

On the regeneration of animal substances.

Contributors

White, Charles, 1728-1813.

Publication/Creation

Warrington : Printed by W. Eyres, MDCCLXXXV.

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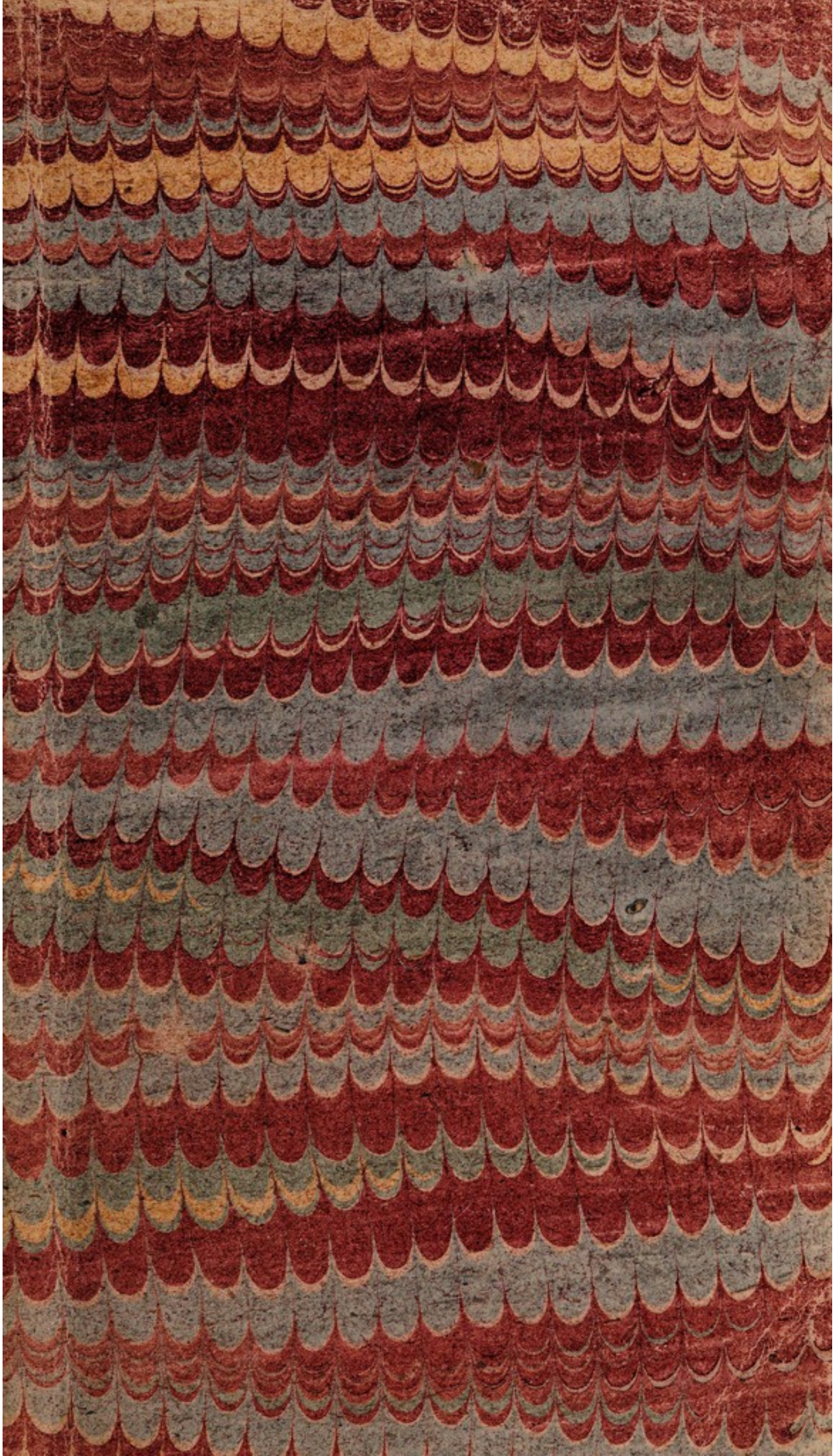
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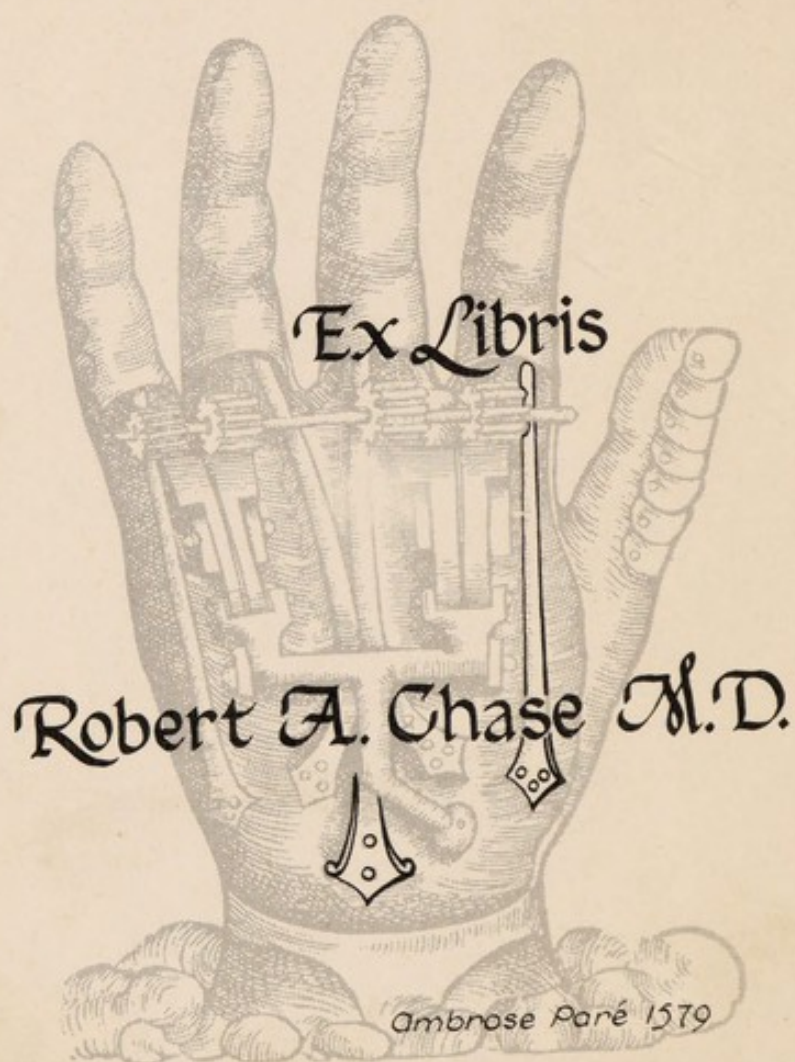
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from his friend J. White
ON THE *N. 6.*

