The Crounian lectures on muscular motion. For the years MDCCXLIV and MDCCXLV. Read before the Royal Society ... Being a supplement to the Philosophical Transactions for those years / [James Parsons].

THE

CROUNIAN Lectures

ON

MUSCULAR MOTION.

For the Years MDCCXLIV and MDCCXLV.

Read before the

ROYAL SOCIETY:

By JAMES PARSONS, *M. D.* and *Fellow of the* ROYAL SOCIETY.

Being a SUPPLEMENT to the *Philoſophical Tranſactions* for thoſe Years.

Mundi Pars eſt Aer, *& quidem neceſſaria: hic eſt enim qui Cœlum Terramque connectit.*

SENEC. *Nat. Qu. l.* 2. *c.* 4.

Animantes autem adſpiratione aeris ſuſtinentur. Ipſe enim Aer *nobiſcum videt, nobiſcum audit, nobiſcum ſonat; nihil enim ſine eo fieri poteſt.*

CIC. *de Nat. Deor. l.* 2. *c.* 33.

LONDON:

Printed for C. DAVIS, over-againſt *Gray's-Inn-Gate* in *Holborn*; PRINTER to the ROYAL SOCIETY. 1745.

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TO

MARTIN FOLKES, Esq;

PRESIDENT,

AND TO THE

COUNCIL and FELLOWS,

OF THE

ROYAL SOCIETY,

THESE LECTURES

ON

MUSCULAR MOTION

Are humbly Dedicated by

Their Most Obedient,

And Most Humble Servant,

JAMES PARSONS.

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PREFACE.

I.

AS the following Sheets were compoſed rather by Injunction and Duty than Choice, it is hoped their Imperfections may claim ſome Indulgence from the Reader; ſince ſuch Freedom can ſcarce be exhibited in the Proſecution of a Subject ſo difficult and confined, as might be expected, if it were more agreeable to the Author, or leſs limited and particular in its Nature.

However, I flatter myſelf that ſomething New will be found in what I offer as my own; *which, perhaps, is capable of being further improved hereafter, towards the Explanation of the Manner in which* Muſcular Motion *is performed.*

II.

The Air *is a principal Agent of Motion thro' all Nature, and may be called the* Spring *of all moveable Bodies. No Animal can move on the Earth, in the Atmoſphere, or Waters, without its kindly Aſſiſtance; nor can there be any Growth of either Animal or Vegetable Bodies, unleſs promoted by this moſt uſeful Element: In ſhort the* Phænomena *in Nature are numberleſs, that neceſſarily require its Aid. In this Light, I find it highly concerned in the Actions of Animals; which, I think, will clearly appear by the Uſe I make of it in accounting for thoſe of their Muſcles: And I find, that without ſuppoſing it ſo, no probable Conjectures can be produced towards accounting for that Motion, which a Review of the ſeveral Opinions of the Authors mentioned in my firſt Lecture will ſufficiently teſtify.*

III.

What the Soul *is, or in what Manner ſhe makes her Impulſe on thoſe Parts of Animals that*

that are the immediate Inſtruments of Motion, we dare not attempt to gueſs; theſe being wrapp'd up among thoſe Secrets only known to HIM *that order'd all Things: But, as the* Bodies *of Animals are mechanical, and therefore naturally fall within the Sphere of our Underſtanding, we may make ſome Attempts towards explaining the ſeveral* Phænomena *that belong to it; and therefore we can only conſider how its Organs are actuated, and not what is the Cauſe of their Motion; and muſt take it for granted, that the* Soul *makes her Impulſe on the Organs, and then endeavour to ſhew the Nature of the ſeveral Conſequences of that Impulſe, as far as it relates to the Motion of the Muſcles.*

IV.

And this is carried on, as the Reader will find, upon a Plan and Foundation not merely conjectural, as is the Caſe of moſt Writers on this Subject, but (1.) *upon the Knowledge of the Structure of a muſcular Fibre;* (2.) *upon a due Conſideration*

ſideration of the Uſe of the Interſtitial Air, *and its Counter-action with that contain'd in the nervous and muſcular Syſtem; and (3) upon my Obſervation of the Circulation of the Blood, in the minute Veſſels of ſeveral Animals, and their parallel Direction to other Fibres: All which Particulars are my own Diſcoveries; and, being duly connected, ſeem to me the moſt likely, that have hitherto appeared, to give ſome Light into the Nature of* Muſcular Motion.

V.

Theſe Things naturally lead me to conſider the animal Body as a Machine conſiſting of Two complete Sets or Syſtems of Organs, each perfect in itſelf, and each containing a Fluid peculiar to itſelf, and different from the other. The firſt of theſe is that of the Lacteals, Blood-veſſels, *and* Lymphatics, *continued to each other, and containing its proper Fluid, the* Maſs of Blood, *and its derivative Juices; and the other is the* Nervous *and* Muſcular Syſtem, *which*

which are alſo continued to each other, and having their proper Fluid the elaſtic Aura *or Air; which are more fully explain'd and connected in my ſecond Lecture, together with an Account of Two Kinds of* Æquilibria *proper to Muſcles, deducible from theſe Syſtems.*

VI.

I have endeavoured, as much as poſſible, to be brief in my Explanation throughout the Whole; avoiding every Digreſſion that might in the leaſt interrupt the Chain of my Reaſoning: And as I have made ſome Objections to the ſeveral Opinions in my firſt Lecture, which I think they ſeem'd liable to (in order the better to arrive at the Truth, yet, with all poſſible Regard to their Characters and Learning), the World is welcome to uſe me with the ſame Freedom; and indeed I ſhall be always glad, if any Improvement ariſes from ſuch Objections to my Sentiment as the Judicious may juſtly *make;*

deſiring

desiring no more at their Hands, than the same Candour, in their Inquiry into mine, *that I have shew'd in my Examination of the Opinions of* others.

THE

THE CROUNIAN Lectures ON MUSCULAR MOTION.

LECTURE I.

SECT. I.

Read in January 1743-4.

THE proper Motion of the Muſcular Fibres of Animals, and the Manner of its being communicated to, and continued in them, is a Subject ſo abſtruſe, that it is with the greateſt Diffidence imaginable I have attempted its Explanation. It is the laſt Subject I would offer at, of all that the boundleſs Scope of Nature affords us. And, indeed, no other Motive ſhould have engaged me in it, than to comply with the Command of the worthy *Preſident* and Council of the *Royal Society*, for whom I bear the utmoſt Eſteem.

II.

In this Eſſay I have nothing in my View but the Conſideration of a *muſcular Fibre*, and that of a *nervous* one, with the Manner of Muſcular Motion's being performed; having purpoſely neglected to touch upon the Nature of Senſation, or indeed any Calculations of the Force or Powers of Muſcles; becauſe they are already well treated of by ſeveral ingenious Authors; and are capable of being handled upon Rules of ſome Certainty; being a Part of the Subject very different from what I take to be the Purpoſe of the *Grounian Lectures*.

III.

