

A new inquiry into the suspension of vital action, in cases of drowning and suffocation : being an attempt to concentrate into a more luminous point of view, the scattered rays of science, respecting that interesting though mysterious subject : to elucidate the proximate cause, to appretiate the present remedies, and to point out the best method of restoring animation / by A. Fothergill, M.D. F. R. S. member of the Royal College of Physicians, honorary member of the Medical Societies of London, Edinburgh, and Paris; also of the Philosophical Societies of Manchester, Philadelphia, &c.;

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Bristol Royal Infirmary. Library
University of Bristol. Library

Publication/Creation

Bath : Printed by S. Hazard, and sold by Rivingtons, Dilly, Johnson, and Hookham, London; and all other booksellers, 1795.

Persistent URL

<https://wellcomecollection.org/works/ebdtcu8s>

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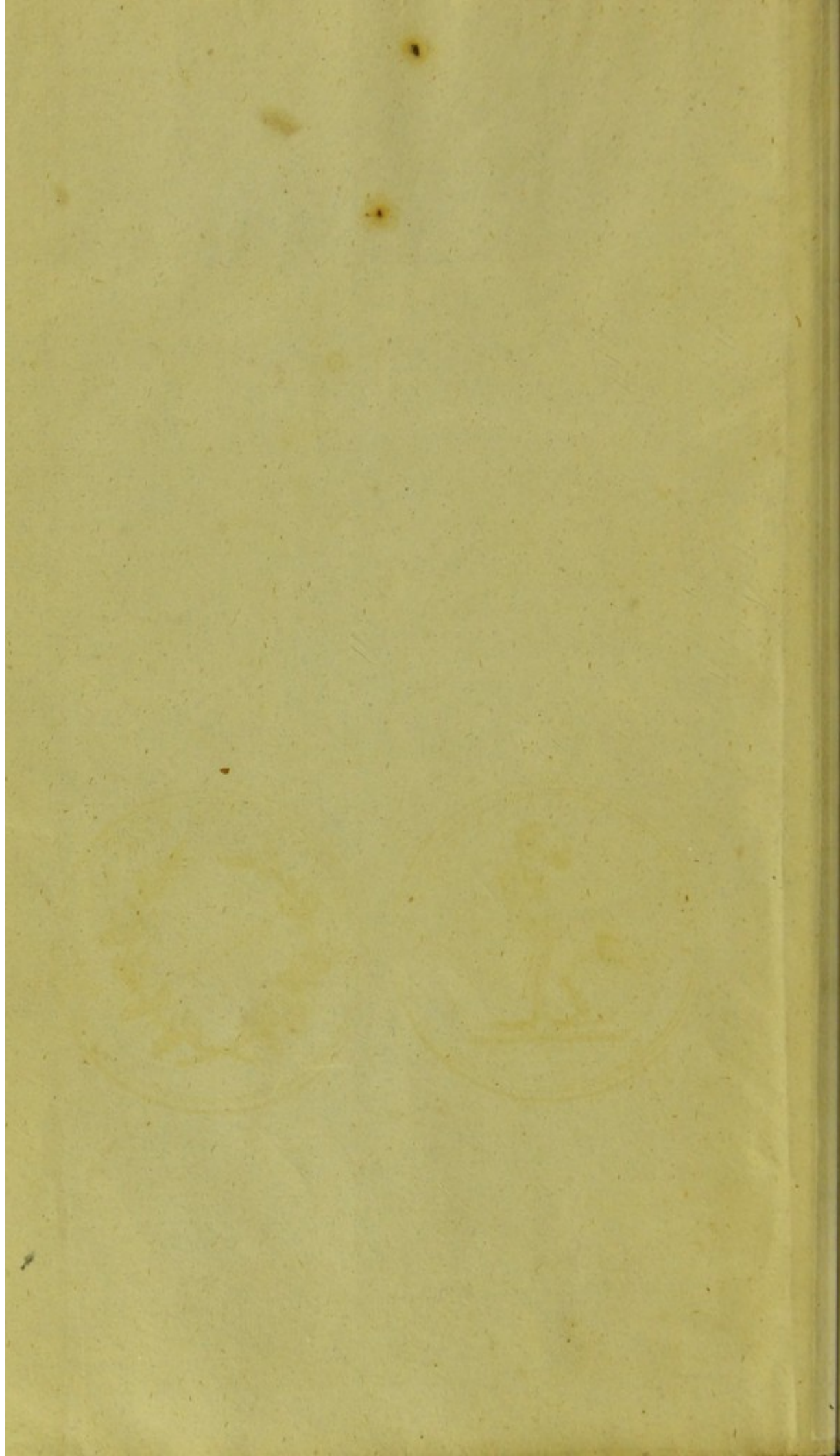
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591

SUSPENSION OF VITAL ACTION,

IN CASES OF

DROWNING AND SUFFOCATION, &c.

Adorned with an elegant Portrait of His Majesty,
Patron of the Royal Humane Society.

And two other plates
Expressive of Apparent Dissolution, and Returning Animation.



THE UNIVERSITY OF CHICAGO

IN THE

DEPARTMENT OF THE HISTORY OF ARTS

OF THE UNIVERSITY OF CHICAGO

OF THE UNIVERSITY OF CHICAGO

OF THE UNIVERSITY OF CHICAGO





W. H. BROWN - 1850



Painted by J. Gausborough R.A.

Engraved by D. Sayers.

GEORGE 3.^d KING of GREAT BRITAIN, &c.

PATRON of the ROYAL H.S.

A
NEW INQUIRY

INTO THE
SUSPENSION OF VITAL ACTION,

IN CASES OF
DROWNING AND SUFFOCATION.

Being an Attempt to concentrate
Into a more luminous point of view, the scattered rays of Science,

Respecting that
INTERESTING THOUGH MYSTERIOUS SUBJECT.

TO ELUCIDATE THE PROXIMATE CAUSE,
TO APPRECIATE THE PRESENT REMEDIES, AND
TO POINT OUT THE BEST METHOD OF RESTORING ANIMATION.

By *A. FOTHERGILL*, M. D. F. R. S.

Member of the Royal College of Physicians,
Honorary Member of the Medical Societies of LONDON,
EDINBURGH, and PARIS: Also of the
Philosophical Societies of MANCHESTER, PHILADELPHIA, &c.

*Vita brevis—Ars longa—Occasio præceps—Experientia fallax—
Judicium difficile!* Hipp. Aph.

BATH:

Printed by S. HAZARD, and sold by Rivingtons, Dilly, Johnson, and
Hookham, LONDON: and all other Booksellers. 1795.

A NEW EDITION

OF THE

ARTS

AND

MANUFACTURES

OF GREAT BRITAIN

AND

IRELAND

UNIVERSITY
OF BRISTOL
MEDICINE



TO THE
KING'S MOST EXCELLENT MAJESTY,
P A T R O N
OF THE ROYAL HUMANE SOCIETY.

LIKEWISE TO THE
RIGHT HONORABLE THE PRESIDENT,
THE VICE PRESIDENTS,
TREASURER AND REGISTER:

ALSO TO THE
MEDICAL ASSISTANTS AND DIRECTORS
IN GENERAL;

THE FOLLOWING INQUIRY,
AS A TRIBUTE OF SINCERE GRATITUDE AND VENERATION,

IS MOST RESPECTFULLY

DEDICATED,

BY THEIR MOST OBEDIENT SERVANT,

AND FAITHFUL COLLEAGUE,

THE AUTHOR.

LONDON, SEPT. 17, 1794.

At a General Court of the *ROYAL HUMANE SOCIETY*, this day convened, for the purpose of presenting the *PRIZE MEDALS*,

RESOLVED

- 1st. That Dr. A. Fothergill, to whom the Gold Medal has been unanimously adjudged, be requested to publish his *New Inquiry into the Suspension of Vital Action*.
- 2^{dy}. That Dr. Lettsom's *Oration*, composed for the occasion, and delivered at this Meeting, together with Dr. Fothergill's *Reply* be also recorded therewith, for the gratification of absent Members.

By Order of the Court,

W. HAWES, *Register*.

Directions to the Binder concerning the Plates.

1. The Portrait of his Majesty to face the Title page.
2. Apparent Dissolution to face P. 92.
3. Returning Animation to face P. 168 before the Appendix.

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*Oration delivered by Dr. Lettsom, on presentation
of the Prize Medal—with the Author's Reply.*

Published by order of the Royal Humane Society.

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DR. LETTSOM'S ORATION,

Delivered before the Royal H. S. Sept. 17, 1794, and Published at their Request.—With Dr. F's Reply.

ANY EULOGY ON THE PRESENTATION OF THE PRIZE MEDAL of the HUMANE SOCIETY to the successful candidate must be defective as well as superfluous—my acclamation is too feeble on a subject so interesting to our very existence, as, not only to ascertain the proximate cause of death, but likewise to prevent its operation.

WHEN AN INTELLECTUAL BEING contemplates his own existence, and how wonderfully he is made, *apparent death* must primarily have appeared as the *real extinction* of human life—when the HEART had ceased to act—the LUNGS to perform their functions—and ANIMAL HEAT seemed to be extinguished:—Bold and elevated in his views must have been that man, who presumed to imitate the power of Deity, in restoring life to apparently-dead matter!

TO SAY THAT THIS MAN is still amongst us is to felicitate not only the community, but the æra in which he realized his daring ideas—ideas at first slighted by the incredulous as visionary; and when realized by doubling human existence, by the envious, as only a surreptitious claim of a previous discovery.

So

So COLUMBUS, when he first divulged his vast project of *doubling the globe*, was insulted by incredulity; and, after he had added a *new*, to the *old* hemisphere, was persecuted by envy.—In like manner, when *the northern luminary*, LINNÆUS, created a new system of Vegetable nature, he found on every side determined assailants; but, fortified by the energies of his capacious mind, he gave this reply—“*posterity will decide;*” and pointing to some academic children at play—these, added he, will become our judges.—It is a sentiment worthy of superior minds, that every arrow, shot at an inferior enemy, dishonours the arm that pulls the bow.

There was a time, many of us well remember, when the HUMANE SOCIETY was first instituted with a view *to restore life* after a complete suspension of the animal functions, that not one of the Directors entertained the least idea of the success which later experience has most happily realized; and, as some proof of the novelty of this plan of beneficence—I repeat to this numerous and respectable meeting, what I then said to its author; that, were *one life* saved within twelve months, it would establish the Institution, and amply compensate every expence and sollicitude attending this arduous undertaking.—Little did any man think, not even the FOUNDERS themselves, inflamed as they were with sacred zeal, that, in the year 1794, there should be
 recorded

recorded 3000 instances, wherein the SOCIETY'S aid had been extended, TWO THIRDS of which had proved successful!

IN THE FIRST CASE OF RESTORATION I cannot but recollect with pleasure, even at this time, the joyful ecstasy this single instance of success afforded.—How inestimable the redemption of a victim from a premature exit is, each of you GENTLEMEN well know, for each has lived long enough to lament the loss of a beloved relative or friend;—but, who amongst us possesses a mind, equal to estimating the accumulated rapture of *Christian philanthropy* in contemplating the REDEMPTION OF THOUSANDS!

WONDERFUL AS HAS BEEN THE SUCCESS OF THIS INSTITUTION, in tracing its influence on other countries and people, the mind is farther gratified with the extension of humanity.—In the LAST REPORTS I observe the following statement, which must inspire a British heart with patriotic pride and pious exultation.

“THE
ROYAL HUMANE SOCIETY

May be justly considered as the Parent of all the HUMANE SOCIETIES established in this Kingdom, Ireland, many parts of the Continent of Europe, in America, and the West India Islands.

THE MANAGERS

Have not only transmitted the necessary information to form HUMANE SOCIETIES, but they have likewise, at an immense expence, presented the Faculty, &c. with their Apparatus, Drags, Reports, and Plans of Resuscitation, resident in the different Parts undermentioned :

Lisbon, Normandy, Vienna, Copenhagen, Algiers, British Settlements in the East Indies, Jamaica, Barbadoes, Hudson's Bay, Boston, Pennsylvania, and Philadelphia, Dublin, Limerick, Waterford, Londonderry, Belfast, Aberdeen, Montrose, Sunderland, Liverpool, Lancaster, Shropshire, Cheshire, Newcastle-on-Tyne, Whitehaven, Severn, Bristol, Kent, Surrey, Darlington, Norwich, Newark, Worcester, Horncastle, Shrewsbury, Leith, Northamptonshire, Ostend, and the University of Prague."

GENTLEMEN, I cannot resist recalling your attention to the establishment of a *Humane Society* under our auspices at ALGIERS.—I repeat Algiers; for, it is surprizing, and almost incredible, though indeed we know it as a fact, that in that barbarous soil a *spark of humanity* is at length kindled.—May it expand, illumine, and soften, the heart equally dark and callous!—What a grateful contrast does this present of the CHRISTIAN SYSTEM to the barbarity of infidels.—In that land, where a Muley Ishmael immolated with his own hands eighty of his relatives—the *amities of the gospel* have led to an establishment that saves the life even of a stranger!

Often have I reflected with pleasure upon these indications

indications of humanity, trivial as they may appear in this barbarous region; and as often have viewed our SOCIETY, with a sacred and religious awe, as the source of good and beneficence, that cannot be estimated by the present generation.—We have witnessed enough to encourage zealous perseverance in its promotion.—*The little cloud, not a hand's breadth, has expanded even beyond our horizon.*—May it be diffused and expanded to the extreme limits of the universe!

THAT GREAT AND GOOD MAN, whose loss was the common loss of mankind, the Prison HOWARD, in the unbounded expanse of his benevolent mind, visited CONSTANTINOPLE to view and reform its prisons, so as to alleviate the miseries of the incarcerated objects.—His ardent zeal roused public attention, and gave rise to various inquiries among the Citizens.—“Who is this MAN that quits home and friends to sympathize with foreign distress?—What is that religion, that source of piety, which can excite and actuate the bosom of ONE to whom we are unknown but as fellow-men—thus to risk his own life, and forego all its comforts, for our present and future happiness!—”

THUS THIS PHILANTHROPIST assured me the people began to reason: and he trusted, after leaving *Cherson*, to revisit this metropolis of the East, to revive those sentiments and inquiries which his first interview had excited.—We know and lament that such worth and beneficence was so suddenly lost to the community:—

community :—Loft did I fay?—HIS NOBLE EXAMPLE may have raifed, even in that torpid people, blinded by ignorance and prejudiced by fatalifm, fome fparks, yet to be kindled, by *another Howard*, or by the facred fire that infpired a HOWARD!

EXCUSE, GENTLEMEN, this digreffion; but I was carried away by reviewing the furprifing and wonderful influence that ONE MAN has had in extending the benefits and fpirit of this Society;—may his fpirit defcend to pofterity with redoubled energy!

HOWEVER PLEASING it may be for an individual to acquire merited applaufe, which our HUMANE SOCIETY has long and honourably beftowed, where each of whose Directors, however, hath thrown his handful of mortar into the edifice of marble;—yet, in doing good from virtuous motives, a fenfe of confcious rectitude will ever afford the higheft reward to the philanthropic bofom.

IN THE ARDOUR OF ZEAL—improvement naturally fucceeds difcovery:—fo Dr. HAWES reafoned, and with laudable exertions accelerated this good work, by propofing honorary rewards, to ftimulate genius, to elucidate his darling fubject of Refufcitation, upon the moft clear, certain, and irrefragable principles.

To doubt and to inquire will always lead to truth, which becomes more brilliant by difcuffion, as the diamond acquires luftre by friction; fo, in fcientific purfuits,

purfuits, one difcovery leads to another, and by degrees the mind is led on to the inveftigation of not lefs ufeful than abftrufe fubjects, which would not be the refult were the vivid glow of light to be at once difplayed: for, one illumines and improves, the latter dazzles and confounds.—This fentiment induced the celebrated FONTENELLE to fay—“if both my hands were full of truths, I would open but one at a time.”

Thofe who can recal the commencement and origin of this Inftitution, and the ftate of knowledge acquired at that time, and next furvey the *prefent accumulation*, muft experience fingular pleafure in tracing the *progrefs and evolution of fcience* as connected with the fubject of the Refufcitative Art, much of which may be afcribed to the difquifitions which have refulted from the HONORARY MEDALS.—I do not fpeak my own opinion merely, but that of *Europe*—for, almoft in every medical work, there are appeals to their judicious authorities as decifive of the facts which they have eftablifhed, enforced, and illuftrated.—Of this kind is the VALUABLE PRODUCTION, which has, at this time, brought together fo many of our members and friends in the caufe of active humanity.

It was once my defign, to have laid before you an *analyfis* of this interefting performance; but it exhibits fo vaft a fund of fcience and ufeful information, that I found it impracticable to make extracts or an

epitome with justice to the original Dissertation.—
This, however, I regret the less, as I hope the Public will be favoured with so interesting a work on SUSPENDED ANIMATION, by the ingenious author, to whom has been adjudged the *Prize Medal* of the HUMANE SOCIETY.—A REWARD the MOST HONOURABLE in its power to bestow, and which is AS HONOURABLY ACQUIRED; but I shall not dwell upon a theme, to which, if my abilities were adequate, my feelings of pleasure and joy crowd on too tumultuously, to allow me to give expression:—I shall therefore now declare the decision of the COUNCIL of the MEDICAL SOCIETY.

THE DISSERTATIONS ON THE QUESTIONS having been read, and on a ballot being taken to determine their merits, the Prize Medal offered by the ROYAL HUMANE SOCIETY WAS UNANIMOUSLY adjudged to that, which had for its motto,

“ Vita brevis—Ars longa—Occasio præceps—Experientia fallax—Judicium difficile ! ”

THE SEALED PACKET BEING OPENED, IT WAS DISCOVERED, THAT ANTHONY FOTHERGILL, M. D.—F. R. S. of Bath,

is the author of the said dissertation.

YOU, GENTLEMEN, who have been formed in the school of philanthropy, know how to estimate the enjoyment of friendship, and will participate with me in the pleasure of presenting your medal to
one

one of the most amiable of men—to ONE who has for many years contributed to augment my felicities of life, whilst he diminished its sollicitudes; and whose virtues, and erudition, I could with pleasure long dwell upon at this time, were they not universally acknowledged, and forbidden by his presence.

In the name of the HUMANE SOCIETY, and in conformity to the adjudication of the MEDICAL SOCIETY, I present this GOLD MEDAL, with the following inscription, as a reward for the BEST ESSAY on the questions propounded in the year 1792, to DR. ANTHONY FOTHERGILL.

On the Exergue,

LATEAT SCINTILLULA FORSAN.

Round the Medallion,

PROPTER VITÆ SCIENTIAM FELICITER AUCTAM.

Within the Wreath,

OPTIME MERENTI

ERUDITOQUE

ANTONIO FOTHERGILL, M. D.—F. R. S.

1794.

Whilst my illustrious friend, the friend of humanity, enjoys this just tribute of applause——may he persevere in that path of useful science, which devotes the acquirements of literature to the important interests of the health, and happiness, of our fellow-creatures!

DR. F——'S ANSWER.

MR. VICE PRESIDENT,
AND
GENTLEMEN!

I AM SENSIBLE—truly sensible—of the very DISTINGUISHED HONOUR, which the ROYAL HUMANE SOCIETY has this day so liberally conferred upon me.—This VALUABLE DONATION, splendid in itself, acquires, if possible, additional splendor by passing through the hands of our MUNIFICENT TREASURER.*

BE ASSURED, Sir, I shall ever esteem this MEDAL as a SACRED—as an INVALUABLE PLEDGE, deposited in my hands for the NOBLE PURPOSE of exciting a generous emulation amongst our ingenious medical brethren.—The UNANIMITY with which it has been adjudged—the GENEROSITY with which it has been bestowed—and the POLITENESS with which it has been presented, equally claim my best—my WARMEST THANKS!

TO YOU, MR. VICE PRESIDENT, I am *particularly* indebted for the *very elegant* though *too*

* Dr. Lettsom being Treasurer as well as Vice President of the R. H. S.

flattering

flattering encomium, just now delivered in your
EXCELLENT ORATION.

May the ROYAL HUMANE SOCIETY and
the LEARNED MEDICAL SOCIETY of LON-
DON ever flourish--ever remain--the DISTINGUISH-
ED PATRONS of HUMANITY--and of SCIENCE !

And may YOU, Mr. *Vice President*, long live--
to co-operate with them, in their laudable and bene-
ficient undertakings--to animate them by your exam-
ple--and to participate with them in the amplest man-
ner, THE SUPREME--THE EXALTED PLEASURE

of

PRESERVING HUMAN LIFE !



CORRIGENDA.

PAGE. LINE.

56	19	Omit <i>No. 30.</i>
59	27	Hints on Animation occasionally referred to, we now learn, have been sometime out of print.
64	24	Omit <i>the presence of.</i>
77	24	For <i>is this</i> read <i>is it, &c.</i>

ENTERED AT STATIONERS HALL.

INTRODUCTION.

VARIOUS indispenfable avocations have contributed to delay the present PUBLICATION, and have constrained the Author to trefpafs on the SOCIETY'S patience until now. During the interval, however, the Work has been carefully revifed throughout; many paffages have been retouched, others illuftrated, and, it is hoped, not without receiving PROPORTIONABLE IMPROVEMENT.

Should the whole now be found more worthy the perufal of the enlightened Reader, the Writer will think the additional labour extremely well beftowed.

Previous to the origin of this new branch of healing (which indeed conftitutes a remarkable æra in Science), death apparent and abfolute had long been confidered as almoft fynonymous terms. For the fubjects of both, appear to have been alike configned to the filent manfions of the tomb, without its being ever dreamt that fuch a vaft proportion of the former, might, by a few fimple means, have been recalled to life, and all the endearments of focial happinefs. Of the truth of this important fact, however, the Tranfactions of this Society have, from time to time, afforded the moft fatisfactory demonftration. Since, in addition to the very pleafing account juft delivered by the Treafurer, we have the following ample confirmation from the Register.

“The HUMANE SOCIETY have reftored to the Public MORE THAN TWO THIRDS of thofe who would otherwife have been interred as inanimate beings.

1. Among thefe, many were the HEADS OF FAMILIES, who would have become a parochial charge had not their lives been thus preferved!

2. Many

2. Many were HEEDLESS INFANTS wandering from their parents, who, but for this institution—would never have returned!

3. Others were SUICIDES rushing into Eternity, in a state of mind the most unfit to appear before their JUDGE! ” *

The numerous humane Institutions to which this has given birth, have also annually contributed their respective *quota* of happy restorations, from apparent dissolution.

These infant societies, like scion plants, having successively shot forth from the parent stem, have been carefully transplanted into various climates, and remote regions, where, we rejoice to find, they have not only taken root, but flourished; nay, even in the inauspicious soil of Barbary!

Great indeed must be the number of persons who, have either directly or indirectly, been preserved by the diffusive energy of the Royal H. S.!

But how much greater still would be the amount, should we attempt to calculate (which would be but reasonable) not only the persons rescued, but the probable progeny descending from them, through succeeding generations!—

Though no consideration, of this nature, can fully compensate for those dreadful ravages of war, by which myriads of human beings are periodically swept from the face of the creation!—yet the remnant thus daily preserved to the community, and that in an increasing *ratio*, must ever afford the most heartfelt consolation to the humane part of mankind, who “seek not to destroy life, but to preserve it.”

No sooner had the Humane Society surmounted the first difficulties inseparable from such a novel undertaking, than

* Transactions of the Royal H. S. 1795.—p. 43².

it not only fixed the attention of the Medical Faculty, but also attracted the notice of the Poet, the Painter, the Philosopher, and the Divine. By such collateral aid, but still more by the uncommon exertions of ONE INDIVIDUAL, has this institution at length happily silenced all objections, triumphed over prejudice, and diffused its benefits over a considerable part of the known world.

The Society will instantly recollect that the individual here meant can be no other than their Worthy Register, or rather INSTITUTOR—Dr. HAWES—To whose unremitting zeal and activity, aided by a LETTSOM-A-COGAN, and a few other CONGENIAL CHARACTERS, the Society owes its EXISTENCE.

He, undoubtedly, was the first, in this Country, who undertook to deliver a course of LECTURES ON SUSPENDED ANIMATION—which was no easy task at that early period.—He also first proposed HONORARY PREMIUMS for the farther elucidation of the Subject. To him, as the EVER ACTIVE AGENT, may in a great measure, be applied that emphatic expression of the CELEBRATED LINNÆUS, who (on witnessing the superior activity, zeal, and energy, which distinguished London, beyond every other city he had visited) exclaimed with rapture,

“ *Punctum vitæ in vitello Orbis!* ” *

If such has been the progress of the present institution, in its early stages, what may not be expected, now that Philosophy holds up the torch to medicine, to illumine its votaries, and direct their course in this new path of science!—A science, no less difficult, than it is sublime and important; involving at once, the most intricate problems, in Physiology, Pathology, Chemistry, and Pneumatic-philosophy!—Calculated not less to exercise the keenest faculties of the head—than to interest the finest feelings of the heart!

It is impossible for physicians of susceptible minds to contemplate the affecting scene which the transition from apparent dissolution to returning animation presents to their eyes, without experiencing the tenderest emotions of sympathy.

What transport then must it afford every compassionate bosom, to be instrumental in recalling a helpless fellow-creature from an untimely grave!—To witness, at that critical juncture, the heartfelt passions of anguish and despair—of hope, fear, surprise, and joy, which alternately agitate the human frame! To mark the lively traits of gratitude painted in the countenances and deportment of the mothers, sisters, brothers, &c. of the restored object! What epicure could ever yet boast so refined, so exquisite a luxury as the benevolent deliverer must experience from such a scene!—a scene far beyond what any pen has yet been able to describe—or pencil to express! * This humane Institution therefore, has one peculiar excellence, that seems to have been generally overlooked, which is to call forth, in the completest manner, the most endearing affections of the human soul—Affections, which ennoble the Species—and exalt humanity!—

On the present interesting, but truly recondite subject, much has been already discovered—but much still remains to be explored.—

In the prosecution of this laborious undertaking, as in the arduous attempt to ascend the Andes, no sooner have we joyfully gained the overshadowing summit, which bounded our view, than the horizon widens, and discloses still higher eminences, which oppose fresh obstacles to our progress!

“ Hills peep o’er hills—and Alps on Alps arise.”

Pope.

* This however, has been attempted by our ingenious Artist, and not altogether without success.—See Plates, p. 99 and 168.

Discouraging

Discouraging as such difficulties may appear, they are by no means insurmountable. Though they may serve to inspire diffidence, and check presumption, yet instead of creating despondency, they ought rather to stimulate our ardor, and renew our zeal.

In the following inquiry, our Readers must not expect to meet with a new series of experiments on brute animals, though such may seem still wanting towards the farther elucidation of the subject. But the extreme reluctance that is naturally felt, on subjecting harmless creatures to a painful, or lingering death, has of late deterred the Author from prosecuting that unpleasant mode of investigation: For dear is that knowledge, which is not to be purchased but at the expence of humanity!

For these reasons, he has contented himself with drawing inferences from the experiments of others, so far as circumstances seemed to warrant; and that without adding to the number of innocent victims.

Nevertheless, while hecatombs of inoffensive animals are daily sacrificed, partly to satisfy dire necessity, and partly to pamper human luxury, Practitioners may reasonably demand, why may not a few be devoted to medical improvement? True—to real medical improvement—but not to idle curiosity, which can in no wise, be productive of utility, much less atone for cruelty.

Though Man considers himself as invested with absolute dominion over the animal creation, yet ought he to exercise it with great moderation. Can he, as an accountable being, seriously believe he stands justified in wantonly taking away that LIFE, which it is not in his power to bestow?

But independent of this consideration, conclusions drawn from experiments on other animals, though performed with the utmost accuracy, must ever be liable, when transferred to the human body, to extreme uncertainty.

A foreign Experimentalist, of distinguished talents, is said lately to have performed upwards of 6,000 experiments on live animals, principally with a view to ascertain whether poisons act on the nerves, or on the blood! Though the result inclined him to the latter opinion, yet he was obliged to leave the matter extremely doubtful; candidly acknowledging at last, that his experiments were still TOO FEW to afford demonstration!