REGENERATION

O F

ANIMAL SUBSTANCES.

WARRINGTON,

PRINTED BY W. EYRES.

MDCCLXXXV.

*A few Copies of this Paper, by Permission of the
Society, have been taken off for the Author to present
to his particular Friends.*

On the REGENERATION *of* ANIMAL SUBSTANCES.

By CHARLES WHITE, *Esq.* F. R. S. &c. *Read*

December 18, 1782.

THE great Author of the creation has endowed the animal world with a wonderful power of repairing and recruiting its various compound machines, and not only filling up and making good lost substances, but in some instances, of even totally regenerating parts; but we must not from hence accuse him of partiality, in not doing it in every instance; for the further we carry our researches into the secrets of Nature, the more we shall be convinced of the great and unbounded wisdom of God, and of the extraordinary resources he has placed in her possession;

----- " The first Almighty cause
Acts not by partial, but by general laws.

Pope's Essay on Man.

The Deity has drawn the line, has fixed the limits, and has said to Nature, hither shalt thou go, and no further.

If this order does not appear to us to be uniformly preserved, we must not conclude that it is not really so, but that it is owing to our slender capacities, that we are unable to trace his hand through all his ways,

“ See and confefs, one comfort still must rise,
 “ ’Tis this, tho’ man’s a fool, yet God is wise.”

Loc. citat.