Since, then, thoſe worthy Gentlemen have done me the Honour of appointing me to continue theſe Lectures on *Muſcular Motion* for the preſent Year, according to the Will of the late Lady *Sadler*, I ſhall endeavour, to the beſt of my Power, to gratify them; yet confeſs myſelf very unequal to the Task; eſpecially, as ſeveral of the moſt learned and ingenious Phyſicians of all Ages have hitherto undertaken it with ſo little Succeſs. However, in order to render what I ſhall advance upon the Subject the more clear and ſatisfactory to the *Society*, ſome of whom may not have made this Part of Philoſophy their Study, I preſume it will not be diſagreeable to premiſe the following brief Hiſtory of the moſt remarkable among the Opinions that have gone before us, by way of Introduction; which will alſo ſerve to facilitate the Conſideration of this Subject, to whoſoever ſhall be

be appointed hereafter to undertake the ſame Task, by bringing the ſeveral Opinions together in a ſmall Compaſs before him.

IV.

Moſt Authors agree, That a Fluid, commonly call'd *Animal Spirits*, flows from the *Brain*, by the *Nerves* to the *Muſcles*, in order to move them; but are at a Loſs to know how it is performed; and alſo, by what means thoſe Spirits are ſent, ſo ſwiftly, into this or that Muſcle to be moved.

V.

Some endeavoured to explain it, by ſuppoſing certain *Valves* placed in the Cavities of the Nerves, (where they are divided into Branches *, to go to different Muſcles) in order to ſtop the Reflux of the Spirits, and cauſe them, upon being brought back from one Muſcle, to be determin'd to the other, from the Valve.

VI.

Others, not well ſatisfy'd with this Scheme, imagined a double Tube, paſſing from one Muſcle to the other, ſo placed, as that the Orifice of one, in its Contraction, (being furniſhed with a particular Valve) might be opened, and the Spirits immediately flow through it, from the Muſcle to be relaxed into that

* *Carteſ. lib. de Homine*, and ſeveral of his Followers, were for placing Valves only in the Diviſions of Nerves; whereas *Regius*, *Philoſoph. Nat. lib.* 4. *cap.* 16. thought them to exiſt elſewhere in the Nerves.

to be contracted; whilſt, at the ſame Inſtant, the Valve of the latter is ſhut, in order to hinder their Flowing-out again, that the Muſcle may be ſwell'd. By this Swelling the Situation of the Parts being altered, the Valve opens again, (the other Valve being now ſhut) and the Spirits flow freely back again to the Muſcle to be contracted.

VII.

Carteſius's * Opinion was not very different from this: He ſuppoſes "Several Openings in each Muſcle, through which the Spirits may paſs from one into the other; which are ſo diſpoſed, that, when the Spirits, which come from the Brain towards one Muſcle, have a little more Force than thoſe which go towards another, they open all the Orifices through which the Spirits of the other Muſcle can paſs into this; and, at the ſame time, ſhut up all thoſe by which the Spirits of this may paſs into the other; whereby all the Spirits, contained before in both Muſcles, ſwiftly paſs into one of them, and ſo ſwell and contract it, while the other remains relax'd and extended."

VIII.

Theſe Tubes, Valves, and Openings, are merely conjectural; having never been found by any Anatomiſt, and being only Children of the Imagination of ſome Philoſophers, produced to ſerve their uncertain Hypotheſes. Nor, indeed, would it be a difficult Matter

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* *De Paſſion. Anim.* Part 1. Artic. II.

Matter to ſhew, that neither of theſe Syſtems can account for Muſcular Motion; and that ſuch a Structure would produce Confuſion, inſtead of that moſt regular and uniform Proceſs we daily ſee, in every Action of Life, if our intended Brevity would permit it; which muſt be obvious to every one in the leaſt acquainted with the Structure and Situation of Muſcles. Let us, however, conſider other more particular Opinions in their Turns.

IX.

Dr. Croune's *Opinion.*

The firſt I ſhall take notice of is the memorable Doctor *Croune*; whoſe Care for propagating the Knowlege of this Part of Phyſiology, is no leſs laudable than evident, in his Foundation of theſe Lectures. He ſhew'd a good Example in his own Attempt towards an Explanation of Muſcular Motion, in a Treatiſe intituled, *De Ratione Motus Muſculorum* *: Wherein, after a ſhort Recapitulation of ſome Opinions before him, particularly of thoſe of *Carteſius*, *Regius*,

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* This Treatiſe was publiſhed at *London* in 1664. in 4*to*. and at *Amſterdam* in 1667, in 12*mo*. and its being publiſhed without his Name, occaſion'd a groſs Miſtake in the Publiſher of Dr. *Willis*'s Works at *Geneva*; who printed it among that Author's Tracts, notwithſtanding there is a particular Tract in the very ſame Volume, known to be *Willis*'s own, intituled, *De Motu Muſculari Medico-Phyſica*. The Editor's Apology for ſo doing is as follows: 'Tractatum *de ratione motus muſculorum, (etſi authoris anonymi) anatomiæ cerebri, nervorumque deſcriptioni ab excellentiſſimo viro* D. Thoma Willis, *M. D. celeberrimo, inſtitutæ, (ut alias, tum a materiæ affinitate, tum ab operis præſtantia petitas, miſſas faciam) quod in prioribus editionibus magno cum doctorum applauſu, & ſine ulla, quod ſciam,* clariſſimi *D.* Willis *querela, appoſitus reperiatur.*' See the *Geneva* Edition in 4*to*, *an.* 1680.

But

Regius, and Dr. *Scarborough*, he endeavours to found his Reaſoning upon Mechanical Laws, in accounting for Muſcular Motion; and lays it down as a principal Maxim, That the Motion of every Muſcle is begun by a certain ſpirituous Liquor paſſing from the Nerves; but is accompliſhed, or finiſhed by two other neceſſary Cauſes which ſucceed it. He deſpairs that any one can ever arrive at the Knowledge of the Manner in which the Soul acts upon the Body, and therefore avoids troubling himſelf about it; but produces many Reaſons to ſhew, that whatever it is that gives Motion to the Muſcles, muſt neceſſarily paſs by the Nerves. This leads him to inquire into the Structure of a Nerve; which, he ſays, "Is com-
"poſed of a certain medullary Subſtance full of
"Juice, with a double Membrane which involves
"that Subſtance; and alſo an infinite Number of
"little Cords within theſe Membranes and medul-
"lary Subſtance, extended from their Beginning to
"the very extreme Capillaments", which are diſperſed and inſerted into the Parts of the Muſcle.

X.

But Dr. *Croune* refers to it himſelf as his own, in a Paper, *p.* 25, intituled, *An Hypotheſis of the Structure of a Muſcle, and the Reaſon of its Contraction.* [Read in the *Surgeon's Theatre*, anno 1694, 1695]. This (ſays Profeſſor *Ward*) is the Subſtance, or Heads only, of the Doctor's Diſcourſes upon that Subject, publiſhed by Mr. *Hook*, in his *Philoſophical Collections*, Num. 11, Sect. 8. P. 22.; which, being afterwards tranſlated into *Latin*, was inſerted in the *Acta Eruditorum*, anno 1682, p. 194. with the Title *De Motu Muſculorum.* See that learned Author's *Lives of the Profeſſors of* Greſham-College, *p.* 323.

X.

