves the vitality of the blood. In the next place, the parts absorbed must have been alive before their removal, and these being carried into the circulation, also prove its vitality. It may perhaps be thought that the life of those particles is either annihilated in the act of absorption, or that they are absorbed only when dead, and thus operate against the vitality of the blood. This cannot be admitted, for if an absorption from the solids only takes place as their particles are dead and progressing to putrefaction, according to quantity, the same phenomena would result from their presence in the circulation, as

are consequent from the absorption of particles, which are evidently dead and putrid, as in cases of gangrene, and the system of course ought always to be in a morbid state. It is not probable however, that dead parts could be united with living, and induce no morbid change in them, while it is impossible, also, to conceive by what means the life of one particle could be destroyed, and that of another sustain no injury. We shall not enquire what purpose is answered by so constant a deposition to, and absorption from the solids, but I think, we may justly conclude, that the particles are alive, both when deposited and absorbed, which being the case, the vitality of the blood must be evident.

Having ascertained that the blood has a vital principle, a question not a little involved in obscurity may occur. From whence is this principle derived? All that can be offered on this point, must necessarily be from conjecture. In the first place, we know that the aliment is necessary for the preservation of life. Is it inanimate matter? It must be admitted that

putrefaction denotes the previous existence of life, and as this is the only natural process by which matter is reduced from a living to a dead state, we must accordingly suppose that all matter has a portion of life, so long as it is capable of undergoing this process. May not the aliment as it comes under this description, also possess life? As, from the great variety made use of, there is formed but one unchangeable product, chyle, which always possesses the same peculiar properties, is there not reason to believe, that it is the source of vitality to the blood? To render this opinion ~~more~~ probable, it may be observed, that if any kind of aliment be analyzed, and the products combined, we will then be unable to subsist on it as aliment. How are we to account for its different effects, if it is not supposed to have lost a portion of life by decomposition? Why is man, and all animals of a perfect order, capable of living, only, on that matter which has been once alive? Or, why, if the aliment be inanimate, cannot life be supported by matter which is evidently dead, as metals, earths and gasses?

Having made it appear sufficiently evident, according to our definition, that the blood possesses none of the properties of inanimate matter, but on the contrary, that it is governed by the peculiar laws of living matter, which must be owing to a vital principle it possesses, if it appears further, that this principle is affected in the same manner, as the living principle of the muscular fibre, we cannot but infer that the principle is the same, and equally perfect in both. To be satisfied that this is the fact, let us observe how it is effected by the same external agents. In a state of health, when the body is exposed to ~~cold~~, do the muscles contract? So it is probable as we have seen before does the blood. Will a muscle, separated from the body, by losing a portion of its life, contract, and by parting with the remainder, relax, and become putrid? The blood, under the same circumstances, coagulates, which, in it, is similar to the contraction of the muscle, it then undergoes the same succeeding changes, affording the same products by decomposition. In persons killed by electricity, poisons, violent exercise, and sud-

den gusts of passion, the muscles neither contract, nor does the blood coagulate, but both hasten rapidly to putrefaction, which proves, that the life of each is completely destroyed. From this view, it appears, that the blood not only possesses a vital principle, similar to the muscular fibre, but from the action of the same cause on this principle, proceed the same phenomena, it is but reasonable therefore, to conclude, that it has vitality in an equal degree with the muscles.

Having rendered it sufficiently certain that the blood has a vital principle in common with the solids, we shall now proceed to consider the last part of the division, and endeavour to make it appear, that it neither circulates nor preserves the life of the body by acting as a stimulus, i. e. as other stimuli act when applied to parts possessing irritability. In the first place it may be proper to observe, that the general received theory of the circulation is, that the blood, from possessing a stimulating property, in consequence of oxygenation, and acting on the irritability

of the heart and arteries, (from whence they derive their irritability I shall not enquire) together with a certain degree of distention, results the action of the heart and all the phenomena of circulation. To this mode of explaining the principles upon which the circulation is carried on, I cannot fully assent. That a certain degree of irritability, or power of acting in the heart and arteries, is necessary, must be granted, but that the blood acts as a stimulus on this power, is by no means probable. In order to shew that the circulation does not proceed from a stimulating quality in the blood, it may be proper first to ascertain what are the effects of stimuli when applied to the irritable parts of the system, and observe, whether the blood by its action produces the same. As the consequences which necessarily succeed the action of stimuli are so well understood, little explanation is necessary. Every person of observation must know, that when a stimulus has been a long time, or frequently used, if we require it to produce the same effects which it did