The antients knew that a fresh broken bone would unite by a callus, that wounds of the flesh would fill up by what is called incarnation, and would be healed over with skin, by what is called cicatrization. But all vain-glorious boasting man must not from hence pretend, that he can make a single fibre grow : this is the act of Nature only. The ablest surgeon living, can do no more than assist her, remove the present obstacles, and prevent others being thrown in her way.

“ Yes Nature’s road must ever be preferr’d ;
 Reason is here no guide, but still a guard.”

Loc. citat.

The moderns have carried this matter further.

I did myself the honour to lay before the Royal Society, a remarkable case of a broken bone, which was inserted in the Philosophical Transactions, vol. LI. part the second, for the year 1760, in which Nature was disappointed of her usual method of throwing out a callus, and after more than six months had elapsed, without

without an union; when all obstacles were removed, by cutting off the ends of the bone, the osseous matter shot out as freely as if it had been from a recent fracture, and the broken bone was perfectly united. Since the publication of this case, a great number of similar ones have occurred, both to myself and others, which incontestably prove, that though Nature is disappointed in her work, even for a long time together, yet, when all obstructions are removed, she is ever ready to exert herself.

In the year 1768, I cut off the upper head of the os humeri of Edmund Pollitt, aged fourteen, whose case is related in the LIX. volume of the Philosophical Transactions. This was much corroded with matter, part of it consumed, and followed by an exfoliation of a large piece of the whole substance of the bone; yet the head, neck, and part of the body of it were actually regenerated, and the entire use of the joint preserved.

Mr. William Johnston, surgeon at Dumfries, has given us a case in the Edinburgh Medical Essays,* where the whole tibia, the principal bone of the leg, being cast off by exfoliation, was regenerated, and was, in a little time, as useful as the old one.

Mr. Le Cat mentions a case in the Philosophical Transactions,† of a child of three years old,

* Vol. V. p. 452.

† Vol. LVI. p. 270.

from whom he extracted the entire tibia, exostosed and carious in its whole extent, between the two articulations; which had remained sound: this great deficiency of bony substance was entirely supplied again by nature, and the patient regained a new tibia, much firmer than that which he had lost.

In the same place, he relates the case of an adult person where he took out three inches and ten lines of the bone of the upper arm, which was followed by a regeneration of bony matter. In this case the form of the bone, as well as its natural length, was preserved.*

Both in compound luxations and in caries,† the heads of the principal bones, and considerable portions of their bodies have been sawn off, and regenerated, such as the tibia, fibula, humerus, radius, ulna, thumb, and finger; the bones were little or no shorter, and new joints were formed, with such a degree of motion, that the patients found little or no inconvenience, and were able to follow their business as well as ever.

Dr. Hunter, in his reflections on cutting the symphysis of the pubis,‡ says, “as to any property which living ligaments possess of stretching,

* Gooch's Cases, vol. I. p. 323.

† Phil. Transf. vol. LIX. p. 39.

‡ Letter to Dr. Vaughan, p. 86.

under violence, permitting dislocations without laceration, I have long taught, that though a very general opinion, it seems not to have been founded in observation. Ligaments will not allow of dislocations in dead bodies without laceration; and elasticity to any degree either in ligaments or tendons, would ill agree with their use in living bodies, which is to keep the parts strongly together; and accordingly, since this opinion has roused attention and examination, every case of a recent dislocation that I have known examined, has been found complicated with a laceration of the ligaments."

Mr. John Hunter, in his *Chirurgical Lectures* goes further, and says, "that a luxated bone not reduced, by pressing against another bone, digs a cavity for itself, which gets cartilaginous edges and cartilage on all its surface; nay, a synovial gland secreting synovia, and a new joint is set up. In the fracture of a bone, though the parts be thrown at some distance, a callus is formed, which unites them. It is agreeable to the same uniformity of operation, that when a bone is broken, which was originally formed in a nidus of cartilage, the renovated bone also forms in cartilage; while a bone, originally formed in membrane, when it is partially destroyed, is reproduced in membrane." All surgeons must have observed this, that in old dislocations which have not been reduced, there is always some degree
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of motion more or less in the dislocated joint, except it has been complicated with a fracture.