In ſpeaking of theſe Spirits, he ſays, That the alimentary Juices abound with very ſubtil active Particles; which, by their frequent Circulation with the Blood, are gradually freed from the terreſtrial Parts, wherein they were confined. Theſe are in great Plenty in the arterial Blood; which, being carried through the Arteries of the Brain, depoſites in its medullary Subſtance, by a ſlow Kind of Diſtillation, a Fluid, which our Author calls a *Mercurial Liquor*, that is (ſays he) exquiſitely impregnated with a *volatile Salt* and *Sulphur*, which flows from thence into all the Nerves of the Body, paſſing every way through them ſlowly, and at length falling into the Veins by a gentle Circulation, till they arrive again at the Heart: And that, by theſe ſpirituous Liquors, all the Parts of the animal Body grow very turgid, and are kept in continual Agitation, aſſiſted by the Circulation, and the *Calor nativus*. And this Agitation is what he calls the *very Life*.

XI.

And although this Author allows the Nerves to abound thus with this rich *rectify'd Juice*, yet he denies that they are regularly tubular, as Authors affirm, but only as they are defined above; and alſo that any Kind of Cavity can exiſt in a Muſcle; and, conſequently, that there can be no *Inflation* of its Parts: But is of Opinion, that in every Muſcle there are three Kinds of Spirits; one peculiar to the *Tendons* and their Fibres, another to the *Muſcular Fleſh*, and another which comes to the Muſcle by the *Nerves*.

XII.

Theſe ſpirituous Liquors, (ſays he) together with the Membranes of the Body, are the Inſtruments of Senſation alſo. For he concludes, that all the ſenſile Membranes of every Part of the Body ariſe from the *Meninges* of the Brain; and that they are all kept in a Kind of Tenſion, by theſe ſpirituous Liquors paſſing conſtantly thro' them. In this State of Tenſion or Tone, he thinks that they may be compared to a Glaſs, or Bell *, whoſe Parts have a vibrating Motion communicated all over them, by being touch'd in One Part. Thus, (ſays he) by the Intermediation of the Membrane of the Nerve that belongs to any particular Organ of Senſe, or by means of the one common Membrane which involves the whole Body, every Object of Senſe is carried, as much as can be, by right Lines, to the Brain; wherein the various and diſtinct Motions of Objects are perceiv'd by the Soul. Hence this ingenious Author would endeavour to ſhew how, in a *Paralyſis*, Senſation ſhould remain when Motion is loſt, and the contrary: For that if that Tone of the Membranes ſhould at any time be totally, or in Part, deſtroy'd, by either Change of Situation of their Particles, or by the Acceſs of too much Moiſture, or any Diviſion of their Continuity

* There ſeems but little Analogy between ſuch vibrating Bodies and Membranes. It is, indeed, the Property of a Bell or Glaſs to vibrate and ſound, when ſtruck, provided it be pendulous, or otherwiſe free: But, if any Part be touch'd, its Vibration and Sound are impeded: How much leſs is a *moiſt* Membrane, in the Body, capable of Vibration; ſince it is in cloſe Contact with other Parts every-where?

nuity by an Accident, that then, indeed, that Vibration or Undulation of Particles, which cauſes Senſation, would be interrupted; like a cracked Bell or Glaſs, which, inſtead of its agreeable ſharp Sound, exhibits a jarring diſagreeable Noiſe.

XIII.

Our Author defines a Muſcle, as conſiſting of an infinite Number of *tendinous Fibres* like Cords; which are ſo blended together at the Extremities, as to reſemble a thick Cord compoſed of many others; but that within the Body of the Muſcle thoſe Fibres are at ſome Diſtance from each other, and the Spaces between them filled up with *Fleſh*; which, with Membranes, Blood-veſſels, Nerves, and innumerable Lymphæducts, conſtitutes the intire Muſcle. This Fleſh, in the Spaces betweent he Fibres, he ſays, is nothing elſe than that Portion of Blood flowing thro' theſe Interſtices; which, being condenſed * by the Coldneſs of the Fibres, is detain'd between them, and conſtitutes the Muſcular Fleſh.

XIV.

He has given an ingenious Scheme for explaining the Manner in which a Muſcle is moved, after having laid down the above *Præludia*; the Sum of which is, That a certain Power is determined from the Brain, by

* It is to be fear'd, if Blood could be evaſated, the leaſt condenſed Particle would be ſufficient to form, by degrees, Abſceſſes, or ſome other Miſchief.

by the Will, with theſe Animal Spirits, through the Nerve to the Muſcle to be moved; which cauſes the firſt Tumeſcence of the Muſcle: And that the Soul has an *Imperium* *, through the whole Maſs of Blood alſo; as is manifeſt in the various Paſſions of Anger, Joy, Love, Baſhfulneſs, *&c.* whereby ſhe is capable of determining the Blood to any Part in a greater Quantity than ordinary, and, conſequently, to the Muſcle to be moved: For, ſays he, it is not abſurd to imagine, that the ſame *Idea*, which excites the Will to move a Muſcle, and the Spirits in the Nerve to perform it, in like manner is capable, at the ſame Inſtant, of determining Spirits to the Heart, by the Nerve

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* It will appear in the next Lecture, that the *Soul* can have no *Imperium* over the Blood, and only preſides over the voluntary Actions of the Body; for the Heart drives the Blood indiſcriminately to all Parts of the Body, for its Welfare, by a propelling Force, which is involuntary: Nor can the Motion of the Heart be accelerated immediately by the Will, but only by ſome particular Act of the Body before; ſuch as an Increaſe of Exerciſe by Running, *&c.* And as to thoſe Paſſions of Anger, Baſhfulneſs, Joy, *&c.* they firſt occaſion quick and irregular Reſpiration: This cauſes a quicker Motion of the Heart, which warms and rarefies the Blood more, whereby it is driven with greater Velocity to all Parts, and among them to the Cheeks. Thus Bluſhing happens, not becauſe the Soul determined more Blood than ordinary to them, but becauſe its *Momentum* is increaſed involuntarily by the Shock or Surprize previous to it: For the whole Surface of the Body is affected in the ſame manner, tho' moſt apparent in the Cheeks. Hence no Increaſe of Blood can be determined to one Part more than another; unleſs ſome Impediment happens to its free Circulation in one Part, or the Reſiſtance becomes leſs in another; which we ſhall hereafter ſhew. But beſides, one would be apt to think, if the *Soul* had an *Imperium* over the Blood, ſhe might as well prevent the Effects of Poiſon, or any other Malignity in it, and correct the Maſs; as immediately determine it in a more than ordinary Quantity to any particular Part of the Body.

Nerve which is inſerted and diſperſed thro' its Auricles, and cauſing it to propel Blood more copiouſly to the Muſcle.

XV.