Such patient zeal, and persevering assiduity, in the cause of experimental philosophy, might command our admiration, were not the utility of the inquiry greatly overbalanced by the cruelty. Nature, we now see, cannot always be compelled to disclose her secrets, though put to the most excruciating torture.

It were greatly to be wished then, that these unavailing severities might in future be mitigated, and that the phenomena in the human body, not only during the suspension of vital motion, but after its total extinction, might be more narrowly inspected. For a just and impartial account of these, together with the apparent effects of the respective remedies, minuted down upon the spot, would certainly afford a more satisfactory kind of knowledge than mere analogical reasoning drawn from animals of another genus.

In the course of the following inquiry, the Author has sometimes been obliged, though very reluctantly, to withhold his assent from the doctrines of the latest and most respectable authors; yet this has neither originated from vanity nor caprice.

Should his own opinions, in their turn, prove erroneous, he stands open to conviction; and having no cause to support but that of TRUTH, he will always be happy to obtain BETTER INFORMATION.

PRIZE QUESTIONS,

PROPOUNDED BY THE

ROYAL HUMANE SOCIETY,

For the Year 1792 and extended to 1794.

1. "What is the proximate Cause of Death in the various Kinds of Suffocation"?
2. "What are the most judicious means to be employed to restore Animation"?

S E C T. I.

Preliminary Observations on Life, and the comparative Faculties of Man and other Animals.

BEFORE we attempt to determine concerning the proximate cause of Death, we should endeavour to ascertain wherein Life consists: But this involves the doctrine of the Soul—and might lead us into an abstruse metaphysical disquisition, without reflecting much light on the main question. Instead, therefore, of entering deep into the controversy, we shall content ourselves with taking a short view of the general result. This we know, that Man has a sentient principle existing within him, which thinks, reflects, combines ideas, and performs various operations apparently

incompatible with any modification of matter hitherto discovered. And with this knowledge, I apprehend we must at last endeavour to rest contented. For if this sentient or thinking principle be immaterial, it cannot be an object of our senses; and if it be not an object of our senses, it will probably ever elude our keenest researches.

In attempting to trace this mysterious principle to its local habitation in the human frame, the ablest philosophers have strangely bewildered themselves; and after all their mental toil and random conjectures have never yet been able to draw aside the impenetrable veil. Thus some have pretended to have discovered its residence in the Pinæal gland, near the centre of the brain, others in the stomach, while others again have placed it in the heart, or diffused it over the whole system. Our modern Materialists, equally unsuccessful in their researches, and utterly unable to fix its residence, have boldly denied its existence, and resolved all the phenomena of mind into mere mechanism, or the result of certain imaginary vibrations.

To avoid the inconsistencies of their predecessors, they have run themselves into greater, and have been obliged to attribute new and unknown properties to matter. Thus instead of solving the Gordian knot, they have rashly cut it asunder. For what are these pretended vibrations but a *petitio principii*—an illustration of the “*ignotum per ignotius?*”

ignotius?” Are the nerves to be considered as elastic cords which perform the vibrations, as the Æolian harp emits sounds, without an intelligent Agent? The structure of the nerves being destitute of elasticity warrants no such idea. Nay, even admitting their hypothesis concerning the non-existence of the Soul, and supposing Man a mere sensitive animal, composed indeed of somewhat *finer clay*, and of more exquisite mechanism than the rest of the brute Creation, yet they would still find it no easy matter from thence to explain the amazing diversity observable in the intellectual powers of Man compared with other animals, or with individuals of his own species. For were they to inspect with the utmost nicety, the brain of a Newton, of an Idiot, and even of an Ape, they would probably find such a striking similarity in the mechanism as might seem sufficient to humble their pride, and put their whole fraternity to the blush. How must they have been confounded, had they lately been present when the French Chemist analyzed the Brain of a man and of a calf, to find the result so very similar in both!

While Spinoza and his followers deny the existence of the Soul, other metaphysicians make ample amends, by allowing Man to be possessed of three separate Souls—viz.

1. The rational, which they hold to be divine,

and infused by the breath of the Creator. This they term the Spirit, in which they suppose the intellect and will to be seated.

2. The sensitive, or irrational Soul, which Man has in common with brutes, and which is formed of the ordinary elements, in which they apprehend the passions and appetites reside.

3. The Vegetative Soul or Principle of Life which Man has in common with plants.

The Epicureans held the rational Soul to be a subtile air. The Stoics, flame, or ætherial light—a third sect maintained it to consist of the same material substance with the Body.

Notwithstanding their warm controversies concerning its Essence, they all seem to agree in referring it to matter more or less subtilized—and therefore, at bottom, may all strictly be considered as materialists.

From specious arguments drawn from their writings, and from a partial view of the phenomena in the animal and vegetable kingdoms, have certain distinguished Philosophers of the present day been led to adopt the system of materialism.

“Perception and cogitation,” say they, “necessarily result from the mechanism of the brain, as much as respiration and circulation follow of course from the structure of their respective organs.” To give their argument its full force, let us admit this for a moment, and also add, that
the

the admirable sagacity of brute animals and the discriminating faculties of certain plants, bespeak a degree of caution and forecast not unworthy of intelligent beings; and yet to what principle can we refer these faculties, but to instinct or organization, any more than the movements of a watch to mere mechanism?

According to their doctrine, then, we are to confound the divine faculty of Reason with the impulse of blind instinct, and consider Man as differing from other animals, not in the *nature* but *extent* of his intellectual powers, and in all other respects, regard him as copartner with his fellow brutes the equal tenants of Creation. But surely they forget that the instinct of animals is extremely limited, and soon reaches its *ne plus ultra*. The Beaver and the Bee erect their cells with invariable exactness, but without knowing why, and without any attempt towards improvement; all their desires centre in themselves and their offspring; and their paternal care ceases as soon as the latter are able to provide for themselves: whereas Man's knowledge is progressive, each generation adds new discoveries to the general stock; then arranges the sundry facts, and erects system upon system. His genius embraces all the objects of nature, and of art. His desires are boundless. He contemplates past, present, and future scenes, and carries his views

beyond the confines of the visible Creation. Anxious to transmit his name, and existence to future ages, he starts back with horror at the idea of annihilation. He *alone*, even in his most savage state, possesses a moral and religious sense, which enable him to distinguish right from wrong, and to pay adoration to a Superior Being.

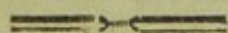
To memory possessed by the brutes, he adds the higher faculty of Recollection. The former only presents the written tablet, but the latter points to the very page.

The human intellect therefore appears to differ essentially, not only in *extent* but in *kind* from that of the most sagacious animal.

If Mind is the necessary result of mechanism, it ought uniformly to keep pace with all the movements of the machine in sickness, and in health. On the contrary, however, we often find that when the corporeal powers are strongest, the mental faculties are weakest; that when the Soul's earthly mansion is decayed, and tottering to ruin, it begins to acquire new force, and to exert its faculties with a degree of energy, and precision unknown in health. Even during Sleep, while all the natural functions are suspended, and the body assumes the image of death, the Mind, being disentangled, remains active, and even contemplates objects with increased power and vivacity. Hence the Mind seems clearly capable of acting
independent

independent of the Body, and to demonstrate a much higher origin, than that of the perishable frame with which it is at present connected. Destined, we also know, after the Body has returned to its original dust, to “flourish in immortal youth, to outlive the wreck of elements, and the crash of worlds!”

Having thus briefly endeavoured to shew the fallacy of ancient and modern systems, respecting the nature of the human Soul—Their inconsistency in attributing the properties of mind to matter, and finally in degrading its higher operations to the same level with those that proceed from mere instinct or mechanism, we shall drop this sublime subject for the present; and by directing our future inquiries chiefly to Material causes, examine whether simple Vitality or sensitive Life, as enjoyed by Man in common with other animals, be yet rightly understood.



S E C T. II.

VITAL PRINCIPLE—*Whether confined to the Blood or any particular Organ.*

Notwithstanding the improved state of Anatomy and Physiology, it does not appear yet to be absolutely determined whether the vital principle exists in the solids or fluids, or even whether it is to

be looked for as a separate principle in any part of the œconomy. “Blood,” says Moses, (the most venerable Historian of Antiquity) “is the Life.” It is by no means probable, that the Jewish law-giver, at a time he was commanding the people to abstain from blood, “because the blood is the life,” had any reference to the rational Soul of Man. Dr. Harvey, the celebrated discoverer of the Circulation, has gone farther, as appears from the following curious passage. “Nor is the blood to be called an original and principal part, only because in it and from it, motion, and the beginning of pulsation arise; but also because in it, animal heat is first bred, the *Vital Spirit* is produced, and in it the *Soul* itself resides.”*

In this opinion he hath also been followed by Dr. Willis, who endeavours to shew that the blood being itself *animate* is the entire source of the vital flame. And lastly, by that able Anatomist, Mr. John Hunter, who also expressly pronounces the blood to be *alive*. Such an unqualified assertion maintained by anatomists of the first eminence, if once admitted, might not only lead to a conclusion, which probably they never dreamt of; but also prove productive of dangerous errors. For Life is allowed on all hands to be the attribute of an organized body alone, and if blood

* Harv. de Generatione Animalium Exercit. 51.

be an organized body, then is it an animal, and if so, here is a living animal destined to circulate within the vessels of another living animal!

That the blood, though in itself a mere passive, inorganic mass, performs many important offices in the system will be readily allowed. It not only nourishes and sustains all the solid parts, the brain, and nerves themselves not excepted, but also contributes occasionally to the reproduction of parts decayed, or lost. Nay we may still venture to add that the blood (for we mean not to deprive it of any vital honours to which it is fairly entitled) affords a perpetual and necessary stimulus to the heart, and vascular system, without which animal life could in no wise be supported. In like manner air and water are essential to the nourishment of plants, without which the Principle of Vegetation would soon languish and expire. But does it follow that the fluid nourishing and sustaining a living part must of necessity be itself alive? As well might we affirm that the milk, the bile, with all the animal and vegetable juices are alive; and that whatever supports the action of a sensible part must itself be sensible. Or as Dr. Johnson, on a similar occasion, once ludicrously observed,

“For surely he that drives *fat* oxen must himself be *fat*.”

Van Helmont and his followers conceived the principle of Life to be seated in the stomach; others

others in the heart, as the grand centre of all the vital motions. Such indeed is the importance of both these organs, that no perfect animal with warm blood can subsist a moment without them. But certain cold animals can survive the loss of either of these viscera for several minutes: the water Polype, without any thing even resembling either heart, or stomach (unless a simple canal may be called such), not only lives, but pursues its prey, and performs its various functions.

Nor have those Philosophers succeeded much better, who have placed the principle of Vitality solely in the brain. The famous Pinæal gland, in whose sacred recess they conceived the Soul to be enshrined, has more than once after death been found replete with stony matter, and that without the Patients testifying during life any visible defect, or derangement of the functions of that organ. The brain of an ox fatted for slaughter has been found in a petrified state. A human fœtus has been born alive having only a few detached filaments of nerves in place of the spinal marrow, but without even a vestige of brain.

The wasp, many minutes after it has been deprived of its head, still continues to dart forth its sting in various directions. The tortoise has been known to survive this operation several months. Nay, what is perhaps still more singular, the male toad, though decapitated in the act of procreation,
yet

yet such is its affection, that regardless of the trifling loss of its head, it deliberately completes the conjugal embrace! *

The principle of Vitality, therefore, does not appear to be seated in the blood or animal fluids; nor to have confined its residence to the stomach, the heart, or even to the brain, though parts, which physiologists have emphatically termed Vital organs. Where then shall we look next for this fugitive being? While we attempt to trace it to this or that organ, and persist in considering it as a *separate* living principle inhabiting some secret recess of the system, it will continue to elude the search; and we shall probably at length be convinced, that philosophers have been pursuing for many centuries past, a mere phantom of the imagination.

Considering the familiarity with which we daily contemplate Life in a variety of living objects, and observe the visible difference between a living and dead body, and which, at first view, strikes the most superficial beholder, one would think there certainly could be no difficulty in discussing this simple question—What is Life? or wherein does it consist? How would the untutored peasant shake his head at the philosopher, who should seem puzzled by a question apparent-

* Spallanzani, Hist. of Animals and Vegetables.

ly so plain and obvious! And yet it may be doubted whether the acutest physiologist be yet able to answer it satisfactorily. One thing seems evident, that organization, or a suitable arrangement of dissimilar parts must precede Life; but the latter is not to be considered as a *necessary*, only a *possible* consequence of the former. Thus the watch may be complete in its mechanism, but unless it be wound up, or the main spring put in motion, it will for ever remain silent. The impregnated egg is supposed to contain, in miniature, the rudiments of the future chick, as the acorn does of the oak: but although the organization be complete in both, yet the chick would never be hatched without the animating heat of incubation, nor the oak expand its foliage without the vivifying influence of air and water. A well-formed embryo, whether animal or vegetable, may either not arrive at Life, or after it has been alive, presently die, while the organization remains entire. Organization, therefore, is only a condition, or necessary step towards animation.

The learned Baron Haller very ably contends, that Vitality consists in irritability, or that motory power of animal fibres, by which they undergo alternate contractions, on the application of a stimulus. On this simple principle he has beautifully illustrated the theory of the vital and animal functions. As an exception to this ingenious system it must however

however be confessed, that certain animal substances, though entirely destitute of Life, testify apparent signs of irritability, such as feathers, cat-gut, vellum, &c. These, on being suddenly exposed to heat, are instantly thrown into various irregular motions and contortions. Several light bodies are also put into visible motion by the Electrical *aura*; and even particles of iron are compelled to dance to the magnetic influence. But these, and similar effects resulting from the power of attraction or repulsion, must not be confounded with the irritability of an organized body. This inherent property renders it susceptible of being excited into action, but in addition to this, organic life further requires an harmonious arrangement of parts, and the influence of stimulating fluids specifically adapted to the respective organs, in order to produce the functions of an animated being. When these circumstances combine, the action that results appears to me to constitute the IMMEDIATE CAUSE of that condition, which we call VITALITY or Life, in its first or simple state of existence. Thus the *fœtus* in *Utero* indeed lives, but it is only the life of a vegetable, or, more properly, that of an aquatic animal; since like the tadpole it remains a breathless being, immersed in a watery fluid till the moment of its birth, that it draws in air from the surrounding atmosphere. Here a new and more perfect state of Life commences,

which

which visibly actuates the whole frame. But this will be more fully explained, when we come to consider the effects of respiration.

To the principle of irritability, which the infant inherits in common with animals, and even vegetables, the Creator hath superadded to man a rational Soul. As soon as this begins to exert its energy, the faculties expand, reason gradually ripens into sound judgment, and consciousness marks the man as an accountable being. These and other mental endowments, as we have already proved, sufficiently distinguish him from all other animals, and at the same time give him such a decided preeminence, as enables him to exercise absolute dominion over them. From whence, however, we may draw this inference, that Man ought to be thankful to the SUPREME DONOR, and merciful to his creatures.

Concerning the essence of the Soul, the intimate nature of irritability, and of that incomprehensible chain which unites them both to an organized body, we are still equally ignorant. Though we cannot doubt of their existence, we can only trace them from their effects, just as we argue from the phenomena of Magnetism and Gravitation.

“Causa latet—vis est notissima.”

Life consists in motion, and the animal machine, during its existence, exhibits perhaps the
most

most curious *Perpetuum Mobile* in Nature. All its vital motions proceed in a complete circle, of which we neither know beginning or end. Thus the heart and vascular system propel the fluids, while these again stimulate the vessels which contain them. Emotions of the Soul influence the Body, and bodily affections disturb the Soul. The circulation of the blood imparts energy to the brain, and affections of the brain disorder the circulation of the blood. Circulation in a great measure regulates secretion, and secretion circulation. The stomach sympathizes with all the vital organs, and all the vital organs with the stomach.

We shall therefore only add in this place, that no sooner is the "*Silver Chord* broken" which forms this singular connection between mind and matter, than the harmony of the whole is destroyed. Vitality ceases—the Soul quits its residence, and the Body, that exquisite piece of mechanism, with all its movements, becomes a motionless, inanimate corpse! The component parts of which soon undergo a decomposition, and the goodly fabric mouldering into its native dust, is afterwards dispersed into its original elements!

S E C T. III.

Suspension of Vital Action from Drowning.

1. From various experiments, the following appearances have been observed to take place in drowning; to which particular attention ought to be paid, as they not only indicate the nature of the death, but the method which ought to be pursued to restore the vital motions.

When an animal is kept under water, it presently begins to expel air forcibly from its lungs in form of bubbles which rise to the surface. This is followed with a strong desire to draw in air, and in this effort it commonly inspires a small portion of water. Air is again emitted, and new efforts made to inspire, and that with similar effects. This is continued with increasing uneasiness from 2 minutes to 5, when respiration ceases, faint gaspings succeed, and it sinks down motionless. Upon taking it out of the water, soon after all its struggles are over, the nose and mouth appear extremely pale, the eyes do not protrude, the pupils retain in some measure their natural lustre, but are remarkably dilated. All sense and motion, both external and internal, except a feeble contraction of the right side of the heart, are now
lost,

lost, and if suitable means of recovery be not made use of, the body gradually becomes cold, and with the loss of heat, the heart by degrees loses its power of contraction.

2. On opening the chest, the cavities of the right side of the heart with the corresponding veins are found to be distended with dark coloured blood through their whole course. The left side of the heart is often almost empty: also the large arteries, except the trunk of the pulmonary artery where it enters the lungs, which is commonly full of blood. The vessels on the surface of the body appear empty, and the skin as pale as if the animal had been bled to death.

3. The lungs often appear unaltered, sometimes in a collapsed state; but if the animal is often suffered to rise to the surface of the water, so that he may inspire air, that organ appears distended. A quantity of frothy fluid, consisting of air and mucus, with a little of the water in which the animal was drowned, may generally be squeezed out of the windpipe. But this is small in proportion to the quantity of air apparently expelled during the act of drowning, though it is more distinguishable when the animal is drowned in ink, or any coloured fluid. The orifice of the windpipe being endowed with exquisite sensibility, the animal as if conscious of the presence of an improper element, rejects it with a convulsive kind of
 B horror.

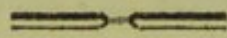
horror. These efforts to exclude water, and to draw in air, are alternately renewed till strength is exhausted, and respiration ceases. Hence the fruitless struggles, which the animal exerts till it finally expires. After which, no more water probably is admitted; otherwise after the body has lain some time immersed, we should find the lungs fully distended, which is contrary however to observation. For it often happens, that no water can be discovered in the lungs of drowned animals. From the painful sense of irritation which is felt on a single drop of water, or other liquid accidentally falling into the windpipe, and from the convulsive motions which ensue till it is expelled, we may form some idea of this distressing situation.

4. In drowned animals, the heart retains its motion longer than any other part of the body. The motion of its right cavity survives that of the left, and that of the latter holds out longer than the peristaltic motion of the intestines, inasmuch that a weak pulsation of the right chamber of the heart often remains upwards of 2 hours after respiration has ceased.

On opening the head, the veins sometimes appear rather distended, yet seldom more so than in other violent deaths, but without the least appearance of extravasation.

5. Upon the whole (2, 4.) it appears, that in drowning,

drowning, the organization of the principal parts remains entire; but that the heart, and large veins in its neighbourhood are distended with dark coloured blood, whilst every other part seems in some measure to be drained of that fluid. Nor does the apparent fulness of certain vessels in the brain, the blood-shot eye, the bloated countenance, or the lividity of the skin, so often observed in drowned persons, who have remained long under water, especially with their head downwards, prove any thing more than that the blood after death had descended by its specific gravity to the more depending parts.



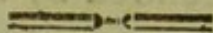
S E C T. IV.

Suspension of Vital Action from Hanging.

6. It appears from experiments, that when an animal is suspended by the neck, it generally ceases to struggle in about 5 minutes. The external veins of the neck being strongly compressed, the return of the blood from the brain is partially interrupted, but continues to circulate in the internal vessels while the action of the heart remains. The windpipe being shut by the pressure of the

cord, and the ingrefs of air excluded, the eyes become prominent, the countenance grows firft red, then livid, and fuffocation enfues.

On infpection of the body after death, the blood-veffels of the brain and its membranes feem rather more diftended than in the preceding cafe; the lungs very little altered, and free from frothy fluid: the heart, and trunks of the larger veffels exhibit exactly the fame appearances as in drowned animals. (2, 3, 4.)



S E C T. V.

Suspension of Vital Aétion from noxious Air.

7. Animal Life is often destroyed by expofurè to noxious air arifing from fermenting liquors, from quicklime, or metals during calcination, from fumes of charcoal, from clofe vaults, common fhores, fubterraneous caverns, wells of fhops, &c.

Mines and coal-pits are frequently infefted with two fpecies of noxious air, fimilar to thofe above-mentioned. The firft termed by miners *Choke Damp* is native fixed air, generated in the bowels of the earth, which being fpecifically heavier than atmofpheric air, occupies the bottom of the mine.

The

The other called the *Fire Damp* is a native inflammable air, and being about 10 times lighter than common air, ascends to the upper region of the mine.

8. These pernicious vapours in their concentrated state, being elements wholly unfit for the purposes of respiration, occasion, the moment they are received into the lungs, an intolerable sense of suffocation, and destroy animal life more speedily than drowning or strangulation. Noxious air in proportion as it is diluted with atmospheric air attacks the principle of irritability, in a more slow insidious way, without producing any violent symptom. When the fire-damp, or inflammable air bursts out into actual flame, the miners are sometimes dreadfully scorched, though in general, they are not burnt to death, as is commonly supposed, but suffocated by the vapour.

In most of the fatal cases occasioned by foul air, or by lightning, the poor sufferers being generally imagined to be past all hopes, the means of restoration are too often wholly neglected.

Some of those few who have been recovered from suffocation, occasioned by the fumes of charcoal, describe their situation as having been far from painful. That, on the contrary, at first a pleasing kind of drowsiness or delirium stole over their senses, without leaving them even a wish to

retire. This was presently succeeded by an entire loss of recollection.

9. The bodies of animals suffocated in noxious vapours, or killed by a stroke of lightning, exhibit the following appearances. Their limbs remain flexible long after death, except they are killed by nitrous air, in which case, they are said to become sooner rigid than those destroyed by drowning, and that, sometimes, even before the heart ceases to vibrate.

The eyes retain their lustre, and the body a degree of heat often higher than the natural standard. This is particularly observed of those that are suffocated by the fumes of charcoal, and their blood, for several hours after death, remains fluid, and even highly florid. In those, suffocated by fixed, and inflammable air, although the limbs continue pliant, the blood is less florid. In all; the vessels of the brain are found turgid, the lungs little altered, the heart and adjoining vessels equally distended as in those that are drowned or hanged.

S E C T. VI.

Suspension of Vital Action from smothering.

10. Smothering, or Suffocation may be occasioned by whatever suddenly obstructs respiration.

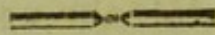
Thus infants through the negligence of the nurse are sometimes overlaid or smothered, particularly in folding-beds. Still-born children, through the ignorance or inattention of the midwife, are generally pronounced to be dead. Some of them, however, especially such as are upwards of 6 months old, might by proper means be happily restored to their afflicted parents.

In many instances of this nature, the tongue is drawn back into the throat, so as to shut down the Epiglottis, and to close the aperture of the wind-pipe like a valve, by which the admission of air is prevented. This may be easily remedied by drawing the root of the tongue forward, and by raising the valve with a finger. Should this prove insufficient to enable the child to respire, such other methods must be had recourse to, as shall be mentioned in their proper place.

11. Incautious persons, employed in digging sand or gravel, are frequently smothered by the falling in of the superincumbent strata. Others are suffocated in close stoves, or by being shut up

in confined air, contaminated by their own respiration, as happened to many of our Countrymen, in the black cell at Calcutta. Similar accidents sometimes occur in the Diving-bell, for want of a supply of fresh air. The same thing happens to animals shut up in the exhausted receiver of an air-pump.

12. Under all these circumstances, where there is no fatal contusion, the vital functions are suspended merely from want of atmospheric air. The body is often found warmer than natural, the limbs pliant, the lungs nearly natural, the cavities of the heart, and large blood-vessels distended with dark coloured blood. In other respects, the appearances are exactly similar to those occasioned by drowning, or by noxious air (4—5.)



S E C T. VII.

Result of Experiments respecting Vital Air—The Nature of Respiration—Its Effects on the Blood—Its Importance to Life, &c.

13. To what has been already hinted concerning the effects of respiration it may not be improper in this place to add the following observations, towards illustrating a function so essential to animation. Though respiration is a problem

blem that has long perplexed the ablest physiologists, yet it has been generally allowed on all hands, that no living creature can subsist without air. Whence is it then, that the unborn infant with its head like that of a drowned person immersed in a watery fluid, not only lives, but grows rapidly, without any evident communication with the outward air? Or how comes it, that worms in various internal parts of the body—the toad in the centre of a rock or solid oak, and marine animals at the bottom of the ocean, live, without any visible access to this necessary fluid? These exceptions might seem to afford insuperable objections to the established theory, respecting the importance of air to animal life. However, we shall find that instead of overturning it, they manifestly tend to support it. Nature has wisely adapted the internal structure of these animals to the peculiarity of their situation—some to receive air directly into their lungs; others indirectly into the mass of blood: others, again, to secrete air by a particular set of vessels, when destined to live in water, instead of air.

The human fœtus, though surrounded with a fluid element, receives maternal blood fraught with air, by the intervention of the Placenta, which seems evidently to supply the place of lungs. Besides, there can be but little demand for air by an animal that has not yet breathed.

Even

Even rocks and trees, though apparently solid, are sufficiently porous to admit air; besides it is well known, that air may be extracted from them in considerable quantity.

That air is indispensably necessary to breathing animals is evident from this, that no land animal can subsist in *vacuo*; no fish or aquatic animal in water previously deprived of its air.

14. It has been lately discovered, that the air we breathe, is not as was long imagined a simple element, but a compound fluid, consisting of 3 sorts of air, possessing very different qualities, viz.

*Azotic air, Vital air, and Carbonic acid or fixed air.**

One hundred parts of common atmospheric air are computed to contain the following proportions. viz.

Of Azotic air	—————	80 parts.
Of Vital air	—————	18 parts.
Of Carbonic air	—————	2 parts.

* In conformity to the new chemical Nomenclature (now generally received), we have here adopted the modern terms, which however may require the following explanation.

The existence of Phlogiston is at present positively denied, (whether justly we presume not to inquire) and since the various phenomena can be satisfactorily accounted for without it, the term is almost become obsolete.

<i>Old Names.</i>		<i>New Names.</i>
Phlogisticated air,	<i>now termed</i>	Azotic air.
Dephlogisticated air,	<i>now</i>	Vital air or Oxygene.
Fixed air,	<i>now</i>	Carbonic acid air.
Principle of Heat,	<i>now</i>	Calorique.

But

But these proportions vary in different situations, according to the purity of the atmosphere.

It is remarkable, that the azotic and carbonic airs, constituting more than three-fourths of the atmosphere, should be found, when examined separately, to extinguish both life and flame.

Vital air, on the contrary, is found by experiment, to support an animal shut up in it, 4 times longer than an equal quantity of atmospheric air. If a lighted taper be immersed in a jar of Vital air, it instantly burns with such superior splendor, as to dazzle the eyes of the beholder: * if conveyed into a jar of azotic or carbonic air, it as suddenly goes out. The experiment is equally striking, if performed on live animals, by confining them alternately in these different kinds of air. Vital air, therefore, is evidently the true *pabulum* of life, and of flame. Without this vivifying principle in the atmosphere, neither could animals breathe, nor fire be kindled. The world would consequently soon become a comfortless desert!

15. A gallon of common air by measure is found barely sufficient to support the person who breathes it, a single minute. If a large blad-

* The brilliant balls exhibited in fire-works owe the whole of their resplendent brightness to the Vital air of the nitre, let loose by combustion.

The lustre of the glow-worm is proportionally increased by Vital air, affording light sufficient to read by in the darkest room.

der, containing this quantity of air, be alternately drawn into the lungs through a tube, and expelled back into the bladder, before the minute is expired, a sense of oppression or suffocation ensues, which presently renders it necessary to forego the experiment, and to breathe fresh air.