when first applied, it is necessary that it should be increased in quantity or quality, in proportion to the length of time or frequency of its action. From this general law respecting the action of stimuli, if the circulation of the blood, from infancy to extreme old age, is the consequence of a stimulating quality it possesses, and the life of the body the effect of its action, like all other stimuli when constantly applied, it ought either to have lost its activity, or, to produce its primary effects, should be increased in quantity or quality proportioned to the length of time, or frequency of its action. But as the phenomena produced by it are the same, at every period of life, without having undergone those changes which would be necessary, was its action similar to that of dead matter, we are induced to believe, that the blood neither circulates nor preserves the life of the body, by acting as a stimulus. To determine further, that in a healthy state, the blood does not act as a stimulus, and that it is in consequence of its possessing life in common with the

solids, that they harmonize with each other, I made the following experiment. To eight ounces of sheep's blood in a state of putrefaction, was added a portion of clear water to make up its former quantity. Having brought it to the same temperature with an equal quantity just taken from a healthy animal of the same kind, I injected it into the jugular vein. The phenomena proceeding from its presence in the circulation, were great uneasiness and palpitation of the heart, quick and laborious respiration, frequent discharges of fæces, convulsions and death. From this experiment it may be observed, that the action of the blood as a stimulus on the heart and arteries, occurs only in consequence of a diminution or deprivation of life, and that their union in a healthy state depends on a vital principle, which they possess in common with each other. If the blood be inanimate, when exposed to the action of the air, it should not only resist putrefaction, (which is a process certainly indicating previous vitality) but when separated from an animal for any length of

time, it should have neither acquired nor lost any property, by which, on being returned into the circulation, it could have produced such different effects. If water be made of the taste and consistence of blood by the addition of salt and starch, and exposed to the air for any length of time, it will neither putrefy nor assume a new property, provided its original quantity be made up by water, which evidently proves a difference between blood and common matter. Although, after exposure to the air, the blood may have every component part which at any time we are able to discover, it has notwithstanding lost a principle by which its nature is materially changed, and from this not being demonstrable, we must suppose it to be its life. If we do not admit that the blood acts as a stimulus, it may be enquired upon what principle depends its circulation. The action of the heart, and circulation of the blood may be more properly considered as phenomena which result from the action of one living part on another, accordingly we are to suppose, that the heart and arteries have a

power of acting on and moving the blood, which power in them, depends on a vital principle united with a particular organization, while the blood although possessing the same vital principle in the same perfection, and united with the same kind of matter, (but this differently arranged) has the capacity to be acted on and circulated for the necessary purposes of the animal œconomy.

Having I think satisfactorily demonstrated first, that fluidity can be no objection to a vital principle in the blood, that it is governed by the peculiar laws of living matter, which must be owing to a vital principle it possesses, that it does not act as a stimulus in effecting its circulation and preserving the life of the body, it may not be improper to say a few words concerning morbid action as induced by a morbid state of the blood. As we have seen in a healthy state, that the blood does not act as a stimulus, of course when it assumes this property, it must be from having lost a portion of its life, and disease or death is the certain consequence,