The Uſe he makes of this is, That a third concurring Cauſe of Motion in a Muſcle ſhould be brought in, in order to render it more complete; and that is, A Fermentation produced by the Animal Spirits of the Nerves, and what he calls, the Spirits of the Blood; which he compares to that of any two chymical Liquors mixing together: And that when this Agitation is begun in the Membranes of the Muſcles, the Fluids will be driven, by Their *Niſus*, in right Lines towards the Extremities of the Muſcle; but that, finding the Spaces much narrower in them than in the Belly of the Muſcle, they are driven back to the Middle into the Muſcular Fleſh, where the Pores are larger, and more lax; which makes the Muſcle ſwell, by the Particles endeavouring to recede from each other, and occupy a larger Space; as, ſays he, happens in all Fermentations: From hence, as the Spaces are made larger in this Muſcle, there is Room made for the Acceſs of more Blood from the Artery in the moving Muſcle. Thus Muſcular Motion is performed (according to our ingenious Author) by three conjunct Cauſes; *viz.* *Animal Spirits* flowing to the Muſcle, *Arterial Blood* determined in greater Quantity than ordinary, and a *Fermentation* * raiſed by

* We ſhall find this learned Author's *Fermentation*, as it ſerves to account for Muſcular Motion, ſeiz'd on by moſt of thoſe that followed him, without giving him Thanks for it.

by their Admixtion, by which the Muſcle is ſwell'd and ſhorten'd.

XVI.

Our Author has not only manifeſted (in his Treatiſe) much Learning, but alſo a penetrating *Genius*, in many curious Remarks and Obſervations diſperſed through the Whole; and merits the Regard of the learned World no leſs than ſome Authors we ſhall mention by-and by; who, by pluming themſelves with *his* Feathers, had monopolized much Eſteem and Attention from Mankind, by the Exhibition of this Syſtem, with very little Addition; and may indeed be juſtly ſaid to have led ſeveral of them, by his Hints, into their moſt favourite Notions concerning *Muſcular Motion*.

XVII.

Steno. *Steno* *, another ingenious Author, wrote his *Conjectures* on this Subject much about the ſame Time with Dr. *Croune*; but had a very different Notion from what we have juſt mention'd concerning the latter; and which, for its Particularity, ſhall have a Place here; eſpecially as it will appear hereafter, that he laid the Foundation, upon which *Borelli* rais'd his Hypotheſis, as to what regards the Structure of a Muſcular Fibre; beſides what Aſſiſtance he has had from Dr. *Croune* on other Accounts.

XVIII.

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* *De Muſculis & Glandulis Obſervationum Specimen.*

XVIII.

This Author, after having expatiated a good deal upon the different Structures of the Muſcles, and made ſeveral learned Obſervations thereon, makes his general Concluſion to the following Purpoſe:

1. That Arteries, Veins, Nerves, Fibres, and Membranes are the conſtituent Parts of a Muſcle: And that, though ſome Authors have pretended to have found Lymphatics, he never could find any.

2. That there is no Muſcle whoſe Fibres do not terminate in a Tendon; which are collected either into firm Tendons at one or both Extremities, or are diffus'd into Membranes, or degenerate into an oſſeous Rigidity.

3. That thoſe very Fibres (which, being cloſely connected together, compoſe the Tendon), when join'd more looſely, conſtitute the Fleſh or carnous Subſtance; and that therefore the Fleſh is not a particular *Parenchyma*. In which Senſe a Tendon is a continued Body from the Beginning of a Muſcle to the End.

4. That there is ſcarce any Fibre in a Muſcle which conſtitutes a right Line; but every one is divided into three Lines at leaſt, which comprehend two alternate Angles. Nor are theſe three always right Lines; but often the Fleſh, as in the *Sphincters*, and ſometimes the Tendons, form curved Lines.

5. Theſe three Lines of every Fibre in the ſame Muſcle, are not always of the ſame Length; altho' there is ſcarce any Difference of Extenſion among them when acting all together: That theſe Fibres are in the ſame Plane; and that, in this angular Order, they form *oblique-angular Parallelograms*, or *Rhomboidal* Figures;

gures; whoſe two oppoſite Parallels, in the Place where they comprehend acute Angles with the other Parallels, are ſtretched to the oppoſite Parts without the Angles. Here he makes a Remark, That in every Tendon, tho' never ſo ſlender, there are as many Filaments as there are fleſhy Fibres in the Belly of the Muſcle; and the interior Filaments are ſhorter than the exterior.

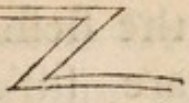
6. His ſixth Concluſion is taken up in the Diviſion of a Muſcle into Extremities and its Middle, with ſome Animadverſions on that Head.

7. He ſays alſo, That a Membrane not only goes round each Muſcle with a tranſverſe Direction of its Fibres, but that it alſo inſinuates itſelf in the ſame manner between every muſcular Fibre.

XIX.

When he comes to ſpeak of the Action of a Muſcle, he confeſſes ingenuouſly, that he cannot attempt explaining the Cauſe or Manner in which it is performed; yet makes a Compariſon towards an Explanation, which he thinks not improper, but wherein, I muſt ſay, I cannot find any Satisfaction. Imagine, ſays he, a Machine for driving Piles into the Ground drawn up by ſeveral Men, each having his particular Cord which is faſten'd to the main Rope: The *Cords* imitate the Tendons; the *Weight* fixed to the Cords, the moveable Part; and the *Men*, the fleſhy Fibres: For, ſays he, as Men (being render'd ſhorter while they pull their Cords) move the Weight, ſo the fleſhy Fibres, being contracted, by drawing the Tendons, pull the moveable Part. There is no more underſtood by this Compariſon, than that the Contraction

of

of the fleſhy Fibres cauſes the Tendons to come nearer to each other, which every-body has ſaid; but the grand Queſtion is, How they are contracted? And as to this particular Structure of the Fibres, I believe none but the Author himſelf ever fanſied he ſaw them ſo. For, ſuppoſing this angular Form in every one  to be the real Structure, the Contraction would reduce it to this Form 

But the Cauſe and Manner how this is brought about upon this Plan is inexplicable; eſpecially ſince much Force is required to draw the Weight or moveable Part. But enough of this Author: Let us now proceed to give a ſhort Sketch of the Opinion of a much more famous Author, the great Dr. *Willis*.

XX.

He commends the foregoing Author very much for his ingenious Conjecture about the Structure of the Muſcular Fibres; and gives a Detail of what that Author has ſaid concerning them, with an Air of Approbation; but attempts accounting for the Cauſe and Manner of the Performance of Muſcular Motion, of which the following is the Sum: *Willis.*

XXI.