If the air in the bladder now rendered unfit for breathing be chemically examined, it will be found that the Vital air has vanished, that the carbonic air is considerably increased, and that the azotic air remains the same as at first.

If a candle is suffered to burn out, or an animal to putrefy in the like quantity of common air, it produces similar effects. Hence respiration, combustion, and putrefaction equally tend to consume the Vital air, and to increase the carbonic air. After this, the air becomes equally incapable of supporting life, or flame, and what is remarkable is always found electrified *negatively*, when at the same time the surrounding atmosphere is electrified *positively*.

If a person *inspires* common air through a phial of lime-water, the lime-water preserves its transparency, but if he *expires* air into the water, it soon becomes turbid, and a precipitation ensues—an evident proof of the presence of carbonic air in the fluid exhaled from the lungs.

16. Since air is so necessary to life (13, 14.), and since it undergoes such a remarkable change
in

in the lungs (15.), it will be necessary in the next place to inquire how this change is produced.

The structure of the lungs is already too well known to need a particular description, suffice it therefore briefly to observe, that the innumerable little vesicles, or air-cells throughout their whole substance, into which the air alternately passes, and repasses at each respiration, are divided from the blood-vessels only by an extremely thin transparent membrane.

Nature, for some wise purpose, has ordained that all the blood in the body must pass through the lungs before it can complete its circuit. As the current of blood is made to pass in review, as it were, of the air through all the branches of the pulmonary artery, and back again through all the ramifications of the corresponding vein, it seems obvious that by being brought so nearly in contact, and that through such a vast extent of surface, they were destined to exert some important influence on each other.

17. The blood, in its passage from the left cavity of the heart through the arterial system, is of a florid crimson colour inclining to scarlet, but on its return by the veins, it gradually deepens to a darker red. In its passage through the lungs, however, it again recovers its florid colour, and when arrived at the place from whence it set out, appears of the same bright hue as before.

But

But if the action of the lungs is by any means suspended 5 or 6 minutes, so as to exclude the air, the blood grows still darker, inclining to black. As the colour deepens, the motion of the left cavity of the heart grows gradually weaker, and soon ceases—that of the right cavity continuing though very slowly, and feebly to beat some time longer.

The circulation being suppressed, the brain no longer receives its wonted current of blood which enabled it to diffuse motion, vigour, and sensibility over the whole frame. The animal of course sinks into a torpid state, becomes cold, and apparently dead. If at this period, the lungs in due time are inflated with air, in imitation of natural respiration, the dark coloured blood begins to resume its florid hue, the heart to renew its motion, weakly indeed at first, but by degrees more powerfully, till at length the brain recovers its functions, and life is completely restored. But if the artificial respiration is suspended too soon, the blood again loses its florid colour, the heart ceases to contract, and the animal relapses into its former state of insensibility.

If this dark coloured blood be now drawn from a vein, into a phial of either azotic, or carbonic air, it undergoes no visible change of colour, but if it be received into a phial of Vital air, it soon resumes its florid hue, similar to that which it exhibits

hibits in passing through the lungs. Or if the lungs of a drowned animal are inflated with Vital air, instead of common air, it restores the vivid colour of the blood much sooner.

18. From what has been observed (15—17.) it appears evident that the blood, and the contiguous air, in their passage through the lungs, undergo a remarkable change by their mutual action upon each other. Nor is this to be wondered at, since it has been found by experiment, that Vital air is capable of changing black blood to a bright red, even through the dense coats of a bladder.

But the change of colour implies a change in the quality of the blood, either from something noxious being expelled from the general mass, or from something salutary imbibed.

That the air which is expelled from the lungs is noxious to animal life, and the air drawn in salutary, has been already demonstrated (14—16.) On weighing the circumstances (13—17.) it seems reasonable to conclude that the principal use of respiration, is to carry off noxious air, and to inhale pure air, and that this process is performed by chemical attraction. For the lungs are known to be merely a passive organ, being acted upon, and supplying the place, (if we may be allowed the homely expression) of a pair of bellows.

The blood, in its rapid career from the heart to all the remote parts of the system, verges to-

wards

wards putrefcency, and unavoidably contracts a certain degree of impurity, constituting what modern chemists style *carbon* or the basis of fixed air, which it carries with it to the lungs as its destined outlet. Here the impure matter or carbon meets with Vital air, to which it has a stronger chemical attraction than to blood; it therefore quits the latter, to unite with the former, and is expelled in form of fixed air. As all the blood must circulate through the lungs, each portion, as it passes through that organ, must undergo the necessary purification at each successive breathing: and thus the whole mass alternately contracts impurities, and is alternately purified. This explains why the blood appears bright in the arteries, and dark in the veins; also why the Vital air after it has been respired disappears, and why the fixed air* is increased (15, 16.).

* Though the azotic air remains the same, yet the Vital air has been discovered, at a single respiration, to be diminished two thirds, while the carbonic air has been increased to 6 times its former quantity. But the volume of air expired never equals that which is inspired by about a fiftieth part. Therefore a considerable portion of the air taken in, must be retained in the system. Besides it has lately been discovered, that Vital air is capable of being absorbed as well as respired by the invisible ducts of the skin.

S E C T. VIII.

*Of ANIMAL HEAT—Its Source—Uniformity—
—and Connection with Respiration.*

19. It seems now to be sufficiently understood, that Heat or, as some term it, *calorique* is no longer to be considered as a mere quality, dependent on a supposed vibratory motion in the particles of matter, but as a real principle or subtile elastic fluid, diffused through all bodies in the terraqueous globe; and which becomes manifest to our senses, by exciting in us the idea of warmth, and by raising the mercury in the thermometer. Before we proceed, therefore, it will be requisite to inquire into the general properties of heat.

1st. Heat is subject to the laws of chemical attraction. When it unites with other bodies, it loses its own distinguishing qualities; no longer affects the thermometer, but becomes fixed, and is then termed *latent* heat. Thus the vitriolic acid, and spirit of wine, though of no greater heat while separate than the outward air, yet no sooner are they mixed than they produce a degree of heat equal to that of boiling water. Here the bond of attraction being dissolved, the latent heat contained in these fluids is suddenly set at liberty, and becomes *sensible* heat.

2^{ly}. Heat attaches itself to all bodies, partly in a sensible, and partly in a latent state; and the whole quantity contained in such body is called its *absolute* heat.

3^{ly}. Heat lessens the cohesion, and increases the expansion of bodies. It raises those that are volatile, calcines or vitrifies those that are fixed, dissolves the most refractory metals, and finally preserves that degree of fluidity in bodies, which is essential to animal and vegetable life.

4^{ly}. Heat, in its sensible state, diffuses itself equally to all surrounding bodies that contain less of this principle, till it brings them to an equal degree of temperature.

5^{ly}. Heat however is conducted more powerfully by some bodies than by others, and this generally in proportion to their density. Thus metals are superior conductors to stones, stones to chalk, &c. When we speak of warm clothing, it is not as we are apt hastily to conclude, that a garment of silk, or flannel, communicates more warmth to the body than cotton, or linen, but because the former being more imperfect conductors, convey less heat from the body, and consequently afford a sensation of more warmth.

6^{ly}. Though cold is allowed to produce effects diametrically opposite to those of heat, yet it is not, as is commonly imagined, an opposite principle, but a mere negative quality, cold being no-
thing

thing more than an absence or diminution of sensible heat, just as darkness is of light. The coldest bodies in nature, as snow or ice, contain a quantity of latent heat, sufficient when evolved in its sensible form, to dissolve iron or the hardest metals.

Were sensible heat wholly withdrawn from our globe, an universal torpor would soon overspread its frozen surface, and the earth with its surrounding ocean would speedily be reduced to a huge ball of ice! on the other hand, were all the latent heat suddenly let loose in a sensible form, the earth with all its inhabitants would soon be burnt up, and the more solid parts of the globe, calcined, or even vitrified!

But the AUTHOR OF NATURE has wisely dispensed the principle of heat, though not equally through our planet, yet in such a degree, and under such limitations as was best adapted to the well-being of the whole. So admirably tempered is the human frame against either extreme, that no climate hitherto discovered can be pronounced too hot, or too cold for its native inhabitants.

Having thus far considered the general properties of heat (19), we proceed to inquire into its effects on the animal system.

20. The heat of inanimate bodies is governed by the temperature of the air, and of surrounding substances, as has already been observed (19);

whence is it then that the heat of animals affords such a striking exception to this general rule? why for instance, does the human body, during health, preserve such an uniform degree of temperature, in infancy, and old age—under every variation of season, and of climate from the Equator to the Poles? Whence is it that, under these extremes where men complain of excessive heat, or intolerable cold, (of both which their sensations afford very inadequate judgment), the mercury in Fahrenheit's thermometer, when placed under the tongue, or in the cavity of the arm-pit, uniformly points to the 97th degree? This surprising regularity of temperature, peculiar to the living body, cannot be explained on the principle of circulation, attrition, fermentation, putrefaction, or any other law of the system hitherto discovered, it must therefore be considered as, an attribute of vitality, and essential to the animal economy.

It appears from some late experiments, that the natural heat of the body may be suddenly diminished, upwards of 16 degrees, by sitting half an hour in a cold bath, and exposing the body immediately after it to a cold easterly wind. To overcome this severe degree of cold, and restore the equilibrium, the reaction of the system is instantly excited, causing violent rigors, and other
painful

painful feelings, the efforts of nature to preserve life.*

In cases of shipwreck, or apparent death from drowning, the heat is sometimes undoubtedly reduced, still much lower without proving fatal.

Fishes are nearly as cold as the medium in which they move. Water, of a temperature equal to that in which land animals live, would scald them to death. The human body is many degrees warmer than the surrounding air, except in those sultry regions of the Torrid Zone, where the heat of the climate often exceeds that of the blood.

To counteract the effects of intense heat, and to enable the system to sustain the scorching rays of a vertical sun, Nature excites a copious perspiration from the lungs, and whole surface of the body, the evaporation of which generates a proportionate degree of cold, and preserves the balance. Hence may be explained, why in the noted experiment of a room heated to 212° , the air of which consequently equalled that of boiling water, Dr. Fordyce, and others, during a profuse perspiration, were enabled to continue several minutes without undergoing any material increase of their natural heat perceptible by the thermometer. Also, why in ardent fevers the heat of the

* Phil. Trans. Vol. 82, Art. 10.

body is sometimes increased 9 or 10 degrees, attended with extreme danger till a critical perspiration supervenes, and opportunely assuages the excess of febrile heat.

The canine race, being destitute of cuticular perspiration, are taught by instinct to supply the deficiency, by increasing a similar discharge from the lungs. Hence the dog, when overheated, is constantly observed to expand his jaws, and thrust out his tongue, in order to increase the evaporating surface.

The sudden diminution of heat produced by perspiration admits of an easy solution. The fluid, which exhales from the body, consists chiefly of watery moisture, which uniting with a large portion of sensible heat, is carried off in form of steam. Hence the more speedy the evaporation, the more sudden is the diminution of heat; or, in more familiar terms, the greater is the degree of cold thus generated. Hence, by promoting a sudden evaporation, water may be speedily congealed into ice, even in the hottest climate.

This curious phenomenon may be readily exhibited thus. Let a very thin phial, containing a small quantity of water uncorked, be kept wetted on the outside with a feather repeatedly dipt in *Æther* (a fluid which evaporates more quickly than any other yet discovered), the water in the phial, as soon as its temperature is reduced to the
freezing

freezing point, will begin to congeal and soon present a cake of ice, to the astonishment of those natives who never before beheld water in a solid form.

21. The blood is the source from which the body derives its heat, but as it is constantly losing a portion of the latter, in its circuit to the remote parts, there must be a generating power in the system, constantly operating to supply the loss. To determine wherein this consists, it will be necessary in the next place, to trace the connection between animal heat and respiration.

It has been shewn that, without vital air, neither life nor flame can subsist (13, 14). But the vital part of the air we breathe is also known to abound with heat in a latent form, (a circumstance perhaps essential to permanently elastic fluids) and also to change the colour of the blood in its passage through the lungs to a more florid hue (16, 17). As no elastic air, however, is discoverable in the blood, the vital air, consisting of *Oxygen*, and latent heat, appears to undergo a decomposition in the process of respiration, and by that means not only finds entrance into the blood, but also gives it a phosphorescent quality.

For the *Oxygen*, uniting with the blood, communicates the florid colour and poignancy, and at the same instant deposits its latent heat, which being gradually evolved in its sensible form, per-

vades the densest parts of the body, diffusing warmth over the whole frame.

Hence during this *Oxygenation* of the blood, and *production* of animal heat, a double elective attraction seems evidently to take place; the blood in the lungs alternately discharging the *carbon*, and absorbing the *Oxygen*, while in its progress through the rest of the system, it imbibes the *carbon*, and sets the latent heat at liberty.

By this curious and truly wonderful process, does animal heat appear to be generated and dispersed over the system according to the demand! By which the human body is enabled to preserve an equable temperature through all the vicissitudes of heat and cold to which it is occasionally exposed. Independent of respiration, however, other causes may exist in the system, that may contribute to the evolution of heat; otherwise whence the warm blush of bashfulness, or of conscious shame? Whence the increase of temperature accompanying every new combination of the fluids, so observable in glandular secretion, inflammation, suppuration, digestion, &c?

S E C T. IX.

Of the PROXIMATE CAUSE of Death, in Cases of Drowning and Suffocation.

22. From what has been observed, it seems evident, that whether death is brought on by submerſion, ſtrangulation, or noxious air, the viſible effects produced on the vital organs are ſo nearly ſimilar (1 to 6), that theſe ſeveral modes of ſuffocation may perhaps all not improperly be referred to one common cauſe.

The ableſt authors, hitherto have been greatly divided in their opinion, not only concerning the nature of vital action, but the cauſe of its ſuſpenſion. By ſome, apparent death is pronounced to be an affection of the lungs; by others, of the heart; while others again contend that it is wholly ſeated in the head. Some attribute it to a diſtention of the brain; others to a collapse—An evident proof that the proximate cauſe has not yet been fully diſcovered. Such a ſtriking difference in Theory cannot but materially influence Practice, and therefore demands inveſtigation.

In caſes of drowning, M. Louis, De Haën, and others conſider the introduction of water into the wind-pipe as the immediate cauſe of death. But later experiments have ſhewn, that 2 ounces
of

of water—a quantity, perhaps, greater than is commonly found in the lungs of drowned animals, may be injected into the wind-pipe without proving fatal.

In the *Hydro-thorax*, an incredible quantity of water is sometimes collected in the cavity of the chest, without suddenly destroying life. A remarkable instance of this is related in the Memoirs of the Parisian Academy of Chirurgery, where upwards of 5 pints were repeatedly drawn off by a perforation made between the ribs. As the instrument could be passed to the depth of 5 inches into the cavity, without touching the lungs, that organ must have been almost deluged with water previous to each operation, and yet the fluid, notwithstanding its pressure, did not produce a sudden suspension of the vital functions.*

If an artificial dropsy of the chest be produced by injecting a considerable quantity of water into the thorax of a healthy animal, it immediately causes oppression, and difficulty of breathing but no fatal syncope ensues. For the water is gradually absorbed, and the symptoms soon disappear. In drowning, the case is very different, since a few minutes submersion is sufficient to destroy the life of the animal, even whether water enters the wind-pipe, or not, for in many cases none is to be

* Memoirs de l' Acad. de Chirurg. Tom. 2. p. 546.

found in the lungs after death. But if the small portion of water which occasionally enters the lungs (as sometimes actually happens), be still insufficient to cause death *directly* by suspending respiration, it follows that, it must produce it *indirectly* by excluding the atmospheric air.

23. Other eminent writers have endeavoured to explain the death of drowned, or suffocated animals, from a surcharge of blood in the vessels of the brain, and have therefore considered it as a case of real apoplexy. Among these may be mentioned M. Littre, Wepfer, Boerhaave, and Cullen, to whom also may be added the ingenious Mr. Kite, who, (in his late elaborate essay) appears to have investigated the subject with no small attention. An opinion advanced by such able writers, and so powerfully supported by their followers ought not to pass unnoticed.

The distention of the blood-vessels of the brain observable in these cases, and particularly after strangulation (though much insisted upon), affords no convincing proof of apoplexy, since a variety of other instances of violent death present similar appearances, even where there could be no suspicion of the brain being overcharged.

In almost every fatal accident proceeding from an *external* cause, the blood preserves its fluidity much longer than where sudden death is occasioned by any internal affection; and the elastic
force

force of the arteries continues several hours after death to propel the uncoagulated blood onwards towards the veins. Hence blood often flows a fresh from the orifice of a vein long after life is extinct. Hence also the apparent distention of the veins without any real increase of the quantity of blood. Nor is it even pretended that in violent death, produced by drowning or suffocation any extravasation of blood, or serum, has ever yet been discovered in the cavities of the brain, though generally very conspicuous in fatal incidents occasioned by genuine apoplexy.

Mr. Kite, one of the most powerful advocates on the side of apoplexy, having endeavoured to prove, that in cases of hanging, death is not occasioned by the compression of the nerves of the neck, or of the carotid arteries, adds the following remarkable passage, which unfortunately strikes at the very foundation of that system of *plethora* which hitherto he had so strenuously supported.

“ A third opinion is, that death proceeds from the compression of the jugular veins: but it appears from the experiments of M. Emettus that all the larger veins of the neck, both *internal* and *external* have been separately tied, without apoplexy, or even sleepiness having been induced. Further it is related, that the carotid arteries and jugular veins being *all tied* in a dog, that he enjoyed the most perfect health and vivacity

city for some weeks! The same author further observes, that upon repeating the operation often, although none of the dogs died, or were apoplectic, yet some of them, for the space of a few hours, seemed sleepy." *

Certainly a more likely method of producing a sudden and violent surcharge of blood in the brain could hardly have been devised by human ingenuity, and yet we are told so far from causing apoplexy, it "only occasioned drowsiness for a few hours, and that in all other respects the animals enjoyed the most perfect health and vivacity."

The experiments, moreover, having been *often* repeated, and similar ones also instituted by Mr. Kite and others with the same effect, we can scarcely entertain a doubt respecting their validity.

Now, admitting these facts, the conclusion is obvious, viz. that in cases even of hanging, death is not occasioned by a congestion of blood in the brain.

Neither, on the other hand, does diminishing the quantity of blood conveyed to the brain retard the fatal event, as may be seen from the following experiments.

"The wind-pipe of a dog," says an acute Experimentalist, "was secured by a ligature at the

* Kite's Essay on the recovery of the apparently, dead. p. 139.

instant of inspiration; in less than 4 minutes he ceased to struggle. The blood in the left side of the heart compared to that of the right was as 13 to 12. The veins of the head were evidently less distended than natural. Here then, there being no obstruction to the passage of the blood through the lungs, it could not be collected in the right side of the heart, and consequently *no* accumulation was found in the head, and yet this animal died as soon as others, from ordinary hanging."

Again—"The 2 carotids of a dog were secured (which we now know may be done without materially injuring the functions of the animal). In half an hour after this operation, he was hanged. In less than 4 minutes he ceased to move. The vessels of the brain were much less distended than in ordinary death. Here the principal supply being cut off, instead of the vessels of the brain being in a state of congestion, contained a much *less* quantity than natural, and consequently no species of apoplexy could follow from *distention*, and yet this animal died as soon as others which had undergone no such operation." *

The following experiment, by that eminent anatomist Professor Monro, evidently proves that, in hanging, death is not produced by apoplexy, but a very different cause.

* Coleman's Dissertation on suspended Respiration, p. 137

“A dog was suspended by the neck with a cord; an opening having been previously made in the wind-pipe below the cord, so as to admit air into the lungs. In this state, he was allowed to hang 3 quarters of an hour, during which time, the circulation and breathing went on without being much interrupted by the experiment. The cord being now shifted *below* the opening into the wind-pipe, so as to intercept the ingress of air into the lungs, and the animal being again suspended, was completely dead in a few minutes.” Then which nothing can be more decisive, at least so far as one solitary experiment can extend.

It is moreover observable that in apoplexy, life often continues several hours, while in drowning or hanging, the animal functions are abolished in a few minutes. In apoplexy, respiration, together with the action of the heart and arteries, go on, and the pulse often vibrates more forcibly than in health. In hanging, or drowning, respiration is suppressed, and the pulse obliterated.

In apparent death from apoplexy, very few recover, and those few generally become paralytic.

In vital suspension from drowning or hanging, many are restored, and yet no palsy supervenes.

In the former, copious bleeding affords the principal relief; in the latter, it generally proves highly injurious.

In a word, the two cases evidently appear to be
totally

totally different, and to require a very different mode of treatment.

In cases of apparent death, an apoplexy indeed may sometimes occur, not as a *certain* consequence but as an *accidental* circumstance. Thus in hanging, if the feet are pulled violently to accelerate death, as often happens, it may produce a dislocation of the vertebræ of the neck, and extravasation in the brain. Or in drowning, if the person happens to be in a deep state of intoxication, or receives a contusion of the head in falling into the water, and yet after all is restored to life, it is no wonder if an apoplexy, or palsy ensues—a circumstance, however, by no means frequent in other cases of restoration from apparent death.

24. Others imagine they have traced the *immediate* cause of death, to the *presence* of *black blood* in the left side of the heart, and its vicinity. This blood being deprived of the influence of the air, is supposed to be now rendered incapable of exciting the action of the heart, and therefore must be the *proximate* cause of the suspension of its functions.*

This opinion, though sufficiently plausible like the former, may possibly, on further inquiry, be found equally destitute of foundation. For in

* Godwin on the Connection of life with respiration, p. 195.

the first place, this dark coloured blood is by no means peculiar to cases of drowning or suffocation, being on the contrary almost an inseparable attendant on sudden death, from whatever cause produced.

2^{ly}. Even admitting it to be the *immediate* cause of death, in the cases now under discussion, it follows that if by any means we could restore this black blood to its florid colour, we might with certainty restore life. For the cause being removed, the effect must cease. Now this change of colour may be readily accomplished in the pulmonary blood by merely inflating the lungs with common air. And were this alone sufficient to recal life, would it not be unpardonable to suffer any one to die suddenly of this dark coloured blood, where a bent tube, and a pair of bellows could be procured? But experience shews that inflating the lungs of an animal apparently dead, though it changes the contiguous blood to a florid state, yet unless it also succeeds in restoring the natural action of the heart and lungs, it avails nothing towards the restoration of life.

3^{ly}. It further appears from experiments on drowned animals, that the heart instead of instantly stopping, continues to contract a considerable time after the blood has acquired this dark colour. In fishes, and in the human embryo, the blood must necessarily appear dark, and yet the circulation is performed with sufficient vigour.

4^{ly}. In suspended respiration, the dark coloured blood is not confined to the cavities of the heart and pulmonary vessels, but extends through the circumvolutions of the brain, and whole sanguiferous system. Therefore if the action of the heart could not be excited, until the entire mass of blood were changed to its pristine colour, no person apparently dead could ever be restored. For were black blood the efficient cause of the suspension of the action of the heart, that organ would for ever remain at rest, till the necessary change of colour could be brought about.

5^{ly}. It has been observed by an eminent author, that on exposing an animal to intense heat, the blood when drawn from a vein appeared as florid as that which issued from an artery. That, on the contrary, when subjected to extreme cold, the blood assumed as dark a colour as if the animal had been drowned, and yet these remarkable changes in the appearance of the blood, caused no visible change in the animal functions.

Can we suppose, then, that dark coloured blood supports life in one case, and destroys it in another?

In the cold fit of a quartan ague, the lips and whole visage suddenly assume a livid hue. In the subsequent hot fit, the countenance becomes intensely red. But notwithstanding the blood suddenly becomes dark coloured, during the severity of the rigor, yet the vital actions are not suspended; on the

the contrary, the pulse and respiration are manifestly accelerated, and though the patient shivers with extreme cold, the thermometer placed under the arm-pit shews no real diminution of natural heat—A circumstance, which I have more than once observed, but not without astonishment!

6^{ly}. During suspended respiration, the black blood in the left cavity of the heart and arterial system cannot resume its florid colour, till it has completed its circuit, and returned through the lungs. Hence it is evident, the heart must be brought to contract from the stimulus of this black blood, before the circulation can be restored.

On the whole then, since the presence of black blood has been found to be neither incompatible with life, nor to preclude recovery; it cannot be admitted as the *efficient* cause of the suspension of the circulation, much less as the *immediate* cause of death; but the effect, or rather a concomitant circumstance.

25. “The *proximate cause* of that disease produced by drowning, hanging, and suffocation,” says another late writer, “appears to be mechanical obstruction in the interior pulmonary vessels, from *collapse* of the lungs, with a want of latent heat in the blood.”*

This idea seems to approximate more nearly to

* Coleman's Dissertation on suspended Respiration. p. 150.

the truth, but still leaving a small space between, resembles those parallel mathematical lines, which are said to be continually approaching each other, and yet never meet. For his own experiment, so well imagined for guarding against accumulation in the brain, must have still more directly prevented collapse, or mechanical obstruction in the interior pulmonary vessels. Therefore though meant to subvert the hypothesis of another, it unluckily tends to sap the foundation of his own.

Accordingly it informs us “there being *no* obstruction to the passage of the blood *through the lungs*, it could not be collected in the right side of the heart, and yet this animal died as soon as other animals from ordinary hanging.”*

Besides, were this the real cause of apparent death, it is not easy to conceive how restoration could ever be brought about without inflating the lungs; and yet instances of spontaneous recoveries are by no means wanting.

In certain cases, moreover, the heat of the body, even after death, has been found to exceed that of health, and therefore neither a *want of latent* or *sensible* heat in the blood, could be supposed to constitute any part of the disease. Thus a violent flash of lightning, the fumes of charcoal or of burning sulphur cause immediate death or suffocation, without

* Dissertation on suspended Respiration. p. 138.

extinguishing animal heat, which rather increases, and continues several hours.

The lungs, after the last expiration, contain a quantity of air, and instead of suffering a *collapse*, are often found considerably *distended* after death. The same is observed in animals that die under the exhausted receiver of an air-pump, which probably happens in the act of inspiration. Be this as it may, a collapsed state of the lungs, upon which such stress has been laid, should it ever occur, cannot be the immediate cause of death, but rather the effect of a certain mode of dying.

26. Others imagine the question admits of a very simple and easy solution, and therefore without hesitation pronounce the proximate cause of death (in the cases under consideration) to be nothing more than a mere *stoppage of respiration*. But they seem to forget that the effect ought immediately to follow the cause, as the shadow does the substance. Were their position true, persons in a state of syncope or apparent death would be utterly irrecoverable, and torpid animals could never be roused into action. Not to mention that in the Pearl Fisheries expert divers are known to remain 12 or 14 minutes under water without breathing.

27. It appears from what has been observed, that the effects of the various kinds of suffocation are so

very fimilar, that they may be confidered as dependent on the fame caufe, viz. the privation of vital air (22). This animating fluid, derived from the atmosphere, being proved effential to refpiration (13, 14), and refpiration to life (19), leads us to trace the following chain of caufes and effects, which in the act of drowning or fuffocation of neceffity follow each other in rapid fucceffion.

No fooner is the vital air excluded, than refpiration is fufpended; refpiration being fufpended, the paffage of the blood through the lungs is intercepted, and of courfe through the whole fyftem. The action of the heart being impeded by the fame caufe, the circulation is fuppreffed. The brain, unfupported by the circulation, being unable to exert its influence, the mental and corporeal actions ceafe, and the mind is no longer confcious of the ftate of the body. The blood being deprived of its power of generating heat, a coldnefs diffufes itfelf over the fyftem. Unlefs aid be now properly adminiftered, the principle of irritability gradually forfakes the fibres, firft in the extreme parts, afterwards in the heart itfelf, when the animal dies.

28. From an attentive confideration of the various phenomena thus brought into a fmall compafs, the order in which they fucceed one another, and the effects which enfue (27); does it not appear evident that, in thefe different fpecies of fuffocation,

the

the EXCLUSION of VITAL AIR from the lungs is the primary cause of suspended respiration, and that suspended respiration is the immediate cause of the suspension of the other vital actions? But since vital action may be suspended by various causes without being extinguished, it is now well known that persons, labouring under such a state of suspension, may often yet be recovered by renewing the action. Such a critical situation, however, may not improperly be considered as an intermediate step between life and death. If to this succeeds the EXTINCTION of IRRITABILITY, or of that oscillatory principle (whatever it may be) which renders the heart and muscular fibres SUSCEPTIBLE OF STIMULUS, it constitutes the PROXIMATE CAUSE OF DEATH.