In a conversation I lately had with Dr. Monro, he confirmed Dr. Hunter's opinion, with the relation of the two following dissections. He immersed a dead child in warm water, till it was perfectly soft and flexible; he then dislocated the shoulder. Upon dissecting the parts, he found the capsular ligament lacerated.

A man in Edinburgh was killed by a fall from a horse, and his shoulder was at the same time dislocated. Upon dissection in this case also, he found the capsular ligament lacerated.

Dr. Monro told me, he did not in the least doubt what Mr. John Hunter had advanced on this subject; and informed me, that he had a case, last winter, of a patient who had an exfoliation of half the lower jaw, particularly of the whole condyle on the left side; the lost part was regenerated, he had the entire use of the jaw, and the joint was as perfect as on the other side, except being a little fuller, and attended with a trifling degree of hardness. I had the satisfaction of seeing the exfoliated bone amongst his valuable collection, and found the head of the bone perfect, except a little carious on one side.

In the same collection I saw an astragalus, (one of the bones of the foot) which had come away entire, and the patient, as Mr. Fyfe informed me, had the perfect use of his foot and
anle.

anle. I likewise saw in the same place, a thigh bone, which had been broken, the ends had not coaptated, but had overshoot each other three inches, and were perfectly united. Cases of this sort I have often seen, and have now a thigh bone by me, united in the same manner; but in that bone in the possession of Dr. Monro, there is this circumstance, which I had never before observed, that the sides of the bone had not approximated each other, but in one point. The callus had shot out in such a manner as to form cancelli, and the void space had all the appearance of having contained a medullary substance. Dr. Monro told me he had a whole chest of regenerated bones in his possession. He likewise described to me the following experiment, he had made.

He laid open the abdomen of a pig for several inches, in such a manner, that the intestines protruded; which convinced him, that all the integuments were completely divided. He then reduced the intestines, and sewed up the wound. After it was perfectly united, he killed the pig. He then made incisions above and below, and on one side of the cicatrix; after which, he injected the aorta; and, though there was not a possibility of the injection entering but on one side of the cicatrix, yet the arteries, on both sides, were perfectly injected, a convincing proof, that they must have regenerated, for it cannot be

supposed that the mouths of so many small vessels could possibly have coaptated, so as to have continued the circulation through the cicatrix. I had the satisfaction of seeing both the preparation and an engraving from it, which, it is hoped, the doctor will favour the public with, together with the several other valuable experiments.*

Teeth have regenerated in every period of life. Mr. Thornton, a very ingenious medical student at Edinburgh, informed me, that he had a found tooth drawn by mistake some years ago, which as soon as he found out he immediately replaced. It grew again, and was as good in every respect as any other. But in process of time, this tooth began to decay, and give him pain, which became exquisite whenever the tooth was touched, even in the slightest manner. He therefore had it drawn, and one of the fangs was found to be carious. From this it is very evident, that nerves will grow again, after being disunited.

Mr. Cruikshanks, in his Letter to Mr. Clare, p. 87, says, "Not only the brain, but the nerves also, appear to have other properties than we have hitherto apprehended. Some years ago, I

* Since this paper was read before the Society, Dr. Monro has published his useful and ingenious observations on the nervous system, with the engravings of these preparations. Vid. Tab. XLVI. and Tab. XLVII.

demonstrated,

demonstrated, by experiments on living animals, that nerves divided unite again; and that when portions had been cut out, they were regenerated: in both instances the animals perfectly recovered. These experiments I hope soon to be able to lay before the public; meantime I am happy to find, they have been recently confirmed by so great authority, as the Abbè Fontanà, to whom I communicated my discovery, and shewed my preparations of united and regenerated nerves.”*

Mr. Gooch has given us a remarkable case of the cuticle and nails, † being frequently cast off and regenerated, particularly in the feet and hands, sometimes twice in a year. Those of the hands were cast off whole, and we are furnished with an engraving of a pair of these cuticular gloves.

There is another similar case related by Mr. Latham, ‡ but with this difference, that this patient did not cast her nails.