Animal Spirits are carried from the *Encephalon*, by the Nerves, to every Muſcle; and are received by the membranous *Fibrillæ*, and by theſe forwarded into the tendinous Fibres; there to be reſerv'd as in a proper Receptacle or Store-houſe. Theſe Spirits, as they are of a moſt active and elaſtic Nature, as often

as it is neceſſary, expand themſelves, and fly ſwiftly into the fleſhy Fibres; and, having made their *Impetus*, recede into the Tendons, by turns. But, while theſe Animal Spirits paſs into the fleſhy Fibres, at the proper Inſtinct for performing the Motion, they meet with very active Particles of another Kind ſupplied by the Blood, which ferment together; ſo that, from their Strife and Agitation, the fleſhy Fibres, which were before lax and porous, are fill'd up, and are forced into Corrugations; from which the Contraction of the Muſcle proceeds. When the Contraction is finiſh'd, the pure Spirits, which remain, recede, for the moſt part, into the *tendinous* * *Fibres*, the other Particles remaining among the *Fleſh*; the Blood ſupplying the Expence of theſe, and the Nerves of the others. And as to the Inſtinct or Diſpoſition to the Ordination of Motion, our Author thinks that to be produced by *other Spirits*, ſent out from the Brain to the Muſcles when Motion is requir'd, which, by their various Impulſe, ordain thoſe Spirits, already placed in the Tendons, to different Motions either of Expanſion or Receſs. This is the Scheme for the Performance of Muſcular Motion, according to this learned Author; the chief Part of which is the Agency of Fermentation; wherein there appears but very little Difference between this and the Doctrine laid down by Dr. *Croune*. There ſeems however ſome Impropriety

* Here are clearly Dr. *Croune*'s three Kinds of Spirits; thoſe in the *Muſcular Fleſh*, thoſe of the *Tendons*, and thoſe ſent from the *Brain*; beſides the Fermentation they produce by meeting in the Belly of the Muſcle.

pricty in imagining, that, when fleſhy Fibres are fill'd or puffed up by Fermentation, they ſhould be ſubject to any kind of Corrugation; it being rather an Effect of Emptineſs than Repletion in flexible Bodies.

XXII.

This Hypotheſis, however ingenious in the Whole, does not ſeem very ſatisfactory; and indeed it was ſoon taken into Conſideration by the famous Dr. *Mayow*, who rejects both this and the Opinion of *Steno*; urging many Arguments againſt the Sufficiency of either in accounting for *muſcular Motion*. Let us ſee how far he excelled them on the ſame Subject himſelf.

XXIII.

This ingenious Author * takes notice of two Sorts of Fibres; *viz.* *muſcular Fibres*, and membranous *Fibrillæ*: The former he deſcribes with *Steno*; being ſatisfy'd with what that Author has ſaid about them, as to their Structure :—The latter, being the *Fibrillæ*, he ſays, are a wonderful Series of Fibres parallel to each other, and which interſect the fleſhy Fibres in a tranſverſe Direction, yet ſomewhat obliquely. This Obſervation he has made upon boil'd muſcular Fleſh; and ſays alſo, That altho' it had been the Opinion before him, that Contraction was performed by the muſcular or fleſhy Fibres, yet it is his Opinion, that the *Fibrillæ* are principally con- *Mayow.*

* *Tractatus quinque Medico-Phyſici. Vide De Motu Muſculari, cap.* 2, 3, 4, *&c.*

concerned in that Action: For that, in order to a due Contraction, if it was made in the fleſhy Fibres, they muſt of Neceſſity be much more ſhorten'd than the intire Muſcle itſelf; becauſe they are not diſpoſed according to the longitudinal Direction of the Muſcle, but are inſerted obliquely into the Tendons: And alſo that the Muſcle would ſwell to an immenſe Size; which, he ſays, does not happen upon muſcular Motion. Hence he concludes, that the Motion is performed by the membranous *Fibrillæ*; which, being contracted, draw the fleſhy Fibres more cloſely together, and render the whole Muſcle ſhorter and more hard.

XXIV.

It is remarkable, that in *Plate* 3. *Fig.* 2. of this Author, the Figure he gives to repreſent the Situation of the fleſhy Fibres, and the *Fibrillæ* that interſect them, is copied by Dr. *Stuart*, *Plate* 2. *Fig.* 2. with this Difference, that *Mayow* calls the minute interſecting Fibres, membranous *Fibrillæ*; whereas the former calls them nervous *white Fibrillæ* *; and, in his third Figure, ſuppoſes each carnous red Fibre to have a Chain of *Veſicles*, which repreſent a String of Beads or *Necklace*. Now, as to theſe *Veſicles*, our Author ſeems to have given the Hint to ſome of thoſe

* Theſe are no more than the Fibres of the Membrane that inveſts the muſcular *Fibres* mention'd by *Steno*, and which really exiſt; for, in tearing aſunder, with one's Fingers, the Fibres of a boiled Muſcle, they are very apparent; and ſeem to be what *Bernouilli* imagines to bind his fleſhy Fibres at equal Internodes, of which more hereafter, being firſt thought of by this Author, (*Mayow*) as Agents in muſcular Motion.

thoſe that wrote on the ſame Subject afterwards: For, where he ſpeaks of the Manner of the Circulation of the Blood thro' the Muſcle, againſt ſome Opinions before him, " that it is extravaſated from " the Arteries, and abſorbed by the Veins," he ſays, That the Veins and Arteries meet by the Intermediation of Veſicles, which he calls, *Collectio Veſicularum ſanguiferarum* *; that no ſuch Extravaſation can happen, and that this Collection of *Veſicles* conſtitutes the chief Part of the muſcular Fleſh; and alſo, that their chief Uſe is, like a Strainer, to ſeparate from the Maſs of Blood certain Particles, neceſſary towards the Contraction of the Muſcles. This, if maturely conſidered, will be found to ſquare pretty much with *Keil* and *Stuart*, as to their *Veſicles*; as will hereafter appear, when we ſpeak of theſe ſeveral Authors.

XXV.

He alſo agrees in other reſpects with ſome of his Predeceſſors; particularly about the Neceſſity of an Effervеſcence, being raiſed in a Muſcle, neceſſary to its Motion; occaſioned by the Admixtion of Particles of

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* Which indeed do not exiſt, but are however firſt thought of by this learned Author; who alſo finds it neceſſary to bring to his Aſſiſtance the *Fermentation* of the moſt worthy Founder of theſe Lectures; yet differs from him as to the Nature of Animal Spirits; the latter giving them the Name of *a Liquor exquiſitely impregnated with a volatile Salt and Oil*; and the former calling them *nitro-aerial Particles*, which ferment by mixing with the *ſalino-ſulphureous* Particles of the Blood: Both which Terms ſeem to be the Invention of Dr. *Mayow*.

of different Natures, according to the Power of the Will; which proceed from the Brain and Maſs of Blood. Thoſe from the Brain, he ſays, are *nitro-aerial* Particles, and the true Animal Spirits; and thoſe from the Blood he calls *ſalino-ſulphureous*; and that the former, being ſent by the Nerves, meet the latter in the Muſcle wherein they are ſecreted, as was ſaid before, and make the Emotion and Fermentation, which is the Cauſe of muſcular Motion.

XXVI.

As to his Manner of muſcular Motion's being brought about, it ſeems to be intirely his own Invention: He denies that it can be performed by Inflation, either of the muſcular Fibres, or *Fibrillæ*; the latter of which, according to him, are ſolid Bodies, and can undergo Contraction no other way than by Twiſting or *Contortion*; and that thoſe *nitro-aerial* Particles are very fit to affect the *Fibrillæ* in that Manner, To prove this, he brings the following Experiment: Let a ſmall String of a muſical Inſtrument be held between the Fingers of each Hand, at a conſiderable Diſtance from each other, over a lighted Candle, ſo as that it may become ſufficiently heated without burning: When throughly hot, it will be perceived to contract with a conſiderable Force, by twiſting itſelf; and, moved from the Candle, will be eaſily diſtended again, by untwiſting. Thus, ſays he, the *nitro-aerial* Particles iſſuing from the Candle are the Cauſe of the Contraction of the String; as they are of the *Fibrillæ* being writhed and ſhortened about the muſcular Fibres in the Body; which being by that means drawn cloſer together, the whole Muſcle is ſhorten'd.