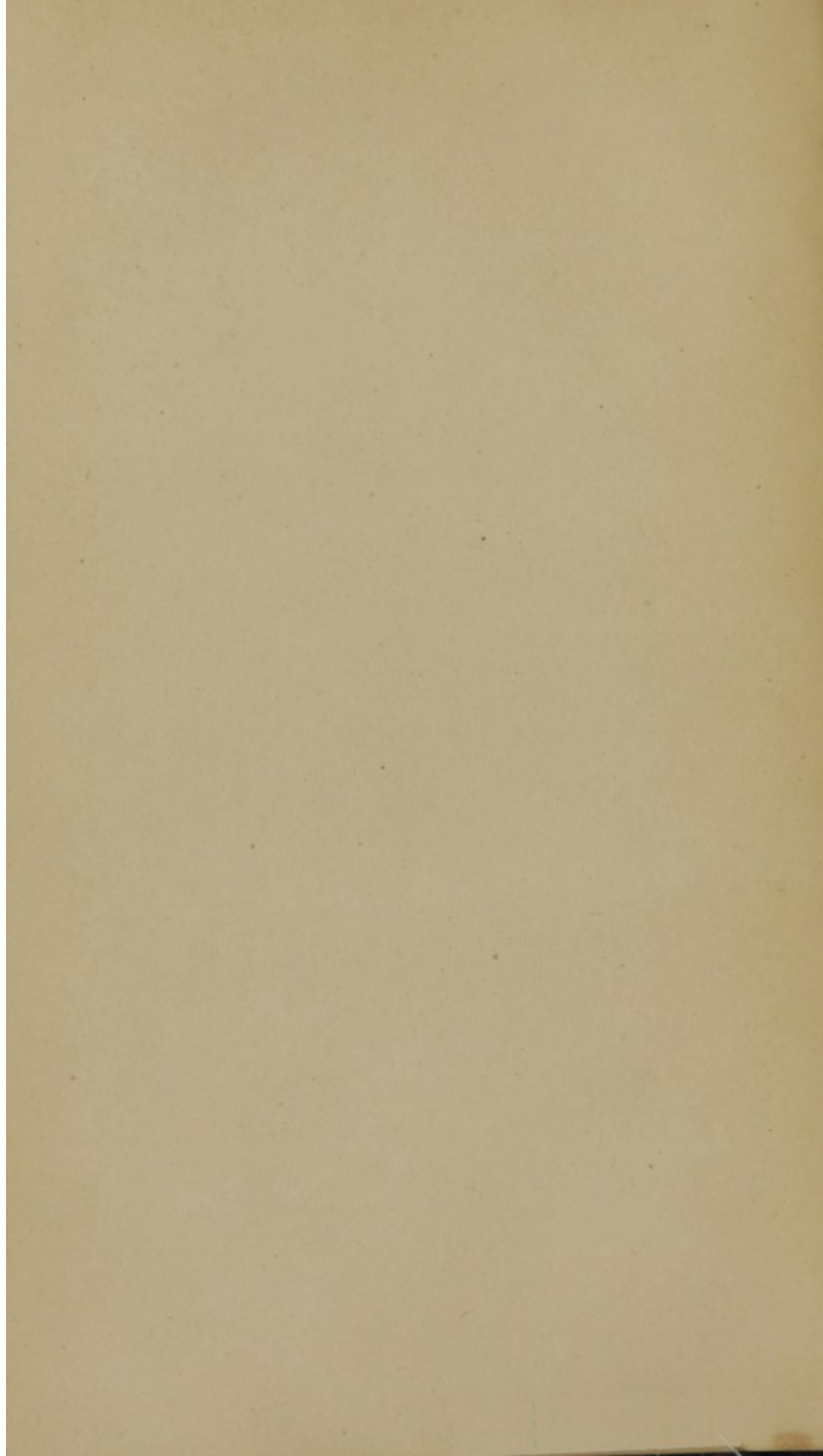
as proved by the last experiment. That the blood is often in a less vital state or in one different from what it is in health, is evident, not only by its sensible qualities, but its being no longer governed by those laws to which it is subject, when manifestly endowed with life.

It was before observed, that when separated from the body in health, coagulation takes place, which was considered as the first effect of a diminution of life, accordingly when it coagulates with difficulty, or not at all, it must be supposed to have lost the same principle to a greater or entire degree, proportioned to the force of action in those hurtful powers which may have been applied. That the causes inducing many diseases, in which the blood is so evidently affected, act primarily on it is highly probable. The experiments of Fontana* prove, that poisons destroy life immediately when admitted into the circulation, while this being suspended, their application to the nerves and muscles produced no effect. From the symptoms of diseases induced by miasmata, there is

* Fontana on Poisons.

great reason to believe, that the blood is also primarily acted upon, and by this means, affects the powers of sensation and motion, the healthy state of which depends on that of the blood. In diseases where the blood is in a dissolved or less vital state, as in malignant and gangrenous states of fever, a transfusion might be an object of importance. By abstracting the dissolved or less vital blood, in small quantities and at short intervals, while at the same time, the same quantity having the vital principle in a vigorous state, being introduced from a healthy person, it might be changed from an almost inanimate, to a highly vital state, which would then suffer the heart and arteries to act on it, and convey to the solids new living particles, while those which have become less vital by the stimulating action of the dissolved blood, being displaced and thrown off as excrementitious, a speedy restoration of health might be the certain consequence.

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