This law of Nature, which extends to every living creature, is immutably fixed by the CREATOR, otherwise Man might presumptuously arrogate to himself the power of raising the dead, and dispensing even immortality.

29. It were therefore to be wished, that the terms *re-animation*, *re-suscitation*, *re-vivification*, &c. which are now become so familiar, but which to superficial readers may seem strongly to imply the act of *resurrection*, were either laid aside, or explained under due restriction. To restore a person from a temporary suspension of vital action, is within the

province of the Physician: But to restore life, after it has entirely vanished, is an act of OMNIPOTENCE, and belongs ONLY to HIM, who gave it. The former is merely to re-kindle the flame of a taper, by gently fanning the ignited wick: the latter, to re-animate a corpse, after the vital spark is totally extinct.

As absolute death consists in a total cessation of all the vital and animal functions, with an entire loss of irritability; so apparent death, in the various kinds of suffocation commonly termed *asphyxia*, may be defined A TEMPORARY SUSPENSION OF THE VITAL MOTIONS, IN CONSEQUENCE OF THE PRIVATION OF VITAL AIR ESSENTIALLY NECESSARY TO RESPIRATION.

If this idea of the nature of the disease be just, it will enable us to unfold the principal symptoms, and to point out the most rational method of cure.

30. From the effects of vital air, in supporting respiration; in giving a florid colour to the blood; and in generating heat (13—19); we learn why in suspended respiration, the lungs cease to expand, the heart to contract, the arteries to vibrate, and finally why the machine, though sound and entire in all its parts, yet, on a sudden, like a clock whose pendulum is stopped, remains entirely at rest. In the latter, if we move but the pendulum, the wheels are immediately put in motion, and the clock
again

again correctly marks its hours and minutes as before: so likewise in the animal machine, (for such is the harmonious consent of parts) that if motion can but be renewed in one of the principal organs, it is directly communicated to the next, and from thence, to all the rest.

Thus if the lungs respire, the heart recovers its action, the brain its energy, the nerves their sensibility: the grand obstacle once removed, the subordinate springs of life presently resume their respective movements.

From the privation of vital air in drowning, we can now explain why the blood grows dark, the lips and countenance livid, and why the body loses its native heat; since, by renewing respiration, circulation is renewed, and the blood, having regained what it had lately lost, all these symptoms soon disappear. But such is the importance of vital air to organic life, that its effects deserve yet further investigation,



S E C T. X.

VITAL AIR—*Its extensive Influence in the Animal Œconomy—Whether the Source of Irritability, in all organized bodies.*

30. Though Vital air appears to have been first discovered by the sagacious Dr. Mayow, about the middle of last century; and though he described some of its most curious properties, yet the subject was unaccountably suffered to pass into oblivion, till lately that it was fortunately revived by Dr. Priestley and others. From their observations, respecting its effects on the blood and respiration, I was led to consider it as the CAUSE of irritability, the PRINCIPAL AGENT in the animal œconomy, and therefore ventured, at an early period, to throw out some HINTS towards expediting its application to medicine, and more particularly to the theory of Animation. The idea at length, being adopted by others, has of late been offered as entirely *new*! Be this as it may, since Vital air has been prosecuted with such uncommon ardor, it has given birth to some of the most brilliant discoveries which shed lustre on the present æra. From which, we are now enabled, not only to unfold the theory of respiration and animal heat, but

but also to explain many other curious phenomena both in health and disease. Among these, the following problems, which, many years ago, I proposed under the form of queries, appeared to me to rest wholly on the properties of vital air.* Whether even at the present advanced period of science, they will admit of a more satisfactory solution on any other principle, is submitted to the discerning Reader.

1st. Why the new-born infant, by unerring instinct, is taught to breathe within a few minutes after its birth, otherwise it dies. And why, having once drawn in the vital air, it is ever after under a necessity of continuing that process to the last moment of life.

2^{ly}. Why the subtile fluid acquired by the lungs is perpetually consuming by vital action, and demands perpetual renovation from the external atmosphere.

3^{ly}. Why the lungs may be considered as a pneumatic engine, with which the blood requires to be incessantly fanned: and why, if this operation be suppressed only a few minutes, the animating principle, like an expiring taper, fades, languishes, and becomes extinct.

4^{ly}. Why an animal, after its wind-pipe is divided,

* Hints on Animation, p. 122.—Printed for Doddsley, 1783.

vided, and the contents of the chest laid open to view, may be kept alive several hours by inflating the lungs with air. And why the appearance of alternately living and dying may be thus exhibited during the interval, by repeating and occasionally suspending the operation. Also, Why, in cases of drowning and suffocation, inflating the lungs with pure air is of the first importance in restoring animation.

5^{ly}. As the purity of the atmosphere, the florid colour of the blood, and the vigour of the system depend chiefly on vital air; and since vital air is moreover the basis of one of the most striking primary colours, viz. red—in all its beautiful tints—we may easily explain the following circumstances.

Why, in sudden faintings, the speedy removal of the patient into the open air affords such immediate relief.

Why an open country or sequestered village is more salubrious than a large town or populous city.

Why the inhabitants of the former, who enjoy ventilation, and breathe pure mountain air, appear with lively and ruddy countenances; while those, who reside in the latter, and respire the vitiated air of crowded rooms, look pale and sickly.

6^{ly}. Why in certain diseases, where respiration is extremely laborious, and the blood in consequence imperfectly oxygenated, as in asthma and dropsy of the chest, the countenance wears a livid aspect.

7^{ly}. Whether

7^{ly}. Whether a defect of vital air in the system, as in cases of sea-scurvy and malignant fevers, may not explain why petechiæ or livid spots appear on the skin.

Also, whether the different shades from purple to black, which the parts assume in the blood-shot eye, in contusion, in mortification, and finally in those purple marks with which children are often born, and though commonly attributed to the longings of the mother, may not more probably proceed from the same cause, viz. a partial or imperfect oxygenation of the blood.

8^{ly}. Whether it be not an excess of vital air, on the contrary, which often heightens the complexion to a crimson or scarlet dye, as in the exacerbation of hectic or inflammatory fevers.

9^{ly}. Lastly, whether this principle, which reddens the blood and tinges the cheek of beauty, is not probably the same which diffuses elegant shades of the same colour over a considerable part of the vegetable creation—which blooms in the rose, the tulip, and the carnation; which glows in the western sky; and which adds even colour to the calces of metals, as in red lead, cinnabar of antimony, vermilion, &c. But to return; —

31. It is observable, that the motion of the heart not only survives that of the organs of voluntary motion, but continues a considerable time after

after it is separated from the body. Nay, after it has even ceased to palpitate, yet as it still retains a latent power of contraction, its systole and diastole may, by the application of heat and other stimuli, be alternately renewed and continued some time longer.

Hence it would appear, that in drowning or suffocation, though the pulse be imperceptible, and life apparently extinguished, yet the heart still preserves this latent power or susceptibility of motion, longer than is commonly imagined; for though unable to propel the blood through the vascular system, yet it wants only to be gently excited by suitable stimuli adapted to renew its action, without exhausting its power. Hence may be understood the numerous instances of recovery from apparent death by means that, at first view, would seem wholly inadequate to the effect.

Therefore, though the voluntary motions are governed by the brain, through the intervention of the nerves, the involuntary organs seem to be actuated by the irritable principle independent of the brain: or in other words, sensibility and irritability, though often confounded, are evidently distinct in their nature and in their origin. The former depends wholly on the nerves, the latter is a property peculiar to muscles. Some parts of the body are very irritable, though but slightly sensible. The nerves themselves are acutely sensible, but not irritable. In

In the first rudiments of the chick, at an early period of incubation, and before the brain or nerves are visible, the *punctum saliens* points out the embryo heart in miniature, and marks its primæval irritability as a sure presage of vitality. As this singular organ thus exhibits irritability the first, so it never relinquishes it till the last, and may therefore be considered as the *primum movens* and *ultimum moriens* of the animal machine. Could we trace the origin of its motion to its true source, we might perhaps be enabled to renew its action with more certainty when accidentally suspended, and throw new light on the theory of animation.

Haller and other anatomists agree, that the heart has very few nerves in its internal substance, but M. Behrends even denies that it has any, except a few small twigs, which wholly terminate in the coronary vessels. These nerves, adds he, or those of the spinal marrow being irritated, disturb not its motion, neither does the application of opium. In apoplexy, all the functions depending on the nerves are suspended, but not the motion of the heart. That it has very little sensibility is evident from this, that when pierced with a sword, or otherwise injured, a sense of faintness ensues, but scarcely any pain. Probably its action is entirely owing to the stimulus of the blood applied to the irritable power. It does not like
other

other muscles become weary by incessant motion, neither does it become less irritable to the blood, by the daily repetition of the stimulus, any more than the eye does to light, the ear to sound, the stomach to the gastric juice, or the intestines to bile. Though its irritability remains when the nerves are destroyed, yet its action then, cannot be so easily renewed as that of other muscles, by means of animal electricity.

If irritability then actuates the heart and vital organs independent of the nerves, it accounts why the involuntary motions which are concerned in circulation, nutrition, secretion, digestion, the healing of wounds, and regeneration of parts, are carried on as well during sleep as in our waking hours. This independent action is ingeniously explained by the learned Dr. Johnstone, on the supposition that the nervous ganglion performs the office of a separate brain or sensorium. This principle, when once established, may lead to future discoveries. Every muscle and, probably, every fibre of a muscle possesses a determinate portion of irritability necessary to its natural tone. The presence of a stimulus applied to the irritable fibre excites an oscillatory motion, the result of which is vital action.

The blood and animal fluids are the natural stimuli, destined to support vital action, and at the same time to draw off a certain proportionate quantity of irritability. If the natural stimuli are
deficient,

deficient, irritability will be increased; if too powerful, diminished. Irritability is daily replenished by the lungs, and alternately consumed by vital action, the surplus therefore and no more ought to be carried off by stimuli. Hence the irritable fibre is never passive, but in a constant state of action; and vitality, as has been already hinted, consists in action and reaction between the vital organs and their respective stimuli.

The periodical motions in organized bodies, the return of the cold and hot fit in agues, and the remissions and exacerbations in other acute diseases seem to depend on the alternate diminution and accumulation of irritability. On the same principle, probably, may be explained the hysteric and epileptic paroxysm, and other remarkable phenomena in diseases.

In regulating these, and other inordinate motions, by nicely adjusting the natural and artificial stimuli to the exact tone of the irritable fibre, consists the GRAND SECRET in the art of healing. Stimulating medicines are said to excite irritability, sedatives to depress it. How?—Why only by altering the equilibrium. Thus heat and light act as stimuli, by drawing off irritability; cold and darkness, as sedatives, because, though only negative qualities, they tend to accumulate it.

Thus wine, spirits, opium, and other active remedies are stimulants, because applied in a cer-

tain moderate degree, they excite irritability; but carried to excess, they exhaust it, and become sedatives. To this principle perhaps may be referred, the action of some of the most deadly poisons, such as the laurel-water and American *Ticunas*, which almost instantly exhaust irritability; and the moment irritability is exhausted, the animal ceases to live.

The principle of irritability seems stronger in the lowest order of animals than in Man, who far surpasses every other animal in point of intellect. In proportion as the vital power prevails, the intellectual power is deficient, and irritability is made to compensate for the want of sagacity. Thus the Polype, though destitute of brain and nerves, and more simple in its structure than, perhaps, any other organized being, possesses a power, which almost renders it proof against external injury. Even the cutting it into sundry pieces serves only to quicken its faculty of reproduction, for it soon regenerates its scattered limbs, and multiplies itself into so many different polypi—A wise provision of Nature for the preservation of life, and perpetuation of the species, even in the meanest of her creatures! In superior animals, according to the degree of instinct or sagacity which they possess of guarding against injury, irritability diminishes, and *vice versa*. Hence in infancy, where the intellectual power is weakest,

irritability

irritability is greatest; and as the former advances, the latter decreases.

As irritability co-exists with animal heat, and keeps pace with it through life, it probably proceeds from a similar cause. But animal heat has already been shewn to depend on vital air, for without vital air no heat can be generated (13—19).* May not vital air then, so essential to heat, be considered as the PROXIMATE CAUSE OF IRRITABILITY, agreeably to what I have hinted in a former Essay?—HINTS on Animation. p. 122.

Admitting this, we can better account for the following circumstances.

1st. Why irritability in a state of excitation may be deemed the principle of life.

2^{ly}. Why irritability is increased by breathing pure vital air.

3^{ly}. Why noxious air, by destroying irritability, and depriving the muscles of vital air, kills an animal sooner than other modes of suffocation.

4^{ly}. Why the heart, being stimulated with blood that has just received oxygen in its passage through

* It has lately indeed been alleged by M. Deciman and others, that flame may be excited, without the intervention of vital air, by a mixture of sulphur with filings of copper or any of the other imperfect metals. Also that inflammable air contains more *calorique* than even vital air; and hence if heat be evolved, no matter from what substance, it still produces the above effect.—True—but the fact must be incontrovertibly proved before we can admit the conclusion.

the lungs, possesses more heat and irritability than any other muscle in the body.

5^{ly}. Why its right cavity, containing a greater quantity of heat evolved in a sensible form, is more irritable than the left, which receives it in a latent state. And, consequently, why the vital motion of the right survives that of the left.

6^{ly}. Why the calces of metals, in consequence of the vital air which they imbibe during calcination or solution in mineral acids, become far more active medicines than the metals themselves. Hence the extraordinary power which calcined mercury, corrosive sublimate, red precipitate, and lunar caustic, though applied in very minute quantity, are found to exert on the irritable fibres.

7^{ly}. Finally, Why vital air promises to afford the most effectual antidote against the baleful effects of mephitic vapours, putrid animal effluvia, and other species of noxious air, which suddenly extinguish human life.



S E C T. XI.

Phenomena of the Brain and Nerves—Laws of Organic Life, observable in the Animal and even Vegetable Œconomy.

32. From the result of various experiments, it seems evident, that the nerves are the instruments of sense and motion, or the conductors of some subtile agent, by the intervention of which, a reciprocal intercourse is carried on between the brain, and all the other parts of the nervous system.

2^{ly}. That the brain, moreover, is the organ of sensation, volition, and all the intellectual faculties; and may therefore be considered, as the *sensorium* or storehouse of ideas.

3^{ly}. That the Sentient immaterial principle is so intimately connected with the brain and nerves, that motions excited in them give birth to correspondent sensations, and these in their turn produce new motions in the organs to which they are transmitted.

4^{ly}. That the mechanism of the brain, however, is not the immediate cause of mental operations, only the instrument by which the SENTIENT PRINCIPLE is destined to perform its offices through a corporeal organ; and that the nature

of this connection, between *mind* and *matter*, is wholly unknown.

5^{ly}. That sensation arises from the impulse of bodies on the sentient extremities of the nerves. That sensation produces volition, and volition determines the action of the muscles.

6^{ly}. That the action of the brain, in performing voluntary motion, is excited by the will, according as this is determined by various appetites and propensities, and particularly by vehement acts of volition, termed passions; without the brain however being conscious of the motions excited, much less of the organs employed. Hence (2—6) the mechanism of the brain, unless united with a Sentient principle, would be wholly inadequate to its functions (2).

7^{ly}. That the action of the brain is influenced by habit, which associates motions with sensations independent of each other, so that the renewal of the sensation, or even its idea, renews also the motion.

8^{ly}. That the sympathy of parts does not depend on contiguity, or mere connection of nerves, but on the impression being transmitted through the brain to the sympathizing organ.

9^{ly}. That the action of the brain is subject to alternate states of rest and activity, as in sleep and waking. That, in the former, the animal functions cease, while the vital functions continue.

10^{ly}. That

10^{ly}. That the action of the brain undergoes a still greater degree of suspension in the asphyxia, wherein the vital functions cease, and the circulation is suspended, but may still be revived while the vital organs remain susceptible of stimuli (9).

11^{ly}. That the sensibility of the system depends on the different degrees of excitement of the brain, and of the sentient extremities of the nerves. That excessive excitement occasions a derangement of the brain, as in phrensy and insanity. That a diminution of the natural excitement produces a partial suspension of its functions, as in torpor and lethargy.

12^{ly}. That the sensibility of the system is increased by heat, and diminished by cold; and is moreover affected by all those circumstances which affect irritability (31). Both these principles can be excited by stimuli applied either to the muscles themselves, or to the nerves connected with them. Both can subsist about the same length of time, without any connection with the brain, and also in the entire body sometime after life has apparently ceased. Both, however, in the living state, are subservient to the SENTIENT PRINCIPLE (1—2).

13^{ly}. The effects in both cases being so similar, (32), some physiologists have been led to conclude that the constituent matter of the nerves, and muscular fibres is also similar, viz. a continuation of the medullary substance of the brain. And

that the contractile power of the latter, not found in the former, may depend on peculiar arrangement, or organization, and yet the active principle or moving power be still the same in both.

Though this opinion has been adopted and ably supported by that eminent philosopher Dr. Cullen, yet it seems liable to some weighty objections, since we know that the vegetable tribes though destitute of brain and nerves, are yet endowed with irritability, (and as some imagine) a perceptive faculty; otherwise it may be demanded whence proceeds the apparent passion of love, which visibly actuates these vegetating amourets at the season of impregnation, as beautifully illustrated by the ingenious Dr. Darwin? * Why are they susceptible of the stimulus of heat and light? Why do they alternately sleep and wake at stated hours, and invariably turn towards the sun? Why, if confined in a dark room, do they languish, and search for any crevice, as it were, to escape, and to expand their foliage to the solar rays? Why do the voluntary motions of the moving plant continue during the presence of day, and regularly cease on the sun's departure? Why does the sensitive plant shrink from the slightest touch, and droop its leaves according to the degree of stimu-

* See his elegant description of the *LOVES* of the *PLANTS*—*passim*.

lus? Why does the *Dionæa Muscipula*, when irritated by intruding insects, first entrap them, and then deliberately squeeze them to death?

These extraordinary movements and periodical revolutions of plants, certainly are not merely mechanical, neither can they fairly be attributed to a *real* perceptive faculty, which implies intellect; but more probably proceed from irritability, which imparts to every living thing a powerful tendency towards self-preservation. Hence the motion of their sap, their nutrition, perspiration, and singular power of regeneration from slips, or cuttings.

If the forked branch of an apple-tree be ingrafted, at its superior points, into the neighbouring branches of two crab-trees, they support it (though apparently suspended in the air) by a friendly infusculation, till at length they behold their foster plant waving its fruit and foliage over their heads.

“Miranturque novas frondes, et non sua poma.”

“Life,” says the Bishop of Landaff, “belongs alike to both the animal and vegetable kingdom, and in each of them it seems to depend on the same principle.” By which must be understood the principle of irritability. Thus if we stop the motion of the fluids in an animal limb by a strong ligature, it mortifies below the ligature, and drops off. A branch of a tree, under like circumstances,

ces,

ces, withers and decays. Both animals and vegetables suffer from the extremes of heat and cold—from repletion and from inanition.—Both are strengthened by air and motion—Both are liable to contract disease by infection—Both can suffer amputation, without being deprived of life—and both, in a similar way, form a *callus*.

Plants not only respire air by their leaves, which amply supply the place of lungs, but also possess the property of decomposing water, and secreting the vital air, one of the component parts of that fluid; while the other, the inflammable air, serves for their nutrition. Hence the vital air, which they so plentifully perspire during the presence of the sun, and the noxious air, which they exhale (though in much smaller proportion) during the night.

Hence the vegetable kingdom, together with the sun, and the waters of the ocean, conspire to replenish the atmosphere with vital air, so necessary to every living creature. Otherwise the daily waste of that fluid, occasioned by innumerable breathing animals, by combustion, by putrefaction, and other causes of its expenditure, could never be supplied.

From the irksome effects of continued darkness, independent of temperature, both on men and plants, and from the enlivening effects of bright sunshine in evolving vital air, we learn why light
is

is no less essential to animal than vegetable life : Why a sense of languor or oppression is generally felt during the darkness of a thunder-storm : Why the presence of the great luminary of day gladdens all nature : why a general gloom and melancholy overspreads the creation when he suddenly withdraws his animating beams, or undergoes a total eclipse : Why confinement in dungeons, independent of dampness, is so injurious to the health of prisoners : and why the meaner sort of houses in this country, since they have been darkened in consequence of the heavy window tax, have been observed to exhibit a race of more pale and sickly inhabitants.* Finally, why the gloomy chambers of the sick are rendered more unwholesome, and acquire additional horrors, by indiscriminately shutting out the cheerful beams of day : and why the malignancy of contagious fevers is often increased, by thus imprudently depriving the patient of one of the most exhilarating cordials in Nature.

It is curious to observe how the animal and vegetable tribes mutually support each other, through their whole existence. Vegetables purify the air

* This fact was repeatedly remarked, in his different journeys, by Mr. Howard, the benevolent inspector of prisons ; though he does not appear to have been acquainted with the properties of light as connected with vital air, the knowledge of which might have pointed out many important improvements in addition to those which he has proposed.

for the use of animals, while the impure air expired by animals affords nourishment to vegetables. It is no less observable, that the common air which preserves organized bodies during life, destroys them after death, by promoting putrefaction, and by converting them into food for a fresh succession of vegetables, which, in their turn, yield sustenance to a succeeding race of animals.

In the living state, the vital power resists this action of the air, but when life is extinct, both animals and vegetables yield to the general law which hastens their decay, because dead substances would only encumber the creation; whereas by speedy dissolution, the elementary particles of matter become fit to assume new forms, and undergo new combinations in the scale of existence.

With what ADMIRABLE ŒCONOMY has the SUPREME ARCHITECT established this reciprocal intercourse between the animal and vegetable kingdoms, for the benefit of Man! By what ELEGANT SIMPLICITY OF DESIGN are the different parts of Nature thus rendered at once subservient to the mutual support of each other respectively, and to the general well-being and harmony of the Whole!

33. Having endeavoured to explain animal heat and irritability, and traced their origin to vital air, we should next proceed to account for

SENSIBILITY

SENSIBILITY and voluntary motion, or that cause (whatever it is) that actuates the brain and nervous system. But as this has hitherto baffled every research, it is with extreme diffidence that we now hazard even a conjecture concerning it.

Nature, ever uniform in her works, produces her most important operations by the simplest means; we must therefore beware of multiplying unnecessary causes.

The nervous influence, or, as Dr. Darwin elegantly expresses it, the Spirit of Animation, cannot be a secreted fluid, since the brain is no longer allowed by anatomists to be a secretory organ.

Neither can its origin be proved to be coæval with the unformed rudiments of the embryo, when the "*dim speck of entity*" first becomes visible, for then no vestige of brain or nerves can be discerned.

Must it not be referred then to vital air or spirit of the atmosphere, emphatically termed in the Sacred Page, the "*BREATH OF LIFE,*" and by ancient philosophers, "*Divinæ particula auræ,*" drawn into the lungs at the first effort of respiration? Is this received in form of heat, light, or electricity? Or, to speak more philosophically, is it that subtile fluid, which fills universal space; pervades all bodies; and actuates every particle of matter; of which, heat, light, and electricity are only effects, or different modifications of the same cause? That

That the principle of heat and electricity bear a striking analogy to each other, is evident from various circumstances. Thus, both originate in the atmosphere—Both enter the composition of bodies in a latent state—Both may be excited by attrition, and assume the form of light, as well as of sensible heat—Both strive to preserve an equilibrium—Both are capable of pervading the densest bodies, and of melting metals—Both promote the evaporation of fluids—Both accompany lightning, fiery meteors, and volcanic eruptions.—Bodies, which are the best conductors of electricity, are also the best conductors of heat—Both act on the irritable parts of plants and animals—Finally, both excite muscular action, and increase the sensibility of the nervous system.

They differ, however, very materially in some respects.

Heat diffuses itself equally to all surrounding bodies—Electricity attaches itself to some particular substances in preference to others.—Heat is communicated slowly—Electricity moves with rapidity.—The effects of the former are progressive—those of the latter instantaneous. The celerity of electricity keeps pace with the celerity of volition, and therefore seems more peculiarly adapted to explain the phenomena of the nervous system. When LOUIS the XVth, from a motive of curiosity, commanded a battalion of 2000 men to stand
hand

hand in hand, and receive the electrical circuit through their bodies, the last man felt the shock, at the same instant with the first. So in the act of volition, the moment the mind wills the hand to be moved, it is moved; but without our being conscious of the manner *how*; because it was not necessary we should know it was done by the mind directing the nervous influence into the moving fibres of the part.

As the mind governs the body, it evidently employs the nerves to execute its commissions, and to transmit its various impressions from the brain to the extremities, and back from the extremities to the brain. To complete this chain of connection between mind and matter, it was necessary the nerves should convey a fluid medium of extreme mobility, tenuity, and elasticity; in a word, exactly such a one as we now know the electrical fluid to be. Though the nerves are the organs of voluntary motion and sensation, and when stimulated excite the irritable fibres into action, yet have they no motion or irritability of their own, however irritated. Whence they are to be considered as conductors, rather than the active agent, or proximate cause of muscular motion.

That they convey a subtile fluid, which actuates the voluntary organs, seems indisputable; and though the perfect identity between this fluid and that of electricity has not been yet clearly ascertained,

certained, yet the late curious discovery accidentally made by M. Galvani, and since pursued in a course of experiments by M. Valli, seems to confirm it, and also to bid fair to throw new light upon this intricate subject. The result of their researches, being published, need not here to be repeated.

If there be any deception, in this otherwise remarkable discovery, that may have imposed on these ingenious foreigners, it must depend on the facility with which ordinary electricity may under certain circumstances be excited. Mere motion of non-conducting bodies, without any apparent friction, is alone sufficient to disturb the equilibrium, and produce electrical phenomena—A circumstance to which philosophers ought to be very attentive in repeating the experiments, before they can draw any positive conclusions.

That certain animals, however, possess a power similar to electricity in every respect, except that of yielding visible sparks, is evident from the effects of the torpedo, and electrical eel. In the structure of these warlike fishes, has been discovered a curious electrical apparatus, over which they have complete command, and from which, in all directions, they can at pleasure deal out powerful electrical shocks. Thus armed at all points, they are prepared to act on the offensive or defensive—to attack their prey, or to repel an enemy, as occasion may require.

34. Let us suppose then that the nervous system, like the electrophorus, when once charged with positive and negative electricity, will continue, on being approached by a conductor, to exhibit electrical phenomena. That, moreover, this animal electricity, when actuated by the mind, will excite the muscles to perform voluntary motions, correspondent to the act of volition.

That, whenever the equilibrium between the positive and negative electricity is disturbed by the contact or impulse of external bodies, applied to the organs of sense, it will transmit the impression to the sensorium, when the mind will instantly return a faithful idea of the sensation thus excited.

When the nerve belonging to any muscle is divided, this intercourse is cut off, and the muscle becomes motionless; but if the wounded part is armed artificially with a conductor of electricity, the communication is restored, and the muscle renews its contractions. All which has been verified by experiment, not only on amputated limbs, but separate muscles.

35. Let us next suppose that, the nervous electricity, like the principle of irritability, is subject to 3 different states, viz. accumulation, diminution, and tone.

If the natural stimuli are defective, it will be accumulated; if too powerful, or too long continued, it will be proportionably diminished. If a due medium is preserved, it will constitute tone, or harmony of the nervous system.

As the nervous influence is liable to be dissipated by acts of volition, cogitation, and association, as well as by external stimuli applied to the organs of sense; it will require to be daily replenished from the atmosphere, and the surplus only, to be carried off. Hence the necessity of alternate action and repose, to preserve the balance of health; and these will be more or less perfect, according as the equilibrium of the nervous influence is kept more or less entire. As respiration continues during sleep, while all the voluntary motions cease, this fluid must, during that period, be considerably accumulated. Hence may be explained the languor and fatigue occasioned by severe exertions of body and mind, or long watching. Hence the new vigour and alacrity experienced by the weary traveller, from the balmy rest of a single night's repose.