* Dr. Monro, in the work before mentioned, has given a plate (Vid. Tab. XIV.) to shew the regeneration of the sciatic nerves, which had been divided in living frogs, and dissected twelve months after. The regenerated parts are of a darker colour than the original nerves, which proves, that there was not a mere coaptation of the divided ends.

† Philosophical Transactions, vol. LIX. p. 281.

‡ Ibid. vol. LX. p. 451.

By performing the operation for the cure of the aneurism, several inches of the trunks of the principal arteries, both of the arm and the thigh, have been destroyed; yet in a few days, the circulation through the whole limb, has been carried on, as perfectly, as before the operation. The method, which nature has taken for accomplishing this business, may be seen by an engraving* from a preparation which I made, and which Dr. Hunter has done me the honour to give a place amongst his valuable collection.

There is a very extraordinary history of a glans penis regenerated after amputation, related by Mr. Jamison, surgeon at Kelso, and inserted in the Edinburgh Medical Essays. † The young man was married, in that country, about two years after the cure, has had two children, and complains not of want or defect even in sensation.

Crabs and lobsters cast their shells, both from their bodies, legs, and claws, and even cast their stomachs, generally every year, which are immediately regenerated. The shell is renewed by a fluid, which they eject; and it invests their whole body, growing hard and dry, in a short time, and becoming as strong a shell, as that which they had before. But, what is more extraordinary, they frequently lose a leg or a

* See my Cases in Surgery, p. 140.

† Vol. VI. p. 434.

claw in their combats, which are very frequent and furious: the lost part will be regenerated in about three weeks, and be almost of its natural size. Brown, in his history of Jamaica, informs us, that the claw of the violet crab, in seizing its food, catches such an hold, that the animal loses its limb sooner than its grasp; the claw continuing its retentive power for above a minute, whilst the crab is moving off.

In the polypus, not only young ones will grow out like warts from different parts of the body, drop off, live, and grow; but you may cut them into a thousand pieces, and turn them inside out, and they will still live, and do well; this is accounted for by its whole body being composed of stomach and parts of generation. The latter not being peculiar organs, but merely particles of the stomach, which are its body, each part of which has the power of producing the like. Its food is converted into chyle, in the stomach; absorbents opening into the part, take up the chyle, and these, at some distance from their mouths, become arteries.

If the *Actinia Urtica Marina*, *Animal flower*, or *Sea-Anemone* be cut through the middle, either transversely or longitudinally, both parts will survive the operation. Nay further, if you tear them from the rock or shell, to which they generally adhere, and a shred is left behind, it will become a fresh and perfect animal.

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The earth-worm and sea-worm will live after being cut in two; but, what is most surprizing, the small red headed earth-worm, being cut in two, both extremities survive the operation; the head produces a tail, with the anus, the intestines, the anular muscles, and the prickly beards: the tail on the other hand, is seen to shoot forth the noble organs, and, in less than three months, sends forth a head, heart, together with all the apparatus and instruments of generation. These parts, as may be easily supposed, were produced much slower than the former; a new head taking nearly three months for its completion; a new tail shooting forth in less than as many weeks. The lizard, and also the viper cast their skin, and some say their tail, and even their eyes; and the sea-slug is said to cast its head; all which are regenerated.

The buck casts its horns every spring, which are reproduced in a few months. But if he be castrated when young, he will have no horns at all, or small buds only, and those soft to the touch, like velvet, and void of firmness. Dr. Ruffel informs us, that he had two old bucks castrated at the end of February, and their horns dropped off, the twenty-first of March following; so that the fall of their horns was anticipated five weeks at least. These horns were renewed, next year, and were longer than the buck's of the same age; but the palms, or collateral branches,

branches, were less and shorter, and neither the velvet of the horns, nor the horns themselves, were ever cast afterwards.

I shall now beg leave to lay before the Society, two cases, that have not been published, in order to prove still further the doctrine I have been endeavouring to establish.