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This Experiment, he ſays, is the more to be relied on, becauſe, by Microſcopical Obſervation, he pretends to have found theſe *Fibrillæ* exactly like a fine String of a muſical Inſtrument. From this Syſtem he concludes, that, as ſome Force is neceſſary to diſtend the String to its former Dimenſions after Contraction, if no Force is applied, it will always remain contracted; and that therefore, when there happens a *Paralyſis* of a Muſcle, its Antagoniſt is convulſed, or is ſpaſmodically affected. Thus much is ſufficient to ſhew what our Author's Notions were concerning this difficult Subject. The next we ſhall conſider is the famous *Borelli*; a Man famous indeed for his Calculations of the Powers of moving Bodies, but much leſs ſo for his Account of the Cauſe and Manner of the Motion of Muſcles. The following is the Subſtance of his Opinion concerning that Particular.

XXVII.

He ſuppoſes *, that, within the Membrane which inveſts a Muſcle, the *Faſciculi* of muſcular Fibres have a priſmatical § Form; which is ſometimes triangular, ſometimes ſquare, and ſometimes *Borelli.*

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* Johan. Alph Borelli *De Motu Animalium*, *Pars prima*, *c.* 2. *Prop.* 1. *&* *c.* 17. *Prop.* 114, 115, 116. *Pars altera*, *c.* 3. *Prop.* 22, 23, 24, *&c.*

§ Our Author thought ſo, becauſe he made his Obſervations upon a dry'd Ham; which, having its Moiſture exhaled, and its Fibres being collected, by the Salt uſed in preſerving it, into Bundles, will flake off in Parcels when boiled. But it muſt be obvious to every one, that Salting, or Boiling, will alter the Contexture of Fibres ſo minute; and, conſequently, that no great Truth can be drawn from ſuch Obſervations.

ſometimes hexagonal; each of which is compoſed of many Filaments, or tendinous Fibres, which are parallel to one another in every little Bundle or Faſciculе, and adhere together by a tenacious *Gluten*, if they are not continued to the Extremities of Tendons, or Membranes; and ſometimes are immediately connected to Bones, or carnous Fibres.

XXVIII.

That beſides, theſe Bundles are every-where inveſted and bound together by innumerable tranſverſe Fibres *, as it appears in a Muſcle boil'd, and immediately dry'd; which nervous Fibres ſeem to compoſe certain reticular Membranes, together with the Capillary Veſſels § that bring Blood to them, and carry it back again; and that theſe Fibres are nervous, he conjectures from their being very hard and tough.

XXIX.

His Deſcription of a muſcular Fibre, which he has obſerved after being boil'd, is, that it ſeems, by the Help of a Microſcope, to be a *Cylinder* like the Twig of a Tree, not hollow, as a Reed is, but is obſerved to be full of a medullary Subſtance, which ought to be ſpungy like the Pith of Elder; becauſe every ſoft Twig, which is fill'd with any adventitious Moiſture, grows turgid, and is neceſſarily porous, ſince it is fill'd

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* Theſe are no other than the Fibres of the inveſting Membrane mention'd under *Mayow* in Note (*) *Sect.* 24.

§ This reticular Structure is made uſe of by Dr. *Stuart* in his Explanation of muſcular Motion; which ſee in his Turn.

fill'd with Particles of Water as with Wedges, as it appears in a wet Rope. He ſeems to be further confirm'd in this Notion, becauſe he obſerved, in the Fibres of a Piece of *dry'd Ham*, certain ſanguineous Particles, or ſtrait and tranſverſe Filaments, diſperſed like *Porphyry* or Marble; which, ſays he, ſeems not poſſible to be ſo, if the internal Subſtance of the Fibres were not ſpungy.

XXX.

From his Notion of this ſpungy Contexture of the internal Subſtance of a muſcular Fibre, he is led further to *imagine*, that it conſiſts of Pores of a rhomboidal Figure, ſo as to reſemble a Chain of *Rhombus's*, which are capable of Contraction like ſo many Bows, by the Help of the *moving Faculty*; and that each of theſe *Machinulæ*, or rhomboidal Pores of the fleſhy Fibres, are ſo minute, that their Length does not exceed the twentieth Part of an Inch. Hence his Definition of a Muſcle is, that its Texture is like a reticular Bundle, compoſed of rhomboidal Chains contiguous to each other.

XXXI.

A Nerve, he ſays, is a Bundle or Capillament formed of a Number of fibrous Threads, connected together by a membranous Binding; and that every Fibre may be hollow like a Blood-veſſel, altho', from the Imperfection of our Sight, they may ſeem ſolid: Yet, if it be not impoſſible, that they may be Tubes, he had rather believe them little Tubes fill'd with a moiſt ſpungy Subſtance analogous to green Elder, or the

like; becauſe the nervous Fibres are not only ſoft, flexible, and moiſt, but alſo becauſe they admit humid Nouriſhment, and a Fluid drops from them; all which Properties require ſpungy Poroſities bedew'd with ſome Liquor.

XXXII.

As to the Manner and Cauſe of muſcular Motion, he allows, that a ſpirituous Liquor, which in ſome Places he calls *Subſtance*, or *Faculty*, paſſes by the Nerves from the Brain to the Muſcle; and that ſome Fluid, proper to the Muſcle, meeting it, ſomething like a Fermentation or Ebullition is excited, which cauſes that ſudden Swelling of the Muſcle. The Examples he gives to render this familiar to the Reader. are the Spirit of Vitriol poured upon Oil of Tartar, or any acid Spirits mix'd with fix'd Salts. Hence we ſee from whom this Author has been furniſh'd with his Opinions concerning muſcular Motion; *viz.* the *Rhombus's* from *Steno*, with a very little Difference; and the Fermentation from the memorable *Croune*; notwithſtanding his being frequently quoted as the real Inventer of theſe Notions.

XXXIII.

Bernouilli. The celebrated *Bernouilli* *, altho' confeſſedly a Follower of *Borelli* on this Subject, as it appears in his own Words, where he ſays, " In which (Account of muſcular Motion) I ſhall " tread in the Track of the incomparable *Joh. Al-*
" *phonſus*

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* *Diſſertatio de Motu Muſculorum. Vide Proem.*

"*phonſus Borelli*, embracing his Hypotheſis:" Yet blames him for imagining that the *Machinulæ* in the muſcular Fibres were of a rhomboidal Figure; and will appear to have made no other Alteration, even in what he finds Fault with in that Author's *Rhombus's*, than to cut off their lateral Angles; and by that means reduce them to elliptical Forms bound together, at their Extremities, very regularly by tranſverſe Fibres.

XXXIV.

The Account he gives of the Structure of muſcular Fibres is the ſame with that of the foregoing Author, ſo needs not be repeated here: We ſhall therefore only give the Reader an Abſtract of ſome Sections of his *Diſſertation on muſcular Motion*, which regard the Part of this Subject we are at preſent concerned in.

XXXV.