Admitting the analogy, if not perfect identity between the nervous fluid, and that of electricity, may we not infer, that different degrees of excitement will produce different degrees of sensibility? That every excess or diminution of excitement, beyond what is natural to the age and constitution,

on, will cause a proportionate deviation from the equilibrium requisite to health, and consequently terminate in disease? Hence the acute sensibility of youth, and the torpid state of old age. Hence too, the different degrees which mark the temperaments of individuals, through all the stages of life.

From excessive excitement may be explained why in certain diseases of the nerves, the organs of sense become impatient of their wonted stimuli, why light becomes painful to the eye, and sound to the ear.

Why in gout, or other nervous affections, persons are so susceptible of every sudden change of weather. And why, in such hasty transitions, particularly in thunder-storms and tempests, they feel tinglings in the flesh or shooting pains, like electrical vibrations, through different parts of the body; which, though attributed to heat or cold, more probably depend on the equilibrium of the atmospheric electricity being suddenly disturbed.

Why in the hysteric and epileptic paroxysm, where the nervous influence is violently excited in particular parts, or the equilibrium between the positive and negative electricity suddenly destroyed, particular muscles are strongly convulsed, and the limbs thrown into dreadful contortions. Why a total loss of excitement in the paralytic arm oc-

cautions an accumulation in the opposite one, and forces it into more frequent and un-usual motion.

Why in vehement passions of mind, the eyes present phenomena, perhaps, not easy to be explained on any other principle than that of sympathy dependent on nervous electricity. Whence otherwise, shall we account for that fascinating power of the eye, in expressing the various emotions of the soul?

Why, according to the degree of excitement, and the nature of the passion, the human eye is equally calculated to beam with benign radiance, or to flash with indignant lightning? Hence the impassioned eye is seen to sparkle with joy—to glisten with pity—to shed tears in grief. Hence the language of the eyes is universally understood even by illiterate people of all nations, and is allowed by lovers to be far more eloquent than that of speech. Hence those brilliant emanations darted from their eyes, when their bosom glows with intense passion. Hence those fiery scintillations, when it is inflamed with jealousy, or burns with inexorable rage.

From the same principle, may likewise be explained, why sudden horror occasions the hairs of the head to stand on end, as if powerfully excited by an electrical conductor. Why anger produces the same effect, on the quills of an incensed porcupine.

Why

Why medical electricity is found to be so powerful in exciting the energy of the nerves, as to force the paralytic limb into involuntary motion; and to renew action, in vital suspension, longer than any other stimulus hitherto discovered.

Hence its utility in the cure of nervous diseases, especially where sensibility is greatly diminished.

Hence, likewise, the reason why friction with the hand, or a flesh-brush, by exciting the nervous electricity, rather than by mere exercise, contributes to the cure of similar affections.

36. Now how far this theory, which at present, is only offered as a probable hypothesis, shall be found more consonant to the laws of the œconomy, in explaining the phenomena of the nervous system, than those of preceding writers, must be left to future inquiry.

Meanwhile, whether the mysterious agent, which is the proximate cause of sensibility, consists in ordinary electricity, or some other modification of that ætherial fluid which pervades the universe (by whatever name it may be distinguished), matters little; provided it is found to be a constant principle in the nervous system, and perfectly adequate to the effect. The facts, in either case, remain the same, and it would be fruitless to dispute about words.

Having, upwards of twelve years ago, entertained

tained nearly the same idea on this subject, it naturally led me to the following conclusion, viz. that irritability *immediately* depended on vital air; but the nervous influence; on electricity. Upon which foundation, a new system of late has been hastily erected, though with profound silence, but so greatly encumbered with superfluous grotesque ornaments, as to injure the simplicity of the original design, if not endanger the whole superstructure. My further inferences were these, viz. "The popular idea, that life quits the body, in an aerial form, at the instant respiration ceases, appears to be erroneous."

"That, on the contrary, the principle of irritability, being an innate property of the living solids, maintains its residence in the vital organs, a considerable time after motion and sensation have ceased."

"That the principle of sensibility or nervous influence, like that of ELECTRICITY, to which it bears such a *striking affinity*, often remains in a dormant state, without betraying the smallest sign of its presence, till it happens to be roused by the proper modes of *excitation*." *

The doctrine, therefore, of Nervous Electricity, which of late has fixed the attention of the Philosophical World, and which Dr. Galvani's discovery undoubtedly tends to illustrate, is not so perfectly *new* as is generally imagined. SEC-

* Hints on Animation, &c. by A. F. in 1783.

S E C T. XII.

PROGNOSTIC *in Vital Suspension*—CAUSES which influence Recovery—SIGNS of the Presence of Vitality—Of its total Abolition.

37. Amongst the various casualties to which we are particularly exposed, in this our insular situation, bounded by the ocean, and intersected with numerous rivers, and navigable canals; it is no wonder, that those from drowning are far the most numerous.

In persons ignorant of the art of diving, drowning is, perhaps, generally effected in less than 10 minutes submerision. To which, however, the accounts delivered to the Society seem to afford many exceptions. Accordingly we find some are said to have been restored from drowning, after 20, 30, nay 45 minutes! * This last is the only

* But what is even this, when compared with the miraculous instances recorded by certain grave historians, who re-count recoveries of this nature, not by minutes or hours, but by days or entire weeks? Kunckel, having related many examples of this sort, adds, “that in Sweden no one doubts the possibility of retaining life under water, for the space of 8 days”! Burmann, not to be behind-hand with him, retails the case of a man, who continued under water 7 weeks, notwithstanding which he not only recovered, but enjoyed health many years after!! Such examples of the marvellous seem not unworthy the inventive genius of the author of Baron Munchausen’s unparalleled adventures!

only instance of recovery after such long submer-
 sion, out of upwards of 600 successful cases.
 Nor is it difficult to conceive how it happened, as
 the man was observed to float on the surface of
 the water, the greatest part of the time; and con-
 sequently might respire air at intervals. But why
 some of the rest survived 20 or 30 minutes, while
 others were irrecoverably drowned in less than
 3, no circumstance is mentioned sufficient to
 account for such a striking difference in the
 event!

38. From what has been remarked, however,
 concerning the effects of drowning (1-5), and other
 modes of suffocation (6-7-10), it seems evi-
 dent, that whatever previously injures respiration
 (13-18), or diminishes the natural heat (19-21),
 the irritability (30-31), or sensibility of the sys-
 tem (32), must not only hasten on a suspension of
 the vital powers (29), but also retard recovery.

Hence it is easily understood, why the follow-
 ing circumstances must be considered as very un-
 favorable, in the article of drowning.

1. A plethoric, asthmatic, or hectic habit. 2. In-
 tense cold, or submerision under ice. 3. Water
 imbibed into the lungs. 4. Intoxication. 5. Ti-
 midity. 6. Horror.

This last, probably, surpasses all the rest, for
 when extreme terror seizes a poor timid sufferer,
 destitute

destitute of presence of mind, the terrific idea at once arrests the principle of life, and instantly cuts off every resource. Hence may be conceived why some perish irrecoverably during the first moments of submerſion.

On the contrary, why a firm habit, ſobriety, fortitude of mind, and a warm ſeaſon may all tend to protract life, and facilitate recovery. If to theſe be added a ſkill in diving, an accidental floating of the body with the face upwards, or above all, the *foramen ovale* remaining open * (as in ſome rare inſtances happens through life), we may account why certain perſons reſiſt the watery element ſo much longer than others. And why a few remarkable eſcapes of this ſort have, in former times, been exaggerated into miracles, and given riſe to the moſt incredible ſtories.

Though our prognos tic, in all ſuch critical caſes, as thoſe of apparent death, muſt ever be doubtful, yet a careful attention to the above circumſtances (37—38), may generally aſſiſt us in forming a tolerable conjecture concerning the probability of ſucceſs.

If the eyes appear clear, the pupils not greatly

* Because the blood, finding this paſſage ſtill open as in the embryo ſtate, paſſes on from the right to the left ſide of the heart, without being obliged to perform its wonted circuit, through the ramifications of the lungs. Hence, it is eaſy to ſee how the circulation may be thus tolerably carried on for ſome time, even after reſpiration is ſuſpended.

dilated,

countenance are, separately considered, infallible tests of its total extinction. Nay, even putrefaction itself, though allowed to be the most unequivocal sign of absolute death, might chance to deceive us in that syncope, which sometimes supervenes the last stage of the confluent small-pox, sea-scurvy, or other highly putrid diseases. Sometimes death is so strongly marked in the visage, as not to be mistaken by the most ordinary spectator: At others, the features remain unaltered many hours after decease, and the countenance wears an aspect of serenity unknown even in health, so as to impose, at first, on the most accurate observer. Hence, it is by no means easy to establish a sure criterion, either of the presence or absence of life. In the latter, however, there is generally observable, a peculiar dimness of the eye resembling semi-transparent glass, accompanied by a flaccidity of the skin, with a peculiar coldness and collapsed appearance of the external parts of the body.—An appearance not easily described in words, though it has often been copied from Nature, and sometimes admirably expressed upon canvass, by certain eminent Painters, as Michael Angelo, Rubens, Titian, &c.

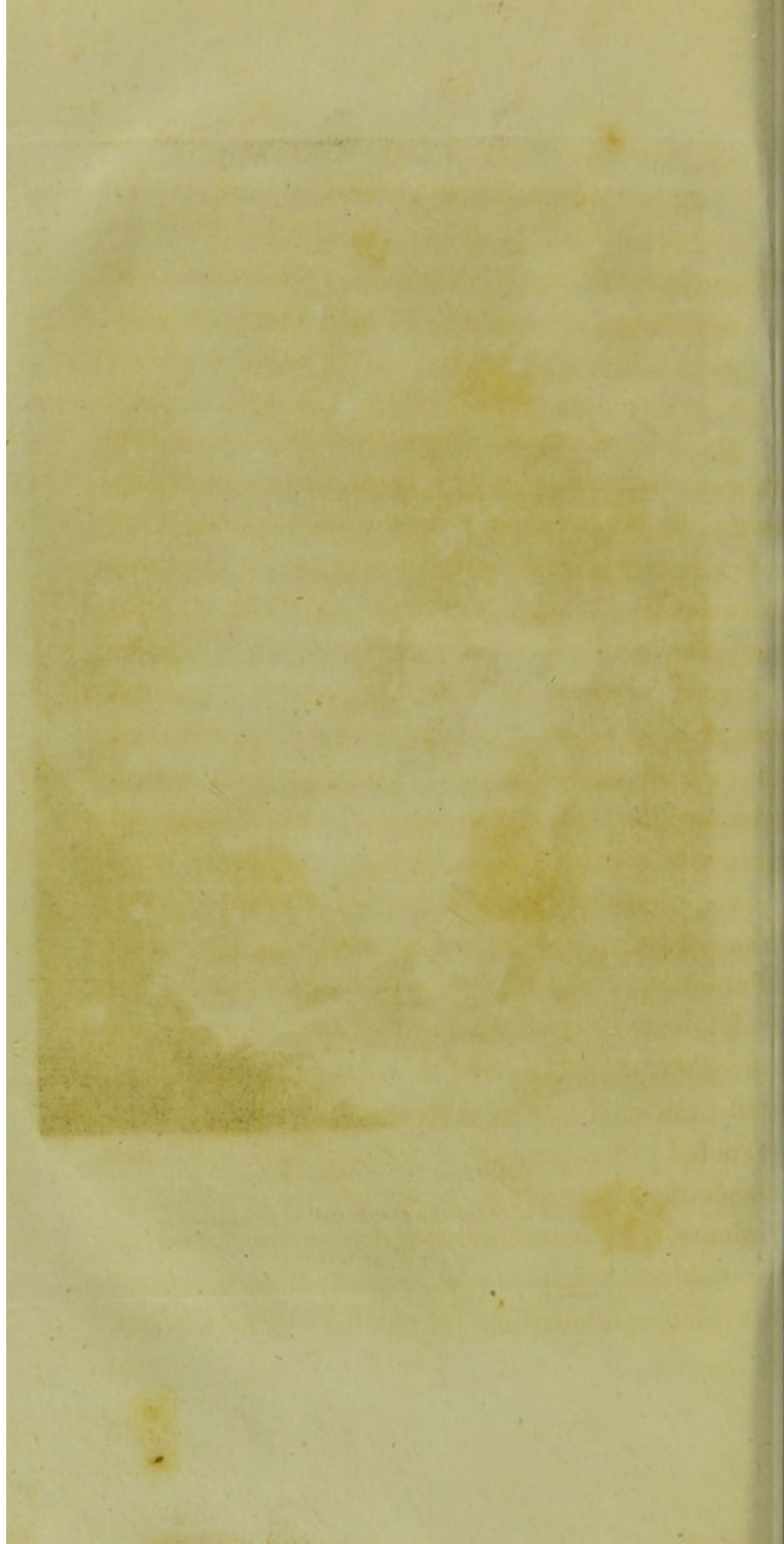




E. Penny del.

J. Corner sc!

Apparent Dissolution.
Engraved from the Original, by Permission
of the Proprietor.



S E C T. XIII.

NATURE'S *Process* in restoring Animation—in the Human Species—in certain dormant Animals.

39. Before we can form a just estimate of the comparative merit of any general mode of treatment, or of the efficacy of the particular remedies of which it consists, we ought to have a previous knowledge of what Nature unassisted by art *can*, or *cannot* perform in restoring animation. To determine which with certainty, would require a multiplicity of experiments, not merely on brutes, but on the human species. But the latter (though the necessary data are wanting) we are by no means authorized to undertake, and hence may justly complain, in the words of the venerable Father of Physic, "*Experimentum difficile!*" The Public, however, is indebted to Mr. Kite for the result of some trials, instituted with this view, on drowned animals. After the strugglings had ceased from the space of 1 minute to 4, if they were exposed to the open air, they soon recovered spontaneously, but seldom, or ever, after the 6th or 7th minute. By imitating natural respiration *alone*, he was able to restore some animals after 8, 10, or 12 minutes submerfion, but candidly acknowledges, that

that this operation, though performed with great attention, often failed; while other animals, that had been immersed longer, recovered spontaneously. He further adds, that if it be not attempted before the convulsive motions of the animal cease, which, on an average of many experiments, happens in about 11 minutes and a half, it will not be sufficient to renew the vital functions.*

Among the human species, however, there are not wanting well-authenticated instances of spontaneous recovery, at an incomparably longer interval, and after every external mark of life had disappeared. Such is the latent energy of the heart, that it sometimes, after remaining several hours quiescent, renews on a sudden the secret springs of life, surmounts the barriers of the resisting blood, and restores circulation with all the other functions. Hence the unexpected recoveries from death-like syncope brought on by sudden terror, or great effusions of blood, even after the funeral obsequies have been prepared. Such, are sometimes the surprising efforts of Nature, in restoring vital action without any visible aid! therefore wholly inimitable by art. But when her own internal resources prove insufficient to repel the danger, she occasionally avails herself of external or adventitious circumstances,

* Memoirs of the Medical Society of London, Vol. 3. p. 297.

and

and these of the simplest kind, such as accidental motion or moderate heat. Hence, some persons have accidentally been brought to life, even after interment, by the rude motion produced in sacrilegious attempts to wrest rings or bracelets from the apparently dead body. Hence, drowned persons, in more than one instance, have been restored by the enlivening rays of a warm sun. Hence too, dormant animals, that remain torpid during the winter, are regularly restored to life and activity, by the genial warmth of spring. The analogy, which obtains between this state of torpor, and apparent death, is so striking, and at the same time so applicable to the present subject, that it seems to deserve more attention than has yet been bestowed upon it. Our readers, it is presumed, will not be displeased with the following entertaining passage from that celebrated Natural Historian M. de Buffon.

“This class of animals,” says he, “are not in a state of natural sleep, as is commonly imagined—they are in a state of torpor, which is produced by the coldness of their blood, by which they lose the use of their limbs and senses. Their internal heat indeed is so small, that it scarcely, at any time, exceeds that of the air; sometimes falls one degree below it. When the temperature of the air is reduced to 11 degrees above
above

above the freezing point, I have repeatedly observed their internal heat near the heart to mark only 10 degrees by the thermometer. There is little reason then to wonder, why these animals so inferior comparatively to others in point of heat, should become torpid, as soon as their own small portion of internal heat ceases to be assisted by the external warmth of the air : a circumstance which naturally happens, when the thermometer is not more than 10 or 11 degrees above congelation. The same extends to all torpid animals, during the winter. Alike are its effects on the dormouse,* the hedge-hog, and the bat. Of this class, the marmot is the most remarkable, which delights in the regions of ice and snow, and is never found but on the highest mountains : it, nevertheless, of all others, is the most liable to be rendered torpid by cold.

These animals, though extremely active in summer, lay up no provision for the winter, because such a precaution would be useless during their dormant state. But when they perceive the first approaches of the season, in which their vital motions are to continue in a great measure suspend-

* In a room, the air of which was at 64, the internal heat of a dormouse which had been asleep, proved in Mr. J. Hunter's experiments equal to 80. But in a temperature of 64, the animal was probably in its natural state of sleep, not torpid : Its heat, while torpid, though beyond that of the marmot, perhaps rarely equals 80 degrees." Phil. Trans. Vol. 68. p. 19.

ed, they close up the apertures of their subterraneous dwellings with such solidity, that it is more easy to open the earth any where else, than where they have closed it. When their retreat is discovered, they are found, each rolled into a ball, and apparently lifeless. In this state, they may be dragged roughly along the ground, or even killed, without their testifying any sense of pain. The blood, un-renovated by fresh chyle, is cold, and entirely without serum: the circulation is, probably, confined to the trunks of the larger vessels.

By a *mild and gradual heat alone*, are they to be recovered from this torpor, and if brought suddenly before a *fire*, they *perish*. A few degrees of heat above the 10th or 11th degree are sufficient to re-animate them; and if they are kept in a warm place during the winter, they do not become torpid, but continue as lively as at any other time. If the marmot remains longer torpid than the dormouse, it is probably, because the weather of the climate it inhabits is longer cold."

"It is curious," adds M. de Buffon, "to observe this animal, when he is prematurely forced to pass from the torpid to an active state. He first yawns, fetches a *deep sigh*, and utters broken, inarticulate sounds like a drunken man. His limbs become less rigid, he stretches out his legs, fetches another still deeper sigh, opens his eyes, and at length recovers. Such are the uneasy sen-

fations he visibly undergoes, from a sudden and forced re-animation; which is, probably, performed in a more gentle and imperceptible way by the vernal warmth, when left in his cell. But what is singular, he never becomes torpid, though exposed to a degree of cold, equal to that of freezing, provided he is kept in the open air, instead of a close place."*

From the circumstance of these animals excluding all communication with the external atmosphere, may not the stagnant air of the cell, contaminated by their respiration, and saturated with carbonic gas, add considerably to the sedative effects of cold in bringing on torpor?

This, and many other particulars, unnoticed by writers of Natural History, must be left as objects of inquiry for future investigation.

Whether, for instance, their circulation and respiration are wholly, or only partially suspended?

Whether the foramen ovale remains open during life? Whether the structure of their heart and lungs is the same as in other perfect animals, while their generating power of heat is so much

* Natural History of Animals, Vol. 2. p. 254. Kenrick's Edition.

inferior? * Whether the blood is florid in their active state, and whether it acquires a black hue during their torpor? Finally, whether they lose both sensibility and irritability, as some writers relate, or whether they are capable of being re-animated by electricity and other stimuli, independent of heat?

At all events, it must be acknowledged, that intense cold, by its sedative effects, is sufficient to induce upon other animals, when inactive, a state of torpor, and even death. If Man is much less liable to become torpid by cold than the dormant tribe, it is perhaps, because he enjoys a much greater and more steady portion of natural heat: but when this is suddenly reduced below a certain point, by exposure to extreme cold, he also is forced to yield to the sedative power. A drowsiness first steals over the senses—the blood runs cold—then, torpor invades the whole frame!

“————— *And down he sinks*
Beneath the shelter of the shapeless drift,
Thinking o'er all the bitterness of death:
Mix'd with the tender anguish, Nature shoots,
Thro' the wrung bosom of the dying man.
 ————— *On every nerve*

* That this, however, is very considerable in the dormouse when life is in danger, appears from Mr. Hunter's experiments since its heat at 81 rose to 93, on the animal being confined in an atmosphere so low as 20 degrees. Phil. Tr. Ibid.

*The deadly winter seizes; SHUTS UP SENSE;
And, o'er his inmost vitals CREEPING COLD,
Lays him along the snows, a STIFF'NED corse,
Stretch'd out, and bleaching in the northern blast."*

Thomson's Seasons. p. 175.

When this state of torpor or apparent death is brought on, whether in the marmot, or the man; whether by the sedative effects of cold, or by submerſion, the phenomena in both are extremely ſimilar. Both are bereft of ſenſe and motion—Both loſe a large portion of animal heat—Both are reſtored by a gentle degree of warmth, but deſtroyed by too great, or too ſudden heat—Both, on their firſt recovery, exhibit ſimilar efforts towards reſtoring reſpiration and circulation.

If the recovery of the marmot is more uniformly certain, it is not only becauſe in him, the torpor is more gradual, but becauſe the degree of heat is regulated by the ſteady, unerring hand of Nature; in Man, by the uncertain, capricious rules of Art.

In high northern latitudes, it is reported, that eels, during the cold ſeaſon, are frequently ſent to diſtant places in a frozen ſtate, where afterwards by immerſion in cold water, they are thawed, and gradually reſtored to life. Nor will this appear altogether incredible when it is conſidered, that not only eels, but frogs and vipers can bear their natural heat to be reduced by a frigorific mixture,

to,

to, at least, one degree below the point of congelation, without being deprived of life. To some, this experiment proves fatal, while others remain apparently dead many hours, but afterwards recover.*

When through exposure to extreme cold, the fingers, or other external parts of the human body are frozen, the heat in these parts must necessarily be reduced to the lowest point consistent with life. If artificial heat be suddenly applied, a mortification ensues, and the parts drop off. But if they are first thawed by friction, with snow, and gentle warmth be then gradually applied, the parts are soon restored to their wonted use and activity.

Having thus far considered the means, which NATURE points out for restoring men, and other animals from apparent death; we next proceed to examine those, which have been suggested by ART.

* Phil. Transf. loco cit.



S E C T. XIV.

PRINCIPAL INDICATIONS.—*Review of the present Artificial Method of Treatment.*

40. From the most authentic information we have been able to obtain, whether from experiments on drowned animals, or observations on the human subject, it seems clear that in all successful cases, the first efforts towards recovery began in the organs of respiration, such as a tremulous motion of the lips, convulsive sobbings, with other imperfect attempts towards breathing: next a deep inspiration, with an obscure motion of the heart, and then the other functions gradually followed in succession, but not till respiration was restored.

Having, in addition to this consideration, traced the PROXIMATE CAUSE of suspended respiration to the Exclusion of Vital air (13—29), and also shewn the connection between respiration and the action of the heart and other vital organs (30—33); our Readers will readily anticipate us in drawing the following conclusion, viz. That the 1st GRAND INDICATION is to RE-NEW THE ACTION OF THE LUNGS, IN ORDER TO OPEN A FREE PASSAGE TO THE BLOOD THROUGH THAT ORGAN:

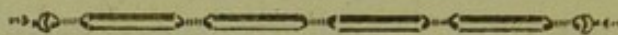
Secondly, TO EXCITE THE ENERGY, OR
PROPULSIVE

PROPULSIVE POWER OF THE HEART, IN ORDER TO ENABLE IT TO OVERCOME THE RESISTANCE.

Accordingly we find, that if those 2 organs can be happily brought to act once more in unison; the blood will instantly renew its wonted circuit, and the vital and intellectual functions will naturally follow in their order (29). The natural stimuli, by which the former are kept in motion, are vital air and warm blood; and when their action is accidentally suspended, the means employed by Nature are (as we have seen) the simplest imaginable; consisting of nothing more than merely restoring the warmth and motion which they had lost (39). The methods contrived by Art, on the other hand, are various and complex; being used also conjointly, or in quick succession, it is by no means easy to determine, to which of them the success ought to be attributed. Let us examine, however, their respective merits, and select those that appear best calculated to answer the end, by the most direct means.

To propose any deviation from the methods, which have been attended with such apparent success, and which, with little variation, have been adopted by the learned of the Faculty, in so many different parts of Europe, may perhaps, at first view, seem presumptuous, if not un-

But the questions propounded by the Royal Humane Society afford ample apology, as they evidently imply that, the art of restoring animation (notwithstanding its wonderful progress), has by no means yet arrived at its *ne plus ultra*; but, on the contrary, still affords sufficient room for improvement. We shall therefore, in obedience to their request, respectfully submit to their consideration, a few remarks.



Venefection.

41. From the apparent accumulation of blood in the right cavity of the heart and neighbouring vessels, venesection, it is true, might seem indispensably necessary. But when we consider, that the quantity of blood, which can be safely drawn from the veins, cannot sensibly diminish the supposed congestion near the heart: That if the right cavity is too full, the left is proportionably empty: That the general mass is in no-wise increased: That the heart and other hollow muscles cannot act with due force, unless moderately distended: and that tension gives tone and vigour to the whole frame; we cannot but hesitate as to the propriety of this operation. But how much more so when to this we add, that bleeding, instead of increasing the action of the heart, and energy of the brain,

brain, has a manifest tendency to weaken both ; and that in cases of debility, which bear no proportion to this, it often produces faintings, convulsions, and death? Therefore, unless we resolve to hazard the feeble remains of life (to support which our utmost exertions should be directed), we must forbear this operation, at least, till the circulation be restored.

On the other hand, however, it is insisted upon by the advocates for congestion and mechanical obstruction, that "bleeding is the first thing necessary, and ought to precede all other means ; particularly, because the letting out part of the blood from the right cavity of the heart of a drowned animal, by means of a puncture, has been observed to renew the contractions, by diminishing the distention." But is it not easy to conceive how this might happen, independent of the evacuation, by the mere irritation occasioned by the puncture? But admitting the contrary supposition, could such an operation be safely undertaken in the living subject? Nay, if it even could, would it not probably, instead of forwarding, retard the main intention, by diminishing the stimulus of tension necessary to the action of that organ? Whence is it that the motion of the right cavity survives that of the left, but from the superior quantity of oxygenated blood which it contains? or, why do persons recover with greater
facility

facility from a common syncope, than from other species of vital suspension; but that in the former case, the left cavity still contains a considerable portion of blood, while in the latter, it is nearly empty? Were both cavities formed to contain exactly the same quantity, the equipoise being so nicely balanced, neither could begin to act, consequently both would remain quiescent.

Therefore, though this distention of the right cavity, has been very generally considered as the grand obstacle to our endeavours, it may perhaps ultimately be found one of the most happy instruments of recovery; this being evidently the *der-nier ressource* of IRRITABILITY (28—31). Here, the feeble remnant of life, as if reluctant to quit its residence, lingers to the last moment. Here, as in its citadel, it collects its remaining force, and calls forth every exertion to preserve the principle of vitality to the last extremity. The blood is the friendly stimulus, to which the heart has been ever accustomed, and of which it is never wearied. It is this, that rouses it into action, in proportion to the resistance it meets with, and the danger it has to encounter. Were it not for this, no escape from so critical a situation as that of apparent death, could ever be effected. It has, on the contrary, been alleged, with much plausibility, that whatever tends to increase the distention of its right cavity must increase the difficulty; Hence friction,
and

and stimulants, by adding to the accumulation, before the obstruction is removed, are supposed to have a destructive tendency. But if the right cavity is already completely full, how can it be conceived capable of receiving any more from a propulsive power acting *a tergo*? Instead of which, would not such impulse tend to urge forwards to the left cavity, now almost empty, the intermediate column of blood; since there is a direct communication from one cavity to the other through the lungs? And would not this, instead of being injurious, prove an important step towards the main object in view, viz. the renewing the action of the heart and arteries, and consequently of restoring the circulation? But as a farther illustration—

At every full expiration, the lungs undergo a partial collapse, and if the next inspiration be voluntarily postponed a few minutes, the blood being retarded in its passage through the pulmonary vessels, begins to accumulate in the right cavity of the heart, as appears from the uneasy sensation felt in the chest. In proportion as the accumulation adds to the anxiety, it creates alarm, and the heart increases its exertions to overcome the resistance. By these efforts, the heart is enabled to propel the blood through the lungs, and support an obscure circulation several minutes after respiration is suspended; particularly where this power is improved by habit, as was noted in the
case

case of diving (27). On the other hand, it has been shewn, that if an animal is strangled at the instant an inspiration has been made, the lungs, instead of being collapsed, are expanded; and consequently no accumulation of blood can take place in the right cavity of the heart, or pulmonary vessels; and yet the event proves as suddenly fatal as when the operation is performed under opposite circumstances (22).