Roger Nuttal, of Bury, twenty years of age, was admitted an in-patient of the Manchester infirmary, under my care, on the 23d of January, 1775, for a tumor on his back. Upon stripping off his shirt, to shew me the tumor, I was struck with a very singular appearance of a stump of the right humerus. I asked him, if he was born with it in that form, or whether his arm had been taken off. He informed me, that Mr. Kay Allen had taken his arm off close to the shoulder, when he was but four years old, and that the stump was grown again to that length, which seemed to be about eight inches longer than he described it to have been, immediately after the amputation. I enquired both of his mother, and Mr. Allen, as to the truth of his relation, which they both confirmed; and the latter, with this addition, that the arm was taken off, as near the shoulder, as the application of the tournequet would permit. The bone had every degree of firmness, and solidity, and the stump was warm to the extreme point, and he informed me, was perfectly sensible when touched.

touched. Along with this, you will receive a drawing of the young man, and the appearance which the stump made, executed by your ingenious Secretary Mr. Bew, at the time the patient was at the Infirmary.

Some years ago, I delivered a lady of rank of a fine boy, who had two thumbs upon one hand, or rather, a thumb double from the first joint, the outer one rather less than the other, each part having a perfect nail. When he was about three years old, I was desired to take off the lesser one, which I did; but to my great astonishment it grew again, and along with it, the nail. The family afterwards went to reside in London, where his father shewed it to that excellent operator, William Bromfield, Esq. surgeon to the Queen's household, who said, he supposed that Mr. White, being afraid of damaging the joint, had not taken it wholly out, but he would dissect it out entirely, and then it would not return. He accordingly executed the plan, he had described, with great dexterity, and turned the ball fairly out of the socket; notwithstanding this, it grew again, a fresh nail was formed, and the thumb remains in this state.

The conclusions I would draw from these facts, are, that, in the human species, not only flesh, skin, and bones, may be regenerated, but membranes, ligaments, cartilages, glands, blood vessels, and even nerves; and this for the wisest purposes,

purposes, that every part may be repaired in its own kind, and in some manner restored by the coagulable lymph, which is poured out, and becomes vascular, and forms organized parts.

By this wise provision of nature, the many accidents to which we are continually exposed, are often more compleatly repaired, than art could be able to accomplish.

In some animals, we see this regenerating and living principle, carried still to a much greater length, where not only whole limbs, but even the more noble organs are reproduced.

The study of nature is not only engaging and pleasant to a high degree, but it inspires us with such a respect and admiration of the Almighty Being, that it is impossible either for a Naturalist or an Anatomist to be an Atheist.

They have constantly before their eyes so many wonderful living machines, differently wrought, yet so compleatly fashioned, and all tending to one great point, the preservation of themselves and their species; in which, there are so many orders of vessels, one depending upon another, yet compleat in themselves; capable of repairing injuries they may sustain, and even of restoring lost substances; that men, who daily see such objects, must be convinced, that these admirable fabrics cannot have proceeded from chance, but must have been the work of an Omnipotent Creator, who has

formed them with the most perfect wisdom, and attention to their several interests and situations ;

“ And spite of pride, in erring reason’s spite,
One truth is clear, Whatever is, is right.”

Pope’s Essay on Man.

P. S. Mr. Parke, of Liverpool, in a Pamphlet he has lately published, intitled, “ an Account of a new Method of treating Diseases of the Joints of the Knee and Elbow,” has given us a case, which fell under the care of Mr. Wainman, of Skipton in Craven ; and, as it is perhaps the fullest confirmation, that can possibly happen, of the regeneration, of not only the head of a bone, but of the capsular ligament, and synovial glands, and even every appendage of a joint, it may, perhaps, be thought to be a proper supplement to this paper. I shall therefore give the case in Mr. Wainman’s own words. He describes it, as “ a violent luxation of the cubitus, occasioned by a fall from a horse in full speed, which forced the os humeri, through the common integuments, a considerable length into the ground, and the bone was quite denudated.” He adds, “ There was not a possibility of reducing it, and I thought it most eligible to take off the limb, which the family objected to. I called in Dr. Taylor, who was of my opinion ; but it would not be complied with. We then judged it best

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to saw off the os humeri, which I did, about an inch above the sinus that receives the olecranon. I then placed the arm, in such a position, as I thought would be most advantageous, prognosticating, that an anchylosis would ensue, in which I was mistaken; the person is now living, and can perform all the motions of the joint, which is as flexible, as if nothing had ever been amiss."

T H E E N D.

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J. B. R. P.