In his ſecond Section, after he has mention'd *Borelli's* Inſpection of a boil'd Muſcle, he ſays, The Fibres of the little Bundles are collected together by tranſverſe Fibres, which are parallel to each other, and form with the former a reticular Texture; to which he aſcribes no other Uſe, than to confine the moving Fibres, leſt, in performing their proper Action, they ſhould be forced too far aſunder * from their natural

* We muſt here aſſent to *Bernouilli*, that the membranous Fibres, which not only incloſe every Muſcle, but proceed to inveſt every Fibre,

natural Situation. Thus every moving cylindrical Fibre, by the Help of this Ligature, is divided into equal *Internodes*, forming *Veſicles*, which are flaccid when the Muſcle is inactive, but when acting, are diſtended, acquiring an oval Figure like the *Rings* of a *Chain*, which, ſays our Author, *Borelli* falſely calls *Rhomboidal Machinulæ*: And alſo adds, that theſe tranſverſe Ligatures are looſe enough to admit a free Communication for the moving Matter to fill the Veſicles.

XXXVI.

His third Section is chiefly taken up in the Confutation of *Steno*'s Opinion, That muſcular Motion is perform'd without the Acceſs of any thing whatſoever, but by the ſole Diſpoſition in the Fibres to change their Figure, from an oblique-angular Parallelogram into a more ſtrait one; and oppoſes to it that common phyſical Axiom, "*Omne quod movetur, movetur ab alio.*" And, in the *fourth* Section, aſſents to Dr. *Croune*, with *Mayow*, *Willis*, and *Borelli*, that Motion muſt be cauſed by a *Fermentation* raiſed in the Muſcle; believing alſo with the latter, that the Nerves are a *Congeries* of Tubes fill'd with a ſpungy Subſtance, which are always full of a very ſpirituous Juice, ſupplied by the Brain, of ſuch a Nature, as (when

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Fibre, ſerve only to keep them in their natural Situation; but that they divide them thus into Bladders at equal Internodes, we muſt deny; inaſmuch as we have been ſo happy as to ſeparate diſtinct muſcular Fibres, and demonſtrate them before the learned *Royal Society*, and to many Anatomiſts ſince theſe Lectures were read. For their proper Deſcription, ſee *Lect.* 2. *Sect.* 3, 4, *&c.* TAB. I. *Fig.* 1. *&c.*

(when mix'd with the Blood) to be capable of raiſing a Fermentation: This is the Animal Spirit. So that, when the Soul performs an Act of Volition, there muſt of Neceſſity happen a certain local Agitation of animal Spirits in the Brain, from the great Union between the Soul and Body; whereby the Beginning of ſome Nerve receives an Impulſe, which is continued to the Juices thro' its whole Length: And ſo, from an Irritation at the Beginning of the Nerve, the laſt Drop of the nervous Juice is, by a gentle Vibration, thrown out at the other Extremity, and alſo from the little Mouths of every other Nerve diſperſed through the whole Muſcle in the ſame manner, according to the Power of the Will. And as a Spunge fill'd with Liquor ſuffers not a Drop to fall out, ſo, ſays our Author, altho' thoſe little Mouths of the Nerves (*in the Muſcle*) are always open; yet the Drops of the nervous Juice never fall from them, without an actual Impulſe or Concuſſion; becauſe the ſpungy Subſtance of the Nerves ſerves them inſtead of Valves *.

XXXVII.

When therefore, ſays he in his *fifth* Section, by the Command of the Will, or from Nature's Cuſtom (in involuntary Motion), innumerable Drops are thrown out together from the Orifices of the Nerves, thro' the intire Bulk of the Muſcle, which is always thoroughly moiſtened with Blood; then theſe ſpirituous

* This is alſo taken from *Borelli*, where he ſpeaks of a Nerve.

ous Particles or Drops, by ſtriking their ſharp *Spiculæ* into the more fine Particles of the Blood, break them, and give the confined condenſed Air Room to expand itſelf, and cauſe the ſubſequent Ebullition and Inflation of the Muſcle.

XXXVIII.

But, becauſe an Objection might lie againſt this Syſtem, as, How it comes to paſs, that the Muſcle ſhould ſo ſuddenly grow ſlender, and reaſſume its former State; ſince, according to our Author's Doctrine of Fermentation, it ſhould ſeem, that, after the firſt Ebullition, the Muſcle ought to remain conſtantly ſwell'd; he proceeds to remove that Obſtacle in his *ſixth* Section, by having recourſe to the following Hypotheſis: Let us ſuppoſe, ſays he, beſides the thick Air we breathe, another more ſubtile Air; which, however elaſtic, can by no means be perceived, as being capable of penetrating freely all the Pores of the Body. He thinks this Suppoſition not at all abſurd, as believing that there is other Matter of different Degrees of Subtility, between this groſſer Air of the *Atmoſphere* and the *Materia ſubtilis*, leſt there ſhould be a *Chaſm* in any Part of Nature; and thinks it muſt be elaſtic, from the ſame Cauſe that that of the Atmoſphere is; to wit, from the continual Motion of the *ethereal Matter*, which always endeavours to drive the leſs agitated and groſs Particles from each other, and thereby obtain for itſelf a free Paſſage.

XXXIX.

This being pre-ſuppoſed, ſays he, the Particles of the ſpirituous Juice of the Nerves are ſo very ſubtile, delicate, and tender, that their *Spiculæ*, which at the moſt gentle Touch are blunted, are only capable of opening the moſt minute Pores of the Particles of the Blood, from which immediately that more ſubtile elaſtic *Aura*, that was condenſed before, ruſhes forth, and expands itſelf, thereby ſwelling the Whole at once; but, becauſe of the exceeding Minuteneſs of its Particles, it freely breaks out thro' the open Pores of the Muſcle, and flies off into the ambient Air. Hence the Muſcle muſt of Neceſſity grow lax in a Moment after its Intumeſcence; unleſs new Drops of the nervous Juice continually fall into it, creating a Succeſſion of Fermentations, and ſo keep it in a conſtant State of Inflation *.

XL.

This is the Sum of the Opinion of that great Genius the famous *Bernouilli*, touching the Manner in which muſcular Motion is performed: The next is that of one as eminent, the learned *Keill*, but whoſe Sentiments of the Matter agree well with thoſe before him. He defines a Muſcle to be " a Bundle of " parallel Plates of fleſhy Fibres, which are com- " poſed of other ſmaller Fibres, and each ſmaller " Fibre

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* We ſhall find the following Author ſays no more than *Bernouilli*, explaining it only a different Way.

" Fibre to be a String of Bladders or Veſicles, into " which, he ſuppoſes, the Nerves, Veins, and Arte- " ries to *open*.