On the whole—if bleeding can ever be necessary on these occasions, it must be where the suspension is preceded by a highly plethoric or apoplectic habit, by intoxication, contusion of the head, or strangulation. Here, the discreet practitioner may sometimes think proper, especially if the eyes appear blood-shot; or the countenance intensely red, to disburthen the brain, by taking away 4 or 5 ounces of blood from the temporal artery or jugular vein, carefully watching its effects, and regulating the quantity accordingly.

But however urgent the indication for bleeding may appear, it will perhaps never be prudent to hazard a larger evacuation, much less, a repetition of it, at least, till the powers of the system are re-established, when the nature of the symptoms will more clearly point out the propriety or impropriety of the operation.

The reports of the Humane Society, for the Year 1785, exhibit, indeed, numerous instances of adventurous practitioners having had recourse to the lancet, sometimes even more than once, during the general process, and yet (if the cases be fairly stated) the success seemed to justify the boldness of the practice! But is it necessary to remind them, that success is, by no means, a certain criterion of the propriety of a particular remedy, especially, where others of a less doubtful nature are used at the same time? Or, that Nature, in this, as in other critical situations, sometimes happily triumphs over the *remedy*, as well as the *disease*? Otherwise, how can we account for the number of miraculous cures and hairbreadth escapes, so frequently attributed to some of the most insignificant, if not, injudicious means? — At all events, since bleeding, in the article of apparent death, can have no direct tendency to restore respiration, or invigorate vital action, but the contrary; its use ought, perhaps, to be restricted to the particular circumstances above-mentioned; and even there, as our judicious Register, Dr. Hawes wisely admonishes, should never be ventured upon without the utmost circumspection. Accordingly, the Medical Committee, in March, 1781, “considered it as their duty to enter, in the most public manner, their *CAVEAT* against
the

the indiscriminate use of the lancet, in the various kinds of suffocation." *

Emetics.

42. That emetics suddenly weaken the powers of life is manifest from the sickness, feebleness of pulse, and general debility, which constantly accompany their operation—Effects, which probably overbalance any advantage that otherwise might accrue from the general concussion. Emetics, therefore, but ill suit with the intention of restoring animation.

Nor can these, or other evacuants have any place in the treatment, at least, until respiration be renewed, and then happily they are seldom wanted, unless an immoderate ingurgitation of food or strong liquors, previous to the accident, should have rendered them necessary. Independent of this, however, emetics are still not without their advocates, in vital suspension. Can this be, because a few drowned persons have fortunately happened to survive their sickening operation, in addition to the danger incurred from the watery element?

* See Transf. of the Royal Humane Society. Vol. 1. p. 105.—
A Work highly interesting to the Medical Practitioner, and worthy the perusal of every humane Reader.

Stimulants.

Stimulants.

43. The action of stimulating medicines presupposes the presence of sensibility or irritability, in the parts to which they are applied.

As all the impressions upon our organs of sense are communicated through the medium of the nerves, no motion or sensation can be excited in parts deprived of nervous energy, or muscular irritability: hence, neither blisters, sinapisms, nor even the potential cautery can produce any sensible effect on the dead body.

In cases of apparent death, however, these faculties though seemingly destroyed, are only suspended, as in torpid animals; and may, therefore, frequently be again roused into action, by a judicious application of proper stimuli.

Of the stimulants employed on those occasions, some act directly on the vital organs concerned; others, indirectly, or through the organs of sense. The former are administered, with an eye to the proximate cause; the latter, to that of nervous sympathy, the effects of which we often behold, but cannot explain. The former, therefore, claim our first consideration.

Artificial Respiration.

44. Whoever considers the effects of air on breathing animals (13—14); their instinctive motions

tions for renewing respiration when suspended ; and the impossibility of recovery till this be effected (19—40), will be convinced of the importance of inflating the lungs.

For the air in respiration is the natural stimulus, which not only expands that organ, and promotes a free circulation ; but imparts vital heat and irritability to the whole frame (21—30).

Hence, pure air is to the lungs, what nourishing food is to the stomach ; but, with this difference, that a man can live many days without food, but not many minutes without air.

Therefore, in every case of vital suspension, the PRIMARY OBJECT is to institute ARTIFICIAL RESPIRATION, till the NATURAL BREATHING can be re-established. The propriety of this being generally allowed, various methods have been invented to accomplish it, though by different means. Those, who attribute the efficacy of this process to the mere mechanical expansion of the lungs, regard not the quality of the air ; nay some even contend, that air blown from the lungs of a healthy person is better adapted to the weak state of the vital powers, than any other sort. Others deny that air, already vitiated by respiration can be fit for the purpose (to say nothing of the apparent indelicacy of the operation), and therefore justly prefer atmospheric air.

Having formerly recommended vital air in preference

ference to the other two, not only from theory, but actual experiment on some of the smaller animals,* its superiority has since been confirmed by many respectable writers both at home and abroad.

Nor is this to be wondered at, seeing it possesses every necessary quality of common air, in a supereminent degree, and is alone capable of producing that chemical change in the blood, upon which vital heat and irritability depend (31). For during the suspension of respiration, agreeable to what has been hinted, the blood loses its florid colour, from being deprived of the vital part of the atmosphere. The animal heat also is suddenly diminished, and the action of the heart grows weaker every moment, till at length it ceases.

That curious aquatic creature, the rotillus or wheel insect, is perhaps, of all others, the most tenacious of irritability. Long after it has appeared to be dead, and even shrivelled, it may still be restored to life, by only dipping it in water, and exposing it, while moist, to the rays of the sun. The reason of which seems to be this: the sun decomposes the water, and the vital air being evolved, gradually renews the latent principle of irritability; because unless the insect be previously moistened with water, it cannot be revived.

* Hints on Animation, p. 17—98.

The feeble state of life then, instead of being an objection to the use of vital air, is rather a proof of its being indispensably necessary.

In the act of drowning, though suffocation generally takes place after a full expiration, yet it has been computed, that from 50 to 100 cubic inches of air still remain in the cells of the wind-pipe. Though this stagnant air must be highly vitiated, and therefore injurious to life, yet it cannot be evacuated by pressure, much less meliorated by similar air conveyed from another person's lungs; but may, nevertheless, be corrected by atmospheric air, and completely restored by vital air.

The ingenious Abbe Fontana, in attempting to respire pure inflammable air obtained from iron, had nearly fallen a victim to his curiosity. On the second inspiration, his countenance was observed to become suddenly pale—On the third, he fell down motionless. Being now removed by the assistants into the open air, he at length happily recovered.

Carbonic and azotic airs, when pure, are still more suddenly fatal than the inflammable; yet may either of these be respired several minutes without much danger, when diluted with little more than an equal part of atmospheric, or even one fourth of vital air.

On the whole, it seems reasonable to conclude, that in the treatment of persons suffocated by the various kinds of noxious air; respired air must be less proper than atmospheric, atmospheric, than vital; and that could the latter be as easily and cheaply procured as the two former, few persons could hesitate a moment in determining which of them they ought to prefer. Whence is it then, that the use of vital air has hitherto been withheld from the human species, and confined to a few experiments on brute animals? Because it is even yet but little known; and its virtues still less understood—A remedy rarely to be had when most wanted, and never without some trouble and expence.

It might, however, be procured on moderate terms from common nitre, which yields it in very considerable quantity—an article, unless in time of war, generally to be obtained remarkably cheap. How many thousand tons of nitre has Europe consumed of late, in making gun-powder, and that with the avowed intention of DESTROYING thousands of its inhabitants! Might not a small portion be spared for *another* purpose, at *least* equally humane and laudable, viz. that of PRESERVING a remnant of our unfortunate fellow-creatures!

Is it not singularly curious, that a substance of such very humble pretensions as common nitre (or *salt-petre*) should possess properties on which hangs the fate of the most powerful empires! since

by chemistry, it may either be converted into a fulminating engine, to overturn fortified cities, or to enable the garrison to launch out death and destruction on the besiegers ! Or, that by a different process, it may be made to pour forth vital air—that VIVIFYING FLUID diffused through the atmosphere, which breathes in the zephyrs, which whispers in the breeze,* and which cheers and supports all animated Nature !

It has been computed by the Abbe Fontana, that a pound of nitre, calcined in a close vessel, yields about 12,000 cubic inches of vital air—a quantity sufficient for a person to breathe more than 24 hours. As this air does not unite with water, it might be kept in large glass jars inverted in a proper tub of water, like any other air used in philosophical experiments ; or were it made to rest on a surface of lime-water, it would be equally secured, and its purity might be preserved for a great length of time. This might prove an important addition to the apparatus of our Humane Society's receiving houses, where it might be kept in readiness against emergencies, and managed with equal facility as common air. There, also might its comparative merit be determined by decisive experiments.

* *That Vital Breeze, which NATURE pours to save,
The breathless victim, from th'untimely grave !*

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Remarks

Remarks on the Operation of inflating the Lungs.

45. The operation of inflating the lungs completely, demands considerable address; and as it constitutes the most important part of the process, it were to be wished, that not only medical Pupils of all denominations, but also some other intelligent persons, in every parish, were fully instructed how to perform it with dexterity—A circumstance of no small consequence, especially in country-places remote from medical aid. The operation may be tolerably performed, by the common people, by only inserting the pipe of a pair of bellows into one nostril, while the mouth and opposite nostril are closed by an assistant, and the wind-pipe gently pressed back; Then by forcing air into the lungs, and alternately expelling it by pressing the chest, respiration may be imitated. In want of bellows, air may be blown through a tobacco-pipe, a quill, a pencil-case, or even a card folded into the form of a tube.

The little portion of water, which is sometimes imbibed in the act of drowning, though too small to occasion death, may yet retard recovery, by interrupting the passage of the air into the extreme cells of the wind-pipe. Hence, probably, the adjacent column of blood cannot so readily receive the beneficial change necessary to renew heat and motion. Though the water cannot with safety be

extracted by the exhausting syringe; yet by repeated inspirations and alternate expirations, it may in the course of the process, be gradually dissipated and discharged in form of aqueous froth.

But the main obstacle to this operation is, the constrictive power, by which (in the article of drowning), the aperture of the wind-pipe is sometimes obstinately shut up. During this obstruction, inflation by the mouth or nostrils, though the wind-pipe be pressed back in the usual way, cannot succeed. For the air, instead of entering the lungs, will find readier admission into the stomach: by which the latter will be distended; the capacity of the chest diminished; and the action of the lungs impeded. Hence may be understood, why unexperienced practitioners are so often baffled in attempting to perform this operation; and why it sometimes fails in cases, which at first, seemed highly promising of success.

In order to overcome the constriction of the glottis, the tongue must be not only depressed, but considerably drawn forward; by which means the epiglottis (the obstructing cause) will be elevated, and the aperture opened (10). This difficulty being surmounted, the operation afterwards will generally go on without interruption. Sometimes, however, the jaw is also locked, by an invincible spasm, when the usual process becomes totally impracticable. E v e

Even here, the humane Practitioner rather than abandon the patient to his fate, will yet make one effort in his favor, by having immediate recourse to Bronchotomy—an operation, which it is unnecessary here to describe. It may not, however, be improper to observe, that in order to prevent the inconvenience of blood entering the wind-pipe, and the danger of dividing the recurrent nerves, on which the voice materially depends, it has lately been proposed to make a longitudinal incision through the integuments and thyroid cartilage, at once into the wind-pipe. How far this new method may deserve the preference, must be left to future observation.

For the purpose of artificial respiration, various inflating machines have been contrived; some of a simple construction, others more complex, as single and double bellows with air-tubes annexed: some adapted to the nostrils, others to the aperture of the wind-pipe.

In place of bellows, some have preferred an exhausting syringe, constructed with an intention to extract water as well as air—a hazardous undertaking! For unless it be used with the utmost circumspection, it may occasionally, instead of water, extract blood.

In order to comprise the whole apparatus in a very narrow compass, the inflating instrument is generally made too small to answer the intention

completely. For unless it be capable of containing a proper quantity of air for a full inspiration, it cannot sufficiently expand the lungs, or communicate a due proportion of aerial influence to the blood. To effect which (in the manner, in which it is commonly performed), would probably require at least two inspirations for one expiration. But the quantity of air necessary for one inspiration, having not yet been determined, an indefinite quantity is thrown in, and the operation, of course, is conducted without much precision.

While one practitioner judges 12 cubic inches to be sufficient, another alleges that 100 are scarcely enough; while a third (Mr. Kite) declares that the lungs are capable of containing at least 300, and consequently, that this quantity would not be too much. In another passage, however, he observes, "a man usually inspires 17 cubic inches, but after expiration there remain in the lungs 87!" Again; that as "animals die in the act of perfect expiration, *no* air can be even squeezed from their lungs." Whence he concludes that, "in cases of suspended respiration, no bad effects can ensue from noxious air stagnating in the cells of the wind-pipe." How shall we reconcile the above passages with one another, or with the following one, which affirms, "that no sooner is noxious air inspired even by a healthy person, than it induces a *palsy* on that exquisitely sensible

fenfible membrane, which lines the orifice of the wind-pipe ?”

After the laft expiration in drowning, there remain, according to a late calculation, at leaft 109 cubic inches of air in the lungs, which probably is near the truth. Now admitting this, which appears to be a moderate computation, might not the forcible addition of 300 more, amounting in the whole to 409 cubic inches, endanger a fatal laceration in an organ of fuch exquisitely tender fabric ?

At a moderate natural expiration, it has been found by Fontana, that 35 inches are expelled, and that in a forcible one, about double that quantity. But fince a confiderable portion of the air is confumed in the act of refpiration, the quantity expired muft ever fall fhort of that which was infpired (15).

On the whole, though it may be difficult, and perhaps not abfolutely neceffary to adjust the proper ftandard with exactnefs; yet it would be defirable, that a certain medium fhould be ftuck out between fuch oppofite extremes: denoting fuch a quantity, for example, as might be quite fufficient on one hand, moderately to expand the refpiratory organ through all its ramifications; on the other, to guard it againft too great force, or over-diftention. Instead

Instead of 12 cubic inches, which seem evidently too little, or 300, which appear abundantly too much; we venture to propose 112, as more nearly approximating the desired medium. Accordingly, the inflator, whether bellows or syringe, should be made to contain just this quantity, to be thrown in at each inspiration, and suffered to remain about 15 seconds, when it may be expelled by a full expiration. These alternate motions should be continued till natural respiration commences, or repeated at intervals, during the space of 3 hours, or till all hopes are vanished.

This operation, properly conducted, evidently tends to expedite the passage of the blood through the lungs, and remove congestion; far beyond what could possibly be effected by bleeding; admitting even that the latter could be undertaken with propriety.

Electricity.

46. Electricity presents us with one of the most speedy and powerful stimulants hitherto discovered, which like other active remedies, may prove salutary or injurious, according as it is managed. Applied in a moderate degree, it excites vital action after other stimuli have ceased to act: carried to an extreme, it destroys irritability, and life itself.

self. For whether the stroke be sent from a thunder-cloud, or a highly charged electrical battery, is immaterial; the effect from either may alike prove fatal. Hence, the impropriety of those violent shocks of electricity formerly given in palsies, which like other exhausting stimuli not only defeat the intention, but prove extremely injurious. While most other stimulants affect the internal organs only by sympathy through the stomach, this at once, penetrates the heart, and pervades the inmost recesses of the frame. Hence in the torpid state of apparent death, it seems admirably calculated to rouse the dormant powers. If to these well known effects of electricity, we add what has been suggested concerning the probability of its being the principal agent in the action of the brain and nerves (33—35); it will, on the present occasion, still further claim our attention. For till the intercourse between the voluntary and involuntary powers can be restored, there can be no hopes of perfect recovery.

The effects of electricity were, sometime ago, finely illustrated by the ingenious Abildgard, in many curious experiments on apparently dead animals; wherein by a dextrous management of its power, he is said to have been capable of alternately suspending and restoring animation at pleasure. These experiments have since been repeated by an eminent electrician in London, and with

with nearly similar effects. On smart shocks being passed through the head, the animal immediately became motionless: on transmitting gentle shocks through the region of the heart, oscillations of the external muscles instantly ensued. When the operation was suspended for some minutes, or its direction altered to more remote parts; the animal relapsed into its quiescent state, and constantly revived on its being repeated as at first. What seemed worthy of attention, the vital organs were more certainly excited, and more vivid motions produced by slight, than by rougher shocks; the latter appearing to retard, rather than promote recovery.

Whether the operation was performed on a large turkey, or a small quadruped, the result was the same. On drowned animals, however, it often failed, especially in the younger sort, the principle of life in them, being very feeble.

From the above phenomena, which appear to be no less singular than interesting, it seems reasonable to conclude, that electricity ought to be principally directed to the thoracic viscera in form of gentle shocks: That these should be so accurately adjusted to the *tone* of the moving fibres, as may renew that perfect unison of action, which is natural to the system (31—35); the due medium of which, however, can only be discovered by attentive observation. Hence,

Hence, perhaps, the surprizing success of electricity in some cases that appeared desperate; and its failure in others, after it had produced some flattering tokens of recovery. Instances of both which are to be met with in the Reports of the Humane Society, for the Years 1787 and 89.

It has been found, by the experienced electrician lately mentioned, to afford present relief in syncope, brought on by violent excitement—by sudden emotions of mind—and even by the stroke of lightning. Thus may electricity, when managed with address, be converted into a remedy to counteract its own excesses. Nor is this to be wondered at, seeing its effects may be so greatly diversified according to the different modes of application, by which its powers are adjusted. Thus it may be directed to pass silently along the metallic wire; to melt it instantly; or disperse it with incredible fury. Thus a violent blast of air extinguishes the burning taper, while a gentle breeze re-kindles it. In like manner, the tickling the soles of an infant causes convulsive laughter; while moderate rubbing produces no visible emotion.

From such remarkable effects produced from apparently slight causes, and from the vast disproportion between the degree of stimulus and the motion excited; we learn, why an animal under a state of torpor, or apparent death, is more speedily

dily restored by gentle vibrations, than by violent shocks.

If electricity be one of the most probable means of renewing vital action, agreeably to what was first hinted in 1783; * it certainly ought to constitute an early part of the process. A late writer, however, peremptorily asserts, that to "stimulate the heart by the electrical shock, without first removing the obstruction of collapse, is one of the most ill-judged, and most dangerous plans of recovery; and that it is absolutely taking away life."

How came it then, in the experiments related by Dr. Abildgard, and the successful cases already cited (to which others might be added) that electricity did not prove fatal? In them, it neither appears, that the lungs were previously inflated, or any attention paid to the collapse: Yet electricity alone, that "ill-judged, dangerous remedy," instead of "taking away life," we find, absolutely restored it.

If under such disadvantages, it succeeded beyond expectation, it seems evident that electricity is not so dangerous in the first instance, as he seems to imagine; that, on the contrary, it may be used with perfect safety, during any part of the process. That artificial respiration, however, may contribute not a

* Hints on Animation.

little to its success, can scarcely be doubted. Therefore to make them co-operate, their forces must be combined, or employed in succession.

Here, the Reader will please to recollect, that in suspended respiration, the lungs, instead of being alternately expanded and contracted, are now entirely at rest.

That the blood, instead of circulating with velocity, to the remotest parts of the body, is arrested in its passage through the lungs: Instead of pursuing its course through the arteries, lingers in the larger veins, as in torpid animals: Instead of being continually renovated with fresh air, is now wholly deprived of its influence.

That the heart in like manner, instead of repeating 70 or 80 brisk pulsations in a minute, now probably does not perform above 10 or 12, and those extremely feeble ones. Hence, while these important functions are suspended, all the other operations dependent on them, must also necessarily cease.

These, and the preceding observations (39—44) point out the two leading circumstances, which demand the first attention; viz.

The lungs must be replenished with fresh air, and the heart enabled to propel the blood to the left ventricle.

The former is to be effected by inflating the
lungs:

lungs: the latter, by exciting the action of the heart.

Now, it is known from various observations, that the blood passes most freely through the pulmonary vessels, when the lungs are expanded by a full inspiration. If at this juncture, the heart can be excited to exert its powers, while the resistance is so considerably diminished; it must more easily propel the blood forward, when part of it will enter the left cavity now almost empty. This being brought into action, will, in its turn, urge it forward into the arterial system.

Here, electricity then seems perfectly adapted to co-operate with artificial respiration in expediting the process: being known not only to promote the progressive motion of fluids in capillary tubes, but also the circulation of the blood in animals (36).

As soon as the lungs therefore are fully expanded with air (and the more *pure* this is, undoubtedly the better), at that moment, let the heart be excited by a gentle electrical shock, passed obliquely from the right side of the chest through the left, in the direct course of the heart, and pulmonary vessels. Let the lungs be now emptied of the air, and again expanded, when another shock may be given. The heart being thus excited into action,
the

the dark blood, loitering near its right cavity, will begin to move forward, and to resume a more florid colour. This being gradually renovated, will renew the action of the left ventricle, when the circulation will also be speedily restored, and that perhaps, with more certainty and expedition, than by the usual mode of conducting the operation.

The longer respiration has been suspended, and the more the vital powers are enfeebled, the more gentle ought to be the means of restoration. In which case, it may be prudent to begin with moderate vibrations, or very slight shocks; * and instead of repeating them at every inspiration, to postpone them to every second or third successive expansion of the lungs. For it will be safer to keep pace with the slow and languid movements of the heart, than to waste the small remains of irritability in fruitless exertions.

The course of the electric circuit may be also properly varied, directing it alternately from right to left, and from left to right; particularly through

* By placing the Electrometer at first only a quarter of an inch from the coated jar, and by gradually increasing the distance, if no sensible effect be produced.

It can scarcely be necessary to remark, that the discharging rods must be *insulated*, otherwise shocks may inadvertently be communicated to the operator.

those parts that are known to retain irritability the longest; as the heart, the diaphragm, and alimentary canal.

Gentle shocks may also, at intervals, be transmitted along the whole course of the spine.

Some prefer negative electricity, as affording a more poignant stimulus than the positive, in consequence of the electrical fire being observed to issue *from* the body in converging rays, as from a point; while in the positive, it is presented *to* the body, in a pencil of diverging rays, by which its action is thought to be weakened. The difference however, it is presumed, cannot be very great.

In drowned subjects, the body must first be well dried; otherwise the moisture may carry off a great part of the electrical fluid, and so defeat the intention; as appears sometimes to have happened, not only in experiments on animals, but also on the human species. Where electrization by sparks, instead of shocks, is preferred; the body ought always to be completely insulated.

“Electricity,” says that experienced Practitioner Mr. Kite, “has, in every instance that has been made public, proved its importance, and afforded the most ample and decisive testimony of its wonderful and extensive influence, even in cases

ses where it failed of producing the desired effect."

To this he subjoins the following account of a drowned person, on whom the usual means, though employed near an hour, did not produce the least benefit or alteration.

"Electricity was then applied, and shocks were transmitted in all directions. The muscles, through which the fluid passed, were thrown into contractions, nearly as *strong* as are usually observed in *healthy* people: This extraordinary appearance recurred, as often as electricity was applied, for the space of *2 hours*; after which period, its effect ceased, and *no* alteration whatever *could* be produced. Since this," he adds, that he "has constantly had recourse to it in similar accidents, and generally with the same effect. But when life is *wholly* extinguished, *not* the least *motion* whatever can be produced by electricity."

In our Society's Reports, there occurs a still more affecting instance of the same kind; where, we are told, "the electrical shock was tried in the case of James Lawson, *4 hours* after he was taken out of the water. The first shock excited a *pulsation* in the temporal artery: The next diffused a *florid* colour over the face, and occasioned the *blood* to flow in a *copious* stream from an

orifice in the jugular vein, which had been opened in the beginning of the process *without a drop* having issued from it. The *subsequent* shocks were attended with *no* manifest advantage, and every favorable symptom subsided! ”

Had electricity, in the preceding cases, been made to co-operate with artificial respiration, or had its stimulating power been regulated in the manner we have just proposed; the event (at least, if we may be allowed to judge from actual experiments on animals) might probably have proved more favorable.

During vital suspension, irritability must be considerably accumulated, till at length the excess proves fatal—Hence the necessity of artificial stimuli, to compensate for the defect of the natural ones, in carrying off the redundancy. But if these are too powerful, or too long continued, they may prove equally destructive, by totally exhausting the moving fibres (31). Thus may the salutary efforts of Nature be overpowered by the officiousness of Art—a circumstance, which sometimes we have had occasion to observe with regret.

Heat.

47. Heat is so essential to life, that without a certain degree of it, neither animals, nor even
vegetables

vegetables could subsist. The eggs of oviparous animals, the seeds of vegetables, and growing plants discover, by the thermometer applied to their internal parts, a degree of temperature evidently exceeding that of the circumambient atmosphere. Heat accompanies the embryo from the earliest period to the last stage of its existence, and therefore has been considered by some as the source of vitality. Hence, the fecundated egg brings forth in due season, whether the proper degree of heat be communicated by incubation, or by the temperature of a well regulated oven.* Hence also, the myriads of animated beings, which, from imperceptible ova, are ushered into existence, by the summer's sun! Hence, dormant animals are roused from a torpid state, by the vernal warmth; and hence too, drowned persons have sometimes been re-animated by the solar rays.

From these, and similar considerations, it was very natural to conclude, that to restore heat to the body, must be one of the most powerful means of restoring animation. Accordingly, it has hitherto been generally attempted, by the application of artificial heat; under an idea, that until

* By the application of electricity, incubation is so remarkably accelerated, that chickens are said to have been hatched in about 48 hours. Mem. de l'Acad. de Berlin. 1778.

this could be accomplished, every other method would prove ineffectual: Without considering perhaps, that an inanimate substance of such a bulk as the human body, containing a large quantity of matter under a small surface, must acquire heat very slowly: That to accomplish this in the internal parts (were it even practicable with safety), would demand great length of time, during which, other measures no less essential must be postponed.—Widely different is the process by which Nature preserves the human heat of an even temperature (20). Whenever this is suddenly varied, the vital actions are proportionably exerted to restore the equilibrium. It is very observable, that life is more endangered when the heat is raised by any means 6 or 8 degrees above the natural standard, than when it is reduced 18 or even 20 below it. Hence, perhaps, it is, that the system is endowed with two powers of resisting heat, and but one of generating it (20).

When respiration ceases in a drowned animal, the power of generating heat is suspended, and the body gradually loses the remains of its natural warmth; till at length it is reduced to the temperature of the surrounding medium.

During this, if we attempt to raise the heat suddenly to the natural standard, we exhaust the feeble remains of life. Nay, although we apply artificial

tificial heat by slow degrees, yet still if no other means are used, it commonly fails of success. But if we first have recourse to artificial respiration, in the manner already described (45), the experiment generally succeeds better, producing the desired effect.

The lungs being thus supplied with air, the blood is again rendered fit to receive a fresh supply of latent heat, and to diffuse it, in a sensible form through innumerable arteries and veins, from the centre to the circumference (19). Thus is the natural heat restored, and communicated to every part of the system, with more certainty and expedition, than by any external means that can be devised.

The most efficacious method of restoring heat then, is to renew the generating power, by renewing respiration. For, till this natural process can be re-established, all that can be reasonably expected from the application of artificial heat, is to prevent the natural heat from being conveyed off; and to preserve sensibility and irritability, till the generating power can be renewed, on which they so intimately depend (19). Even in this view, it is a matter of considerable importance, and demands no small attention in the management.

To conduct it with propriety, the degree of heat ought to be regulated by the internal heat of the body, and the remaining powers of life. Ap-

plied indiscriminately, it cannot but be productive of mischievous consequences.

In cases of suffocation from noxious air, the body retains a greater degree of warmth than natural, even many hours after death. To accidents of this nature, the Russians are frequently exposed, during the cold season, from the noxious air of their stoves, and want of due ventilation.

As soon as a person is discovered to be thus deprived of sense and motion, he is stripped naked, and brought into the open air; where he is rubbed with snow, or cold water is dashed repeatedly over the whole surface of his body.

At first, the animal heat is sensibly increased, but by continuing the cooling process, it is at length reduced somewhat below the natural standard, when signs of life begin to appear.

This method, we are informed, is universally practised among the common people, and with constant success, where respiration has not been suspended more than an hour.

It, perhaps, first originated from the ancient and well known experiment of suffocating dogs and other animals, in the mephitic air of the '*Grotto del Cani*,' where it is often performed to gratify the curiosity of travellers.

When the apparently dead animal is plunged repeatedly

peatedly into the cold water of the adjacent lake, it is observed to recover much sooner, than when only removed into the open air.

But what is still more remarkable in the Russian practice, is, that where the symptoms are brought on by extreme cold, from perishing in the snow; and where the heat of the body, instead of being above the standard, is reduced almost to the point of congelation, yet the same method is pursued, and with the like happy success.

The same custom also obtains in other cold climates, where the rude inhabitants, taught by long experience to avoid the application of heat to frozen bodies, have discovered the superior efficacy of cold, and how to employ it, either to increase or diminish vital heat, and so correct its own excesses—a knowledge, which might do credit to the ingenuity of the more enlightened nations—a practice, that might not be unworthy of their imitation.

But those, who have long been in the habit of applying artificial heat; whether the accident happens in winter or in summer; whether the sufferer is drowned under the ice, or suffocated by inflammable air; bleached by the drifted snow, or scorched by lightning; will doubtless consider it as preposterous folly, thus to attempt to restore lost heat, by the application of cold water or snow! or to make the same remedy answer intentions so diametrically opposite! How shall we reconcile
this

this paradox?—The application of cold acts first as a stimulus, and if long continued, as a sedative: hence rubbing with snow, at first increases the heat of the system; afterwards, begins to diminish it.

If a person, benumbed with extreme cold, suddenly exposes his hands to a hot fire; a tingling pain is felt, but the cold numbness continues. If, instead of this, he immerses his hands in spring-water, though only a small degree warmer than the external air, or rubs his hands with snow, a pleasing sense of warmth ensues, and the numbness vanishes.

When Mr. Hunter exposed a dormouse to the intense cold of 20 degrees, its natural heat, instead of being greatly diminished as might have been expected, suddenly rose 12 degrees.

Where the temperature of the body is considerably reduced, a small degree of additional heat may produce powerful effects. Thus dormant animals become torpid in a temperature of 40; a moderate degree of additional heat revives them, a greater destroys them (39).

Thus Nature instructs us that the artificial heat employed in restoring animation, ought to be very moderate; and the more so, in proportion as the natural heat is diminished.

At the beginning of the process, the degree of
heat

heat subsisting in the internal parts ought first to be ascertained, by introducing a small thermometer into the back part of the throat, or under the tongue. Should the temperature be found equal, or even superior to that of health, as sometimes happens; there certainly can be no pretence for the addition of artificial heat, which would be wholly superfluous. Instead of which, the natural heat ought probably to be somewhat reduced, according to the cooling plan just mentioned. If, on the other hand, the internal temperature of the body should seem to be reduced to the lowest ebb, and the external parts apparently frozen; the application of artificial heat would soon prove destructive, and therefore the cooling method ought in the beginning, to be rigorously pursued.

If, at the highest pitch of temperature then, as well as at the lowest, the application of snow, or cold water affords a more safe and efficacious stimulus than artificial heat, is there not some reason to suspect, that the cooling method might also prove preferable, at all the intermediate degrees? That in drowning, for instance, where the temperature of the body, through exposure to extreme cold, is often reduced many degrees below the standard, might not a momentary application of this method, at the beginning of the process, prove more salutary, than that sudden transition to artificial heat adopted by modern practitioners?

Should

Should it fail, after a few minutes trial, of producing any sign of re-action in the system, the application of a gentle degree of heat should next be had recourse to; for every change of temperature acts as a stimulus. Beginning, therefore, at the low degree of 40, it might be gradually raised to 70; but, perhaps, ought rarely to exceed the tepid warmth of 80.

For till the generating power can be restored, in vain may we attempt, by this, or any other means to raise the heat of the body to the natural standard. Yet still artificial heat is a matter of consequence, in preserving the remains of natural heat, and in cherishing sensibility.

Various methods have been contrived for communicating heat; and many of them, could they be had in readiness, might, under proper management, be employed with advantage. Such as the immersing the body in warm ashes or sand: The wrapping it in the skin of an animal just killed; or the passing a warming-pan over it, while covered with flannel: The placing it in a warm bed, between 2 persons in health; or before a fire: Or, finally, exposing it, when the weather is favourable, to the rays of the sun. All of which, however, are liable to certain inconveniences; the indefinite degree of heat which they communicate is too fluctuating; sometimes too little, often too great,
They

They generally occasion loss of time ; and all except the last, considerably interfere with the more important process of artificial respiration.

A tepid bath affords the most uniform degree of warmth ; and is, perhaps, the most manageable : but where it cannot be immediately had, bladders of tepid water, or flannels wrung out of the same, may in some measure supply its place. These may be applied to the region of the stomach ; to the arm-pits ; and to the extremities : their warmth being retained by a covering of warm flannel.

It is scarcely necessary to repeat, that the internal heat of the body should more than once during the process be examined by the thermometer, and its variations carefully noted. The room ought to be well ventilated, and its heat temperate ; viz. between 56 and 64 degrees of Fahrenheit's scale.

If irritability keeps pace with animal heat, inso-much that with a very few exceptions, both forsake the human frame at the same moment ; then will the degree of internal heat, marked at intervals, by the thermometer, determine the degree of irritability, while any remains ; and, consequently, afford a NEW TEST of the PRESENCE or ABSENCE of LIFE.

Nor does that heat, which, in certain diseases,
is

is generated in consequence of the putrefactive fermentation, and which often subsists many hours after death, affect the present question, which respects recent accidents in a sound state of body only.

Agitation of the Body.

48. Brisk agitation is best performed between two people; one taking hold of the patient's feet, while the other supports the shoulders, with the head properly elevated.

This has also been lately suspected of having a dangerous tendency, though apparently without any just cause. It certainly affords a safe and speedy mechanical stimulus to the whole machine, and may be executed in less than 3 minutes; producing all the advantages that could be hoped for from the action of an emetic, and without the danger.

The successive concussions thus communicated to the heart and internal organs, tend to put the stagnant blood in motion; to renew oscillations in the moving fibres; and to incite the hidden springs of life into action.

A remarkable instance of which accidentally occurred, some years ago, at a funeral procession, where a sudden jolt of the hearse, is said, to have disturbed the repose of the apparently dead Lady within;

within; who, to the surprise of the attendants, and utter confusion of her husband, instantly gave a piercing shriek! This, being repeated in her usual shrill and well known key, left him no room to doubt of his *cara sposa* being still actually alive. It therefore obliged him, though very reluctantly, to put an end to the sepulchral ceremonies, and release the supposed corpse; who, it is added, lived many years after, till at last she had the satisfaction of seeing her husband “peaceably interred” near the very same spot.

By brisk agitation, still-born children have sometimes also been unexpectedly brought to life. Sometimes drowned persons have been restored by the same means.

Being a simple and harmless effort to restore animation, and easily performed by the lower class of people, it ought, by no means, to be discouraged. If it fails, it does no injury, unless it be performed with unnatural violence: If it succeeds, it supercedes the use of other measures.

Friction.

49. Friction, with agitation of the body, was one of the earliest methods employed in the recovery of the drowned; and still constitutes almost the only means known to the common people.

Notwithstanding

Notwithstanding the rude, unscientific manner, in which they generally conduct the operation, yet there are not wanting instances of its success, which probably would have been more numerous, had it been directed by more skilful hands.

Its general effects may be understood, from its stimulating the extremities of the cutaneous nerves, which sympathize with the principal internal organs. But still more, in the present instance, from its exciting the arteries to propel the blood into the corresponding veins, and from thence forwards to the heart. The left cavity of that organ being nearly empty (2), and the valves preventing any retrograde motion in the veins, friction tends to expedite the obstructing column in the pulmonary vessels still forward; when, if the heart lends any assistance, part of the blood must find its way into the left cavity, as has been already hinted (44).

The blood thus put in motion, though at present deprived of part of its wonted stimulus, cannot but affect the heart; since the natural action of that organ is longer supported by its own warm blood, than by any artificial stimulus applied to its external surface alone.

Therefore, though a small portion of blood is only propelled into its left cavity by this means, yet it gradually contributes to renew the contractions of the heart.

Thus

Thus friction, without increasing the general mass of blood, assists in promoting its fluidity, and in distributing a portion of it gradually to the left ventricle, where it is most wanted; in this respect, therefore, it completely supercedes that more doubtful operation, the transfusion of the blood, which has been lately recommended.

To increase the efficacy of friction, it has been customary to accompany it with other stimulants, as common salt, volatile alkali, warm brandy, or other spirits. All which, however, are liable to inconveniences, which, perhaps, in some measure counterbalance the advantages supposed to be derived from their stimulating effects.

It is very certain, that the skin, the organ of touch, loses its faculty of feeling in proportion as it is deprived of its natural warmth, and does not recover it again till this be restored. Stimulating medicines, therefore, applied to it, before it has in some degree recovered its warmth, must prove ineffectual, and in proportion as they interrupt the other measures, prejudicial.

Dry salt, applied to the skin, acts chiefly as a mechanical stimulus; while by its angular points, it generally produces troublesome excoriations, which often degenerate into ill-conditioned sores.

Volatile salts, as spirit of sal volatile, or of hartshorn, are liable to speedy evaporation in proportion

to their volatility, and the warmth of the season. Instead of exciting heat therefore as intended, they manifestly occasion cold, and also by their pungency greatly incommode the eyes of the assistants.

Warm brandy, and other ardent spirits are subject to the same inconvenience of producing cold, and the more so from being first heated, because this increases the evaporation (20).

Nor are oily liniments and embrocations, lately proposed to obviate these inconveniences, entirely free from objection; because, instead of restoring the skin to that natural degree of firmness and tension, so necessary to the tone and energy of the organ of feeling, they tend to relax and enfeeble it still more.

Besides this, their fluidity renders them conductors of electricity, by which, in common with spirits and other liquid applications, they tend to draw off a considerable portion of that fluid, and to defeat the intention of simple electrization by sparks, which some judge, though perhaps without sufficient cause, to be more efficacious than shocks.

In order to render friction perfectly safe, and at the same time to give it its full efficacy, the following cautions may not be unnecessary.

1st. Violent friction, in these cases, is generally unnecessary; it seldom can be useful: it often may prove hurtful. In highly plethoric habits, for example; in diseased lungs; and in recent intoxication;
violent

violent friction, in the rough manner in which it is commonly performed, may, by urging the blood too forcibly to the heart and pulmonary vessels, before the left ventricle can have time to empty itself, produce a sudden extravasation in the lungs or brain, converting at once a hopeful state of recovery, into a fatal hæmoptoë or apoplexy !

2^{ly}. To obviate any danger that may in such cases arise from friction, artificial respiration with electricity, ought in propriety, to precede its use, that a free passage may be first opened through the lungs (44), when friction may be safely pursued with more freedom.

3^{ly}. Where, through want of skilful assistants, the previous process cannot be properly managed, the friction ought to be more gentle ; beginning at the upper and lower extremities, where the circulation is always the slowest, and proceeding gradually to the thighs, abdomen, and chest ; where it should be occasionally suspended, about half a minute at intervals, for the heart to evacuate itself.

4^{ly}. Upon the whole, friction may be performed to the best advantage by the hands alone ; the natural warmth of which will be communicated to the body, and gradually increased by the continued attrition. Not to mention the additional advantage that may probably accrue from its exciting at the same time, the NERVOUS ELECTRICITY (32).

5^{ly}. Next to friction with the warm hand, the rubbing with a flesh-brush may occasionally be had re-

course to: or, what may prove still more advantageous, hare-skins, or warm flannels, well impregnated with the penetrating fumes of gum benzoin, kept in readiness in a state of fusion. Besides its stimulating and gently bracing quality, which seems well adapted to the present purpose, this fragrant gum possesses a pleasant odor, which instead of annoying, may prove grateful to the medical assistants, during their benevolent and truly meritorious exertions, in the cause of humanity.

Stimulating Cordials.

50. In no case of debility, whether acute or chronic, can a stimulating cordial be more immediately wanted, than where the vital actions are suddenly suspended.

As the stomach is endowed with exquisite sensibility and maintains an intimate sympathy with the heart and brain, it certainly, on those occasions, claims particular attention.

In time of health, cordials, on being received into the stomach, presently manifest their enlivening effects: even before they can have time to enter the lacteals, their stimulus is diffused through the remote parts of the system. In order, therefore, to restore the motion of the heart, through the medium of the stomach, some active cordial ought to be early administered. This having been considered by the Facul-

ty as unsafe, if not wholly impracticable, until the power of swallowing should be restored, it has hitherto on that account, been very rarely attempted. Fortunately however, we can now with confidence assert, that instead of waiting for the return of deglutition—an event which may never happen, fluids may at the beginning, be immediately conveyed into the stomach, without occasioning the smallest hazard of suffocation.

The instruments, for performing this and other parts of the process, will be fully described in the Appendix.

Amongst the class of internal stimulants, spirituous liquors, as rum, brandy, or usquebaugh are well adapted, as being speedy in their operation: but the sedative effect which succeeds the action of these, and all other potent stimuli of the exhausting kind, tends to limit their use, and demands no small circumspection.

Good wine (when it can be had), though less active, affords a more generous cordial, and seems to deserve the preference, unless where it has been previously abused by the patient's habitual intemperance in that liquor. Strong wines, drank copiously as daily beverage, at length cease to produce their exhilarating effects as cordials. Hence drunkards feel the necessity of gradually increasing their wonted dose, or changing their liquor.

When the vital powers are sunk to a very low ebb, wine as a cordial, requires to be given in large quantity, to produce the desired effect. Hence, in malignant fevers, attended with extreme prostration of strength, persons remarkably abstemious at other times, are now capable of drinking daily 2 or 3 pints of strong wine, without the least appearance of intoxication.

In the present case, the stomach being still less susceptible of stimuli, seems to require some other more active cordial to be added to the wine, especially as the whole quantity of liquid ought probably to be limited to about a pint, for fear of too great distention.

To this quantity, therefore, of madeira or sherry, might be added a dram or two of some warm aromatic tincture, as that of cinnamon, or lavender: or, what would afford a still more active stimulus, half a dram of pure spirit of sal ammoniac. To give this volatile spirit its due poignancy, it ought to be prepared from 3 parts of quick-lime to 1 of sal ammoniac; keeping it well secured from the external air.

M. Sage, from various experiments, assures us that, by this remedy alone, after others had failed, he was enabled to restore birds and quadrupeds previously suffocated in noxious air.

After artificial respiration with electricity has been carried on about 20 minutes, this stimulating cordial may be found still more beneficial. As

As the lymphatic vessels have been observed to perform their office, a considerable time after the other functions are abolished, part of this quantity will probably be absorbed during the operation; and therefore about half a pint more (if necessary) may be repeated, near the close of the process.

Stimulating Enemas.

Tobacco Smoke—its qualities.

51. Not only the stomach, but the intestinal tube annexed, constituting the alimentary canal, is every where most bountifully supplied with nerves, by which an intercourse is carried on with all the principal organs, and propagated to the remotest parts of the system. This canal, therefore, through its whole extent, may be well considered as the centre of sensibility and nervous sympathy; and, consequently, deserves particular attention, in all cases of vital suspension. Hence, various stimulants have been proposed for supporting its peristaltic motion, and for rendering it a proper medium for renewing nervous energy, by means of its sympathy with the other vital organs.

TOBACCO SMOKE injected into the intestines by way of enema, having at an early period of the art, been first employed in Holland, and its success highly extolled, the practice was soon adopted in this country, where after various trials, the result ap-

peared in some measure to justify the encomiums which had been bestowed on it.

Accordingly, the practice has been invariably pursued to the present time; and the machine for administering the tobacco enema still constitutes a principal part of the apparatus of the different Societies, instituted for the recovery of the drowned.

From the well known partiality of the Dutch to this their favorite panacea, Tobacco, and from their long habitual use of it, not only as a luxury, but a remedy, there seemed reason to suspect that its virtues had been over-rated, and perhaps too implicitly relied upon by English Practitioners. We, therefore, ventured, many years ago, to enter the following *Caveat*, with a view to bring its merit to the test of experiment; but without presuming to pass judgment upon it, prematurely.

“The sickness and universal languor, which these fumes produce on other occasions, when they penetrate beyond the valve of the colon, but ill accord with the idea of restoring vital action. So that it may be doubted, whether *these effects* of this noted remedy may not *counterbalance* its *stimulating* power. The same objection may be also urged against the nauseating effects of emetics in these cases.” *

* Hints on restoring Animation, in 2 letters to Dr. Hawes, published in his Address to the King and Parliament. p. 20. 1783. Doddsley.

Some late Writers, perceiving the force of the objection, have expressed the same doubts respecting the tobacco enema. Others have since, gone much further and condemned it in the strongest terms, and that chiefly for the following reasons. viz.

1st. Because it has been used with success in the directly opposite intention, namely, to relax, as far as is consistent with safety, the contractile power of the muscles, particularly with the view of subduing obstinate costiveness, or reducing strangulated hernias. It cannot therefore but be a doubtful, if not a very dangerous remedy, where the powers of life are already reduced to the lowest pitch.

2^{ly}. Because in some late experiments, where tobacco smoke was injected into the intestines of quadrupeds previously drowned, the action of the heart and muscles presently ceased, and irritability, instead of being restored by this remedy, was soon destroyed.

3^{ly}. Because the infusion of a single dram of tobacco injected in form of an enema, with a view to bring on a temporary debility, has been known to produce extreme sickness, vomiting, faintings, and cold sweats.

4^{ly}. Because 2 or 3 drops of the essential oil of this plant, when applied to the recent wound of an animal, have been found to cause an immediate palsy of the limb, generally followed by vomitings, convulsions, and death.

5^{ly}. If

5^{ly}. If its fatal oil accompanies the fumes of tobacco into the bowels, what may be supposed to be the consequence, where upwards of 2 ounces of this herb are consumed, in attempting to recover the drowned!

On the other hand, however, it ought to be observed, that the advocates for tobacco consider it not only as a very safe remedy, but the principal agent in the recovery. And in confirmation of their doctrine, appeal to the numerous instances of its success, that have been communicated to the different Societies. They further allege, that it can hardly be supposed that the respective Practitioners could all be so strongly prepossessed in its favor, as to unite in exaggerating its merit, or in palliating its mischievous consequences, had any such occurred.

Were its effects really as destructive as its opponents affect to believe, it would have been next to a miracle, had a single person survived the operation, where it was used with such freedom.

Besides, there are found certain votaries of tobacco, able to consume daily a larger quantity of the plant than the one above-mentioned, and that without inconvenience: * Others, who as a remedy in complaints

* Happening some time ago to meet a droll character of this stamp, a remarkable *quidist*, I asked him, how much tobacco might be his daily allowance?

“About two ounces and a half,” says he. — I next inquired,

complaints of the stomach, swallow both the smoke and the saliva in large quantity, without any apparent injury.

That the essential oil is highly poisonous cannot be denied, though certainly in a far less degree applied to the bowels than to a wound: The plant, it must be confessed, is still less so, and the smoke least of all.

The deleterious quality of the oil is also probably counteracted, partly by the alkali generated in the combustion, and partly by its union with the other component parts of the smoke.

On the whole, though the tobacco enema is by no means so dangerous as some have imagined, yet as it still appears in such "a questionable shape," it is hoped the following doubts will soon be cleared up, not by reasoning, but by a course of accurate experiments. viz.

1st. Whether its stimulant or sedative power is most predominant?

2^{ly}. Whether its utility depends on the specific qualities of the plant, or on the warmth and distention, which accompany its exhibition? 3^{ly}.

red, whether he was not afraid of chewing every day, such a quantity of a rank poison? "*Poison*, Master," replies he, stuffing his mouth with an enormous quid, and eying me with a look of ineffable contempt, "*Poison!*—why it is the staff of life—and I can prove it—For a man can live much longer without victuals, than without tobacco."

Then drawing nearer, added he, in a half whisper—"Did you ever know a man die, Master, while able to chew his quid of tobacco?"——Here, rolling his *quid* briskly, and looking archly—he marched off with an air of triumph—muttering the word "*Poison*"—— * * * * *

3¹⁷. Whether the sickening and debilitating effects, which generally accompany its operation, are not inimical to sensibility and irritability—and whether a bladder of warm vital air, which has been shewn to be congenial to both (29—32), might not be advantageously substituted in its place?

But since the cause of tobacco has been lately so very ably defended by our worthy Register, we here drop the pen; for we presume not to decide “where Doctors disagree;” and as the cause is at issue, refer our Readers to—TRANS. of the R. H. S. Vol. 1. p. 503.—where the virtues of this much *injured* plant are amply displayed, and its re-animating powers nobly asserted.

———“*Si Pergama dextra
Defendi possent, etiam hac defensa fuissent.*”

VIRG. ÆN.

After all, should, an unelastic fluid be preferred in this intention, the aromatic vinous cordial above-mentioned (48), or either of the following forms might be properly administered, as a stimulating enema.*

Stimuli adapted to the Organs of Sense.

52. Particular stimuli, appropriated by Nature to affect the external organs of sense only, are light to the

* Take of warm water—3 quarters of a pint.

—— of fresh mustard—half an ounce.

—— of etherial oil of turpentine—2 drams.

The whole to be incorporated with the yolk of an egg.

Or, Take of strong infusion of horse raddish root—12 ounces.

—— of pure spirit of sal ammoniac—1 dram.

the eye, sound to the ear, odors to the nostrils, &c. But during a complete suspension of the sensorial power, the mind is no longer conscious of the impression of the wonted stimuli; because the brain cannot perform its office without the concurrence of the other vital organs.

Before the senses can be recovered, the necessary means must be previously employed to restore respiration and circulation. While these two requisite conditions are wanting, stimuli applied to the external organs cannot restore lost sensation, though they may afford an *useful Test* to determine whether any degree of sensibility still remains. Though they are not always to be depended upon as primary remedies, they may be considered as important *auxiliaries*.

Hence, in ordinary cases of syncope, the natural stimuli alone often succeed in rousing the torpid powers, without any artificial aid, but more generally require to be increased by art, or their intensity augmented, to produce any sensible effect. Though a person in profound sleep is not disturbed by the tinkling of a small bell, yet he suddenly awakes on the ringing of a full peal.

Though the dim light of a small taper may not sensibly affect the eye of a drowned person, yet the resplendent blaze of a large candle burning in a jar of vital air, might cause the dilated pupil visibly to contract.

Amongst

Amongst the class of stimulants used on those occasions, it seems remarkable that blisters and sinapisms have been passed over in silence, though evidently entitled to a place among the external applications, especially as they might be easily tried, without interfering with the other parts of the process.

One of the most active stimuli that can be applied to the external organs of sense (electricity perhaps excepted), is the pure volatile alkaline spirit already mentioned: the effects of which in recalling persons from sudden faintings are much superior to those of hartshorn, or even the best concentrated vinegar.

Therefore a feather, dipt in this penetrating fluid, may be successively applied to the different organs of sense, viz. To the angle of the eye, to the cavity of the ear, to a slight incision in the skin, and particularly to the internal surface of the nostrils.

Applied thus directly to the olfactory nerves, unless sensibility has wholly forsaken them, its subtile stimulus will be instantly propagated to the common *SENSORIUM*, or centre of impressions—an effect not easily accomplished, perhaps, by any other means.



S E C T. XV.

Compendious View of the Method of conducting the
PROCESS.

53. Having thus impartially examined at some length the remedies employed by the Humane Societies, and endeavoured to ascertain their respective merits, with a view towards improvement; we proceed to reduce the method of conducting the process into a more compendious form.

In all cases of apparent death, time presses, and the urgency of the case demands uncommon expedition. For in this critical situation, the vital spark, like the last glimmering of a taper, at each succeeding minute, grows more and more feeble, till the instant it expires!—Not a moment then, surely, ought to be lost—

To prevent delay, therefore, by which too many already have perished, PROPER HOUSES OF RECEPTION, supplied with the necessary APPARATUS (43), ought to be established in every Market-Town, and particularly in all Sea-Ports throughout the Kingdom.—See Dr. Hawes's Address, &c. 1783.

Thus prepared, the most efficacious measures might be immediately pursued by the Assistants; not in hurry and confusion, but with method and regularity, conformable to a well digested plan. As

As soon as the object arrives, all spectators should be excluded the room, except those that are absolutely necessary, and which perhaps never need to exceed 7 in all, including the medical Assistants: two of whom may perform artificial respiration, while two more conduct the electrical operation: two others may manage agitation of the body with friction, while another assists occasionally and hands the necessary utensils.

A greater number will not only embarrass the operation, but render the air impure by their respiration. If the weather will permit, the windows should be kept open, otherwise the temperature regulated between 64 and 70° of Fahrenheit's thermometer.

For the contaminated air of a crowded room, in cases apparently favorable, may defeat all hopes of success, as we have seen with regret, in more than one instance.

If the season be perfectly serene, the body may be placed in the open air to receive the genial warmth of the solar rays, while the other necessary means of recovery are pursued.

The body if wet, must be immediately well dried, to prevent the chilling effects of evaporation (20), and then be wrapped in warm blankets, or the warm clothes taken from some of the spectators, unless the cooling process (45), should be first necessary, in consequence of the object being in an half frozen state. For in that case, it ought to be rubbed with snow, or
flannels

flannels wrung out of cold water, before any degree of artificial warmth can be safely applied.

The internal heat must therefore be determined in the first place, by the thermometer; and the external temperature must be regulated accordingly.

Having prepared a bed or mattress, on a table of a proper height, the body is to be placed thereon, with the head elevated by 2 pillows; when the different parts of the process may be conducted in the following order.

1st. Let the lungs be immediately inflated by means of the proper instruments described in the Appendix. The operator having passed the fore-finger of his left-hand as far into the throat as he can, along this, let him direct the end of the flexible tube (No. 3.) till it has got about 2 inches within the passage leading to the stomach. Then move the ivory sliding director along the tube as far as the finger will reach, till it secures this passage, so as to prevent the entrance of air into the stomach, allowing the opposite end of the tube to hang out of the right angle of the mouth. Let him next depress, and draw forward the tongue with the left-hand, while with the right he directs the point of the silver canula (No. 2.) along the left side of the throat beyond the root of the tongue, till it slides into the aperture of the wind-pipe.

Then having secured the opposite end of the ca-

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nula to the pipe of the bellows (No. 1.), by means of the leathern mouth-piece (No. 2.), the nostrils and mouth being accurately closed by the assistant, who sustains the canula in its place; The operator resting the bellows on his knee, and sitting behind the patient, endeavours to imitate a full inspiration, by injecting into the lungs 112 cubic inches of vital air, or if this unfortunately be not in readiness, common air. When every attempt to introduce the canula into the wind-pipe proves impracticable, recourse must be immediately had to Bronchotomy (45).

2^{ly}. The electrical machine (No. 6.) being prepared, the body insulated, and the lungs expanded, let one discharging rod be placed just below the right breast, and the other above the short ribs of the left, the electrometer being moved a quarter of an inch from the jar, let the electrical current be passed directly through the heart. The electrical shock being given, let the lungs be emptied by making an expiration with the double bellows, or by suffering the air to escape by the mouth, while gentle pressure is made on the chest.

The moment this is accomplished, let the lungs again be expanded, and the shock repeated, varying its direction, its power, and its frequency, as circumstances may point out.

3^{ly}. These alternate operations having been duly carried on about 15 or 20 minutes, let the stimulating cordial (50) be conveyed through the flexible tube into the stomach, by pressing the vegetable bottle in which it is contained (No. 4.).

4^{ly}. Immediately after this, either of the stimulating enemas (51) may be also properly administered, or what would perhaps be preferable, warm vital air (49). The cordial and enema may, if necessary, be repeated near the close of the process.

5^{ly}. These internal stimulants being given, and bladders of tepid water applied to the region of the stomach and to the extremities, the legs and arms must be diligently rubbed with the warm hand or with flannel, or a hare-skin impregnated with the fumes of gum benzoin. The frictions must be gradually extended to the thighs, abdomen, and chest.

6^{ly}. Should a warm bath happen to be at hand, the temperature must at first be very low, beginning at about 40 degrees, raising it gradually, and with great circumspection to 70 or even 80°. During his stay in the tepid bath, which may be 15 or 20 minutes, the friction with a warm hand or flesh-brush under water, may be pursued without interruption.

7^{ly}. As soon as these means of restoring heat and
L 2 sensibility

fenfibility have been tried, the internal temperature of the body may again be examined by introducing the thermometer (No. 9.). If the temperature be increased, even in the flightest degree, it affords a good omen, and the operator must proceed with all possible diligence and circumspection.

8^{ly}. Particular stimuli may next be applied to the organs of sense, as a strong light to the eye, and pungent substances to the olfactory nerves, especially the pure volatile ammoniacal spirit.

Should sneezing or any visible emotion ensue, it will be evident that the sensorial powers are beginning to recover their sensibility.

9^{ly}. Artificial respiration and electricity, having been only suspended 15 or 20 minutes during the exhibition of the internal remedies, and tepid bath, are now to be renewed together with friction, and continued at intervals, during the whole time. Electricity may also sometimes be transmitted through the spine, and other parts of the body; varying the current from positive to negative, and from sparks to shocks.

10^{ly}. At that critical period, when slight twitchings or gaspings mark the first dawn of returning life, instead of increasing, it will be prudent to moderate the stimulating powers, lest the irritable fibres should be exhausted by too frequent, or unnecessary exertions (46).

11^{ly}. The process above-mentioned should be continued the full space of 3 hours, with very few intermissions, unless the vital functions should be restored sooner.

If, at the end of that period, the unfavorable symptoms instead of diminishing should increase, attended with other evident signs of the extinction of life (38), the case may be considered as utterly hopeless, and therefore the process may be discontinued.

Still, however, before quitting the room, it may not be improper to order a strong blister to be applied to the region of the heart, and warm sinapisms to the feet, first sprinkled with the volatile alkaline spirit.

12^{ly}. Where no medical assistant can be had in time, the lungs may be inflated, though less perfectly by means of the conical tube (No. 5.), or any other pipe adapted to the nostril, and secured at the other end to the nozzle of a common pair of bellows, while the mouth and opposite nostril are kept close by an assistant.

Not only this, but the rest of the process (electricity perhaps excepted) might certainly without much difficulty be performed by the common people, were they properly instructed; since it appears that, in Holland, more than half the recoveries of the drowned are brought about by them alone, though, at home, we know but few instances of this sort.—Reports of the *R. H. S.* 1787 to 89. p. 11—13.

13^{ly}. When the natural respiration, and the power of swallowing are restored, the patient should be put into a bed moderately warm, with his head properly raised, and his feet wrapped in warm flannel.

Warm whey and other diluents may now be administered, to encourage a gentle perspiration. But he ought by no means to be left alone, till he has perfectly recovered his senses: some persons having relapsed, and afterwards perished from being deserted too soon, even after the functions were apparently restored. Unhappy instances of this sort have been properly noted in the Society's Reports.

14^{ly}. Should feverish symptoms ensue, accompanied with a sense of heaviness or dull pain in the head or chest (as frequently happens in consequence of the severe discipline so lately undergone), moderate bleeding together with mild laxatives and a cool regimen will generally afford the desired relief.

Application of the Plan to the various kinds of Suffocation.

54. From what has been advanced concerning the nature and proximate cause of suspended animation (29)—and from the similarity of appearances in all the different modes of suffocation, it seems evident that the general plan with the improvements proposed (53) may (with suitable variation) be rendered applicable

applicable to all the different species of the disease: Not only to cases of drowning (1), strangulation (6), and suffocation from noxious air (7), but also to those of intoxication (41), smothering (11), and vital suspension in children still-born (10). Moreover, it equally applies to the various kinds of syncope (46), and sudden faintings, whether the disease be brought on by a close crowded room, the hysterical passion, violent emotions of mind, strokes of lightning (46), or exposure to intense cold (20—39).

In that death-like syncope, however, occasioned by those violent floodings to which child-bed women are often incident, or those more dreadful effusions of blood, under which our gallant soldiers and seamen sink down exhausted in time of battle, a general paleness overspreads the whole surface, and the breathless body becomes as cold as marble—a situation which affords an exception and demands a more than common share of skill and discernment in the treatment.

In order to recall life as speedily as possible, it has been usual, on those occasions, to pour down a considerable quantity of hot wine, spirits, or other stimulating liquors, than which, nothing can be more injudicious.

Practitioners ought therefore to be admonished, that the syncope is the *dernier ressource*, which Nature calls to her aid, to stop the torrent, and to preserve life. During this truce, the particles of

blood coalesce into a glutinous mass to seal up the bleeding vessel. To interrupt this salutary process prematurely by heating cordials, is in effect, to renew the effusion of blood, and to precipitate the patient's fate!

Here, any attempt to restore animation by the application of heat, friction, or electricity, according to our general plan, would be equally injurious by increasing the hæmorrhage. Instead of which, the body ought instantly to be exposed to a free current of air, and treated according to the cooling method. If the syncope however still continues after the bleeding has stopped, or the vessel been secured, prudent measures must be used to restore respiration. Might not vital air artificially cooled supply the most innocent, yet animating fluid for that purpose? Should this fail to renew the circulation, from the heart being deprived of its due quantity of blood, might not this be replenished from the vein of an healthy animal? If ever the operation of transfusion can be really beneficial, is not this the proper moment for a trial?

The principal arguments adduced in the preceding inquiry might be illustrated by an ample induction from facts, but having already exceeded our present limits, this must be left to a future opportunity. In the interim, the intelligent Reader will be pleased to exercise his own judgment, in applying the general principles to particular circumstances.

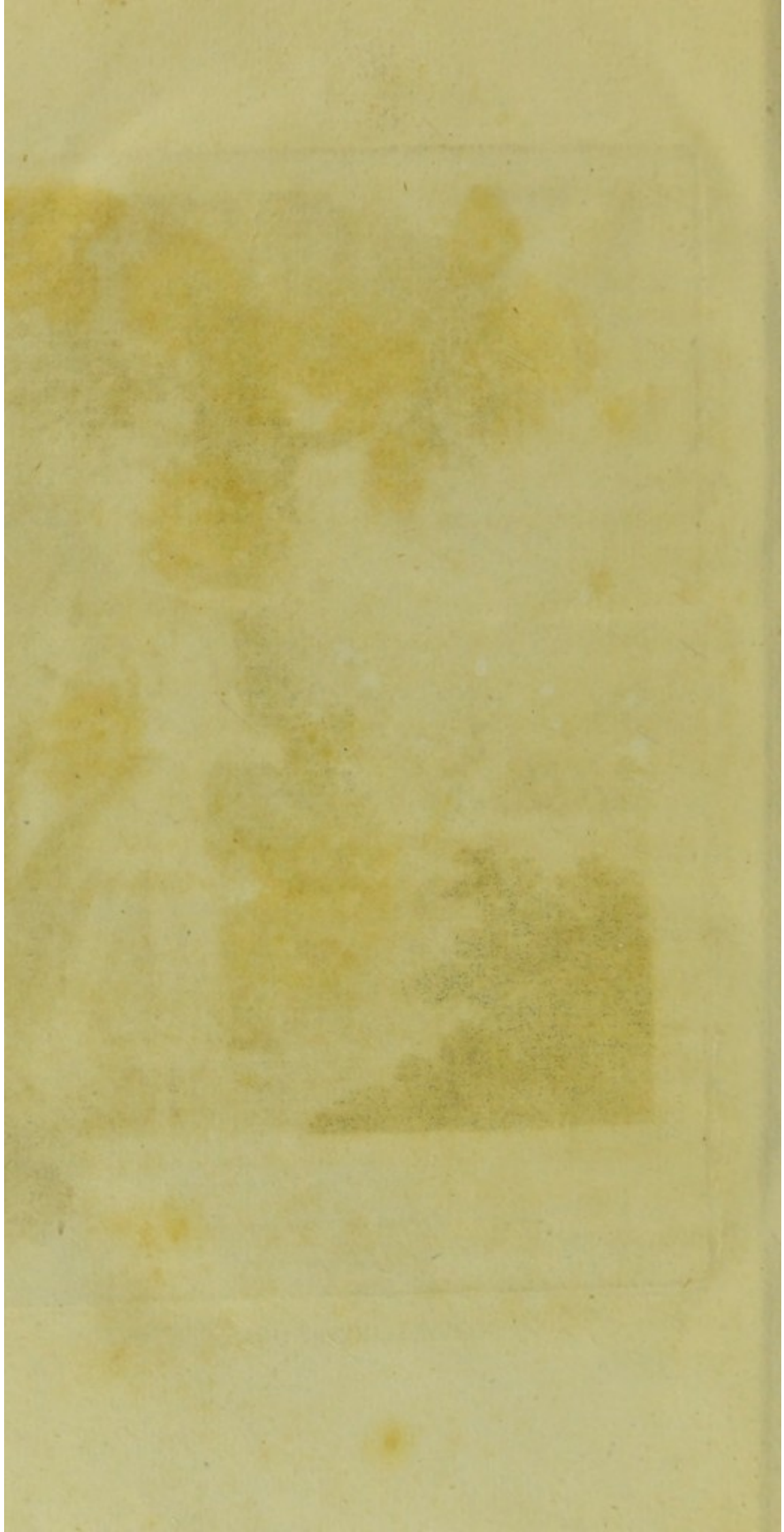


E. Panny del.

Returning Animation.

P. Audinet sc!

*Engraved from the Original, by Permission
of the Proprietor.*



A P P E N D I X.

DESCRIPTION OF THE APPARATUS,

With Hints for additional Improvements.

The Apparatus employed by the Royal Humane Society, and other similar institutions, with their latest improvements, may be seen at their respective instrument Makers in London.*

Though many of the articles are liable to some slight inconveniences, yet all of them may, in skilful hands, be made to answer the intention.

Were we to propose any additional improvements, the apparatus should consist of the following articles. viz.

No. I. In place of an air Syringe, a pair of DOUBLE BELLOWS, with proper valves to perform the double office of inspiration and expiration, having one department for conveying the pure, and another for excluding the impure air. Of a portable size, but sufficient to convey, at each inspiration, 112 cubic inches of air.

* Particularly at Mr. Savigny's, Pall-Mall—Field's, Cornhill—Dickinson's, West Smithfield—&c.

II. A SILVER CANULA, of the form of a male catheter, but of larger diameter, adapted to the nozzle of the bellows. To be introduced into the orifice of the wind-pipe, for the more effectual conveyance of air into the lungs, or by an opening into the trachea, in case of Bronchotomy. The canula may be united to the nozzle of the bellows, either by a flexible tube, or a conical mouth-piece of leather, securing the juncture with waxed twine.

III. A FLEXIBLE TUBE (of the same composition as flexible catheters), to be introduced into the œsophagus, for conveying into the stomach wine or cordials: Having a moveable ivory director of a conical form, at its upper extremity, which by the fore-finger may be made to slide along the instrument into the opening of the œsophagus; not only to prevent air escaping into the stomach, but also to guide the silver canula into the wind-pipe.

IV. A VEGETABLE BOTTLE for injecting liquids into the stomach, through the above flexible tube; the mouth of the bottle being adapted to the upper end of the tube.

Or the liquor might be poured into the tube through a small glass funnel.

V. A CONICAL TUBE of wood or ivory about 4 inches long, adapted to fill the cavity of the nostril. The opposite end being wide enough to receive

ceive the nozle of any pair of common bellows, and being lined with soft leather, to fit the clofer, air may thus be conveyed into the wind-pipe, while the mouth and oppofite noftril are fecured by an affiftant. This fimple apparatus alone, might be ufed by the common people, where medical aid could not be readily had.

Were the tube made forked, it would be ftill better, as the lungs might then be inflated by both noftrils at the fame time.

VI. A SMALL ELECTRICAL MACHINE, with an electrometer annexed, and a coated jar of about 26 inches, compofed of thin glafs, together with a pair of difcharging rods properly infulated.

VII. VITAL AIR in cylindrical glafs jars, of a gallon or upwards each, inverted with their mouths downwards in a large tub of lime-water, and well-secured from the external air.

VIII. STIMULATING REMEDIES, particularly the pureft volatile alkaline fpirit—alfo a fmall quantity of each of the following, viz. eau de luce, falt of vinegar, fpirit of lavender, tincture of cinnamon, &c. in fmall phials of ground glafs, well fecured.

IX. A SMALL THERMOMETER with a fliding fcale, proper for determining animal heat.

X. AN ELASTIC MACHINE for injecting stimulating enemas: also a TOBACCO INSTRUMENT, for conveying the warm fumes into the intestines, should the latter be preferred.

XI. PHOSPHORIC MATCHES, WAX TAPERS, TWINE, &c.

XII. AN ADDITIONAL ELASTIC TUBE, for conveying vital air from the under part of the jar to the inhaling valve of the bellows, where the orifice must be rendered air tight. About the middle of the tube, a stop-cock to admit the air during inspiration, and to intercept it during expiration. The Vital air, if managed with œconomy, may be respired 2 or 3 times successively, when it will still be found more pure than common atmospheric air—being now less liable to be contaminated than in natural breathing.

Should the advanced price of nitre render the preparation of vital air too expensive a remedy, the latter may be obtained by a similar process from manganese, wherever that mineral can be easily procured. Besides the air from manganese has been lately discovered to be of superior quality, and in greater abundance—a circumstance of no small importance, now that the demand for vital air, on account of medicinal purposes, is daily increasing. Nor is this to be wondered at, since the new light, which

which it continues to reflect on the œconomy has already begun to dawn on the pathology—a circumstance which seems to denote that a material **REVOLUTION** in the Practice is at no great distance.

The whole Apparatus, exclusive of the double bellows, electrical machine, and air jars, may be comprised in a small portable case, similar to that which is employed by the Royal *H. S.*

The silver canula and flexible tubes, being similar to those improved ones lately introduced into use, specimens may be seen at the different instrument-makers, where they may be adapted to the double bellows. The rest may be easily conceived, without further description or engravings.



R E C A P I T U L A T I O N,

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General Inferences from the Whole.

From the preceding arguments may be drawn the following deductions, which (in order to assist recollection) are here brought into a more concise and perspicuous point of view.

It seems reasonable to conclude then,

1. That the faculties of Man, compared with those of other animals, or even with those of individuals of his own species, cannot be explained on the principle of organization, or apparent difference in the structure of the brain.
2. That Man differs from other animals, not only in the extent, but the nature of his faculties—that human reason is essentially different from animal instinct, and that philosophers have erred in attributing the properties of MIND to Matter.
3. That Vitality is the attribute of an organized being alone, and therefore the blood being an inorganic mass cannot with propriety be pronounced to be alive.

4. That

4. That the vital or animal Principle is not to be considered as a separate being, confined to the brain, or residing in some particular organ.

5. That Irritability, though allowed to be the principle of vitality, requires other conditions essential to organic life, to produce the functions of an animated being.

6. That in addition to the other requisites which constitute animal life, Man is endowed with a rational soul, the faculties of which distinguish him from all other creatures, and give him a decided pre-eminence in the scale of sublunary beings.

7. That the essence of the Soul, and the nature of its connection with the corporeal frame are wholly unknown, and can only be traced from their effects.

8. That in drowning, a small portion of water generally enters the lungs—that the blood is accumulated in the right chamber of the heart and venous system—that the organization of the principal parts remains entire, and the brain free from extravasation.

9. That in hanging, the phenomena are nearly the same, only the vessels of the brain more distended.

10. That suffocation from noxious air destroys life sooner than drowning, though the phenomena in general are similar, only in the former, the body remains more flexible, and retains its heat longer—That in either case, the appearance of the lungs is uncertain; sometimes they seem collapsed—sometimes, distended—at others, quite natural—The brain also free from any sign of extravasation.

11. That air is essential to all breathing animals—that vital air is the only respirable part of the atmosphere fit to support life or flame—that part of it is expired in form of carbonic air, and part retained in the system.

12. That vital air changes the blood in its passage through the lungs to a more florid colour—that the blood alternately contracts impurities in its circulation, and is alternately purified by the process of respiration.

13. That the heat of the human body preserves an even standard in infancy and old age, under every variation of climate from the Equator to the Poles.

14. That it is principally, if not wholly dependent on respiration and the oxygenation of the blood—

blood—That this is carried on by a curious chemical process, during which a double elective attraction seems evidently to take place.

15. That the PROXIMATE CAUSE of death in the various modes of suffocation cannot be fairly traced to water imbibed into the lungs, nor a surcharge of blood in the brain, or accumulation in the heart, nor yet to a collapse of the lungs, or defect of latent heat, nor, in short, to any other circumstance that has hitherto been assigned.

16. That the IMMEDIATE CAUSE of SUSPENDED RESPIRATION is the exclusion of vital air from the lungs—That if to this, be added the extinction of irritability, it constitutes the PROXIMATE CAUSE of DEATH.

17. That this opinion is not very remote from the truth appears from this, that it affords a key whereby all the principal symptoms may be explained.

18. That VITAL AIR affords an easy explanation of many intricate phenomena in Nature, particularly in the animal œconomy, which otherwise would appear inexplicable.

19. That SENSIBILITY and IRRITABILITY, though generally confounded, are distinct in their

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nature and in their origin—that the former depends on the nerves, the latter on a property peculiar to the muscles.

20. That the heart gives the first indication of irritability, and besides other peculiarities, retains it longer than the other muscles.

21. That VITALITY consists in action and re-action, between the vital organs and their respective stimuli—that the irritable fibre is never passive, but in a constant state of action.

22. That in nicely adjusting stimuli to the due tone of the irritable fibre consists the PRINCIPAL SECRET in the art of healing.

23. That irritability is stronger in the lowest order of animals than in Man—that this compensates for their want of sagacity—that the final cause is the preservation of life.

24. That vital air is essential to irritability, and may be considered as its PROXIMATE CAUSE—that this was FIRST hinted by the Writer in 1783, though lately brought forth by some other authors, as a DISCOVERY ENTIRELY NEW.

25. That the effects of irritability, and the action of chemical stimuli admit of a more satisfactory solution from this, than from any other cause. 26.

26. That the MECHANISM OF THE BRAIN is NOT the proximate cause of mental operations, but only the instrument by which the human SOUL is destined to perform its functions through a corporeal organ.

27. That the SENSIBILITY of the system depends on the different degrees of excitement of the brain, and of the sentient extremities of the nerves.

28. That irritability is not dependent on the same cause as sensibility, as Professor Cullen supposed, since it prevails among the vegetable tribes destitute of brain and nerves.

29. That irritability alone is sufficient to illustrate the periodical revolutions, and other singular phenomena of plants, without having recourse to a PERCEPTIVE faculty which implies INTELLECT.

30. That the daily expenditure of vital air is amply replenished by a powerful combination of natural powers during the presence of the sun.

31. That this explains why serene sun-shine gladdens all Nature, and why darkness if too sudden, or too long continued depresses the spirits, and is unfriendly to health.

32. That, with ADMIRABLE ŒCONOMY, the
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different parts of Nature are rendered at once subservient to the mutual support of each other, and the general HARMONY of the WHOLE!

33. That ELECTRICITY and HEAT bear a striking analogy to each other, and yet differ materially in some respects—That the former, from the celerity of its movements, and from its effects being SIMULTANEOUS, is more peculiarly adapted to explain the phenomena of the nervous system.

34. That although the perfect identity between this and the nervous influence has not been demonstrated, yet some late experiments tend to confirm it. Not to mention that the torpedo and gymnotus evidently possess a certain species of electricity, over which they have complete command.

35. That the NERVOUS ELECTRICITY seems subject like irritability to accumulation, diminution, and tone—that from these different states may be explained many curious phenomena of the nervous system, which otherwise would appear extremely mysterious.

36. That the nervous influence was attributed to the principle of electricity by the Author more than a dozen years ago—that the doctrine therefore of nervous electricity, which now makes so much noise in
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the philosophical world, and which Galvani's experiment tends powerfully to confirm, is not so entirely *new* as is commonly imagined.

37. That in DROWNING, certain circumstances hasten on the fatal event, while others tend to protract it—that NO certain CRITERION of the presence or absence of life can be drawn from any *single* symptom—that this however may generally be determined from a certain *assemblage* of signs considered collectively.

38. That NATURE'S PROCESS IN RESTORING ANIMATION, and the extent of her resources ought to be previously known, before we can appreciate the efficacy of artificial means.

39. That the TORPID STATE of certain dormant animals bears a strong resemblance to apparent death from drowning or suffocation—that they are revived by moderate warmth, but destroyed by sudden heat.

40. That in vital suspension, the two PRINCIPAL INDICATIONS are to restore RESPIRATION, and the ACTION of the HEART—that if these two primary organs can be brought to act in unison, the subordinate movements will generally follow in succession.

41. That **VENESECTIONS**, though apparently indicated, is a very doubtful, and even dangerous operation, and ought not to be hazarded, at least till the circulation be restored.

42. That **EMETICS** are also very dubious remedies, and can rarely be necessary on those occasions, unless immoderate repletion previous to the accident should be known to interrupt the general process.

43. That **ARTIFICIAL RESPIRATION** is an important part of the treatment, and ought to be performed at the beginning, and pursued till natural breathing can be re-established—that its effects will be more certain and expeditious if conjoined with **ELECTRICITY**.

44. That **VITAL AIR**, recommended by the Writer long ago, has been found preferable to atmospheric air, or air blown from another person's lungs, for the purpose of artificial respiration.

45. That **COMMON NITRE** involves in its substance the basis of gun-powder and vital air—two opposite principles, the former destined to destroy, the latter to preserve human life.

46. That, not only medical pupils, but other intelligent persons, in every parish, ought to be instructed

structed in the method of inflating the lungs—that this may be tolerably executed by the common people, even without the proper inflator, in places remote from medical aid: Also other parts of the process, electricity excepted.

47. That the INFLATOR ought to contain 112 cubic inches of air, as a proper quantity for one inspiration—that the operation ought to be conducted with more precision than has hitherto been done.

48. That ELECTRICITY is one of the most powerful stimulants—that its power ought to be adjusted to the feeble state of the system—that moderate vibrations are more safe and efficacious than strong shocks—that it ought to accompany artificial respiration, though it may be safely applied independent of that operation, during any part of the process.

49. That HEAT is essential to animal and vegetable life, and therefore has been employed as one of the most powerful means of restoring animation—that it requires however much caution, and seldom succeeds alone unless respiration be previously restored—that it ought to be carefully regulated by the internal heat of the body.

50. That, instead of artificial heat, the Ruffians apply SNOW or COLD WATER to the apparently dead body—that this COOLING METHOD, howe-

ver paradoxical it may appear, is nevertheless attended with surprising success, particularly in cases of suffocation from noxious air.

51. That the *USUAL METHODS* of communicating heat are very uncertain—that the temperature is fluctuating, sometimes too little, often too great—that it ought to be adjusted by the thermometer—that if the internal heat keeps pace with irritability, it may afford a *NEW TEST* of the presence or absence of life.

52. That *AGITATION* of the body has alone sometimes succeeded in restoring vital action—that it affords a speedy mechanical stimulus to the whole frame—that it is easily performed by the common people.

53. That *FRICTION* also under due regulation is a very useful auxiliary in stimulating the cutaneous nerves, and in expediting the motion of the blood towards the heart—that the rough manner in which it is often conducted may prove mischievous—that saline, spirituous, or unctuous substances, instead of increasing, tend to diminish its efficacy—that it may be best performed with the hands, or flannels impregnated with the fumes of gum benzoin.

54. That a stimulating **CORDIAL** is highly necessary—that it may be safely conveyed into the stomach without occasioning any danger of suffocation—that spirituous liquors being exhausting stimuli are less proper than generous wine with a small addition of some cordial tincture, or volatile alkaline spirit.

55. That stimulating **ENEMAS** are also indicated—that their effects, like those of cordials, are propagated to the other vital organs by sympathy—that the **TOBACCO** enema appears to be a doubtful remedy, though not so dangerous as some imagine—that while it is condemned by some, it is ably defended by others—that the cause remains *sub judice*, and waits the result of future experiments.—That in the interim, **WARM VITAL AIR** and other stimulants of a less equivocal nature might deserve a trial.

56. That **STIMULI** adapted to the **ORGANS OF SENSE** may prove useful auxiliaries and afford a **TEST** whether any degree of sensibility remains—that next to electricity, the pure **VOLATILE ALKALINE SPIRIT** appears to be the most active.

57. That in cases of apparent **DISSOLUTION** not a moment ought to be lost—That **RECEIVING HOUSES** with the necessary apparatus as recommended by Dr. Hawes might tend to save many lives, and prevent that delay and subsequent hurry and confusion by which numbers are lost—That the **PRO-**
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cess ought to be conducted with METHOD and regularity, and with an eye to all the concomitant circumstances.

58. That the electrical current should be directed through the region of the heart, during the expansion of the lungs—that a full expiration then should be made, and the shock again immediately repeated; varying its power and frequency as circumstances may point out.

59. That after these alternate operations have been carried on 20 minutes, the stomachic cordial and stimulating enema ought to be administered.

60. That to these, should succeed the warm bath, beginning at 40 degrees, and gradually raising it to 70 or 80—that where this cannot be had, bladders of warm water may be applied to the region of the stomach, and to the extremities.

61. That friction may accompany the operation the greatest part of the time, even during the tepid bath.

62. That when signs of returning life begin to appear, the stimulating powers ought to be moderated, lest the irritable fibres should be exhausted by too powerful excitement.

63. That the process ought to be continued with patience and perseverance the full space of 3 hours, or while any hopes remain.

64. That after the functions are restored, the patient ought not to be left too soon, for fear of a fatal relapse—but treated according as the subsequent symptoms may appear to indicate.

65. That the general plan, with suitable variations, is applicable to all the different species of vital suspension.

66. That the formidable syncope occasioned by excessive floodings or other great and sudden effusions of blood, affords an exception to the general method, and demands the utmost circumspection—that the ancient operation of transfusion might perhaps, on this occasion, deserve to be revived.

67. Finally, that the GRAND INTENTION of the WHOLE ARTIFICIAL PLAN is to REMOVE EVERY KNOWN OBSTACLE—to CALL FORTH THE HIDDEN RESOURCES OF NATURE—and ENABLE HER TO RESTORE A FREE RESPIRATION AND CIRCULATION.



CONCLUSION.

C O N C L U S I O N .

It is now time that this DISSERTATION should draw to a CONCLUSION, though many topics still remain upon which we could expatiate with pleasure.

The THEORY OF ANIMATION presents a spacious field for inquiry, abounding with curious and inviting objects which engage our attention at almost every step. But the present excursion has only permitted us to take a short and transient glimpse of that grand assemblage, and to select from the number those only that appeared to be most worthy of attention.

To such of our ingenious Colleagues as may be inclined to take a larger range, and to contemplate the whole at leisure, these cursory observations are cheerfully offered, hoping they may tend in some measure to facilitate their researches.

In the course of our inquiry, many difficulties have started up, and though some of them have been surmounted, yet others still remain, concerning which we could only offer probable conjectures. Such, however, may still not be without
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their use, though they should even prove erroneous. For if they serve only to stimulate some abler Writer to take up the pen where we are obliged to drop it, (though with no other view than to detect their fallacy) yet still the end will be answered.

“Vice fungar cotis.”

It is by collision chiefly, that those sparks of Genius are elicited, which contribute to irradiate the darkest subject, and to point out the direct road to truth.

Since no person from the Prince to the Peasant can at all times be secure from those dreadful disasters, which suddenly suspend vital action; and since medical Practitioners themselves are by no means exempt; it surely becomes them to use every exertion to IMPROVE THE ART OF RESTORING ANIMATION.

May each progressive step in this interesting path of science tend to that GREAT OBJECT! And may every laudable attempt, undertaken with that benevolent view, enable us with MORE CERTAINTY TO PRESERVE LIFE, AND TO DIMINISH THE SUM OF HUMAN MISERY!

THE END.