Keill. " That the Contraction, or Swelling of " the Muſcles, is performed by the Blood " and Animal Spirits diſtending theſe Veſicles;" but endeavours to prove, by many ingenious Arguments, that neither the Spirits alone, nor the Quantity of both together, diſtend the Veſicles; but that both mixing and rarefying * together, cauſe them to ſwell: For, " That the Globules of Blood continu- " nually circulating through theſe Veſicles of the " Fibres, which are, probably, capable of containing " only one Globule at a time, in which Globule (he " ſuppoſes a Globule of Air) meet with the Animal " Spirits which drop from the Nerves: That the " Spirits ſurrounding the Globule of Blood muſt at- " tract the Particles of it, of which they are com- " poſed, more ſtrongly than the others of the Glo- " bule of Blood; and, conſequently, their *Niſus* " to one another ceaſing, the condens'd Globule of " Air will expand itſelf with a very conſiderable " Force; whereby each Veſicle of the Fibre will be " diſtended,

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* What the foregoing Authors call Fermentation, Effervescence, *&c.* this Author calls Rarefaction. *Bernouilli* endeavours to explain it by the *Spiculæ* of the nervous Juice ſtriking againſt the finer Particles of the Blood; and this Author, by the Attraction and *Niſus* between the Animal Spirits and the Drop of Blood when they meet in the Veſicle: So that, in the Whole, they may be conſider'd to ſpeak the ſame thing (and even not to differ much from their Predeceſſors); for it is no great Matter whether the Globule of Air is freed from its Confinement, by *Spiculæ* opening the Pores of the Blood, or by the Attraction of Particles to each other.

" diſtended, and, conſequently the Fibre ſhorten'd,
" or the whole Muſcle will be contracted.
" But, when the Particles of the Globule of Blood
" are mixed with the nervous Fluid, they will both
" together incloſe the Globule of Air again, and com-
" preſs it into as ſmall a Space as it was in before:
" And thus the Contraction of a Muſcle muſt imme-
" diately ceaſe, unleſs freſh Blood and Spirits, ſuc-
" ceeding one another, continue the Swelling of the
" Veſicles *."

XLI.

This Syſtem, however ingenious, as it admits of ſo many bare Suppoſitions, upon which theſe Authors found their Arguments, it will be difficult to think it the true Explanation of muſcular Motion: But admitting every Suppoſition to be true, yet the Time that this kind of *Niſus*, *Attraction*, *Rarefaction*, *Fermentation*, &c. muſt neceſſarily take up in the Performance, can no way be accountable for the quick Motions performed by the Muſcles of the Organs

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* The only Difference that ſeems to be between this and the foregoing Author is, that the *Aura*, after being let looſe, and ſwelling the Muſcle, flies off into the open Air, according to *Bernouilli*, and the Muſcle ceaſes to ſwell: Whereas our preſent Author ſays, his Globule of Air is again condenſed into as ſmall a Space as before, and the Swelling and Contraction of the Muſcle ceaſes: However, their Concluſion is the ſame for the Continuance of the Motion or Swelling; this Author requiring freſh Blood and Spirits ſucceeding one another; and the foregoing Author the ſame, in theſe Words: --- *Muſculus iterum detumeſcat, niſi jugiter novæ inſtillentur Guttulæ Succi nervoſi, quæ novam & novam pariendo Ebullitionem, Muſculum in continua Inflatione conſervent.*

Organs of Speech, the Twinkling of Eye-lids, or any others that are done as quick as thought, no more than it can be reconciled to the Nature of involuntary Motion, in thoſe Muſcles that are not ſubject to the Impulſe of the Will.

XLII.

His Explanation of Rarefaction, admitting we expected no Uſe of it in muſcular Motion, ſeems to be very particular too; for we can ſcarce have any other Cauſe in View for Rarefaction or Condenſation, than *Heat* or *Cold*; which are ſufficient of themſelves to prodace thoſe Effects in the moſt *homogeneous* Fluid, without the Admixtion of any other. Whether Rarefaction can be effected by any other Cauſe in the Body, will be hard to determine, if we do not ſuppoſe thoſe Spirits to be an acrimonious Fluid, capable of cauſing a Commotion with the Globules of Blood in the Veſicles, which would amount to a *Fermentation*; but our Author ſays all is done without Fermentation, by this methodical *Niſus*, and Attraction of the Particles of the Spirits to each other.

XLIII.

Quincy. I muſt here inſert another very remarkable Notion propagated by *Quincy*, from a Hint of *Bellini*, as it appears in his Explanation of the eighth Aphoriſm of *Sanctorius*'s ſecond Section, where he owns his being led by * *Bellini*, in his Notions

* *Opuſcula de Villo contractili.*

Notions of the Structure and Power of a distractile Fibre. He supposes the Parts of a distractile Fibre to be made up of certain *Machinulæ*, like *Syringes* and their *Embolus's*, and their Motion to be analogous to that of the Instrument mention'd. " The Obser-
" vations and Experiments (says he) which have been
" made of late, but more particularly by Mr. *Boyle*,
" about the Spring of the Air, have explained to us
" the Contrivances and Properties of a *Syringe*; and
" the Reasons upon which that Phænomenon of the
" Difficulty of drawing back the *Embolus*, when the
" Pipe is stopped, depends; and the Necessity of any
" Liquor's following it, wherein the Pipe is im-
" mersed: The Reason of which being well consi-
" dered, it will be found, that all which is necessary
" for this Contrivance is, that the *Embolus* be so
" exactly adapted to the inner Surface of the Barrel,
" as to prevent any Air passing between them when
" it is drawn up; and that it matters not what Figure
" the Barrel is of, so that the *Embolus* is well fitted to
" it. It easily therefore might be contrived to make
" a Case of Syringes, wherein every Barrel may
" also serve as an *Embolus* to its Exterior, which
" immediately includes it. And, with this View, it
" is not at all difficult to imagine a continued Series
" of Particles so put together, that the inner may
" be moved and drawn upon one another, without
" suffering the Air immediately to enter into the In-
" terstices made by their Distraction: Whereupon,
" as soon as that Force which drew them is removed,
" they will, for the very same Reason as the *Embo-*
" *lus* of a *Syringe*, rush up again into their former
" Contacts." This is his Notion of the Arrange-

ment of the Particles compoſing the main Subſtance of an animal Fibre, and of its Conſtruction.

Now it is no difficult Matter to overturn this Syſtem, ſince there are two principal Objections to be made to it, which prevent the Trouble of any further Conſideration. The firſt is, That this abſolutely is not the Structure of a muſcular Fibre, as we ſhall make it appear in the following Lecture: And, ſecondly, There is a great Abſurdity in the Compariſon he makes between the Action of a *Syringe* and its *Embolus*, and that of a *flexile* fibrous Thread: For, as it is neceſſary, in the Action of that Inſtrument, that its Sides ſhould be inflexible, hard, and able to bear the exceſſive Force of Suction in the Retraction of the *Embolus*, and the Force of the Air in its Repulſion, with how little Propriety can this minute ſupple Fibre of a Muſcle be ſaid to be capable of a like Action, or ſuch a Wedge-like Conſtruction as this Author thinks applicable to it.

When, in mechanical Reaſoning, we find it neceſſary to illuſtrate an Opinion by a Compariſon, there ought to be a true Similarity of Structure in the Objects whoſe Actions are to be compared; otherwiſe it would be altogether as prudent to liken a human Blood-veſſel to a Blunderbuſs.

XLIV.

Monro. The ingenious Profeſſor * *Monro*, of *Edinburgh*, ſuppoſes the nervous Fluid to be "an extreme fluid ſaponaceous Water, flowing in a "con-

* Anatomy of human Bones and Nerves, *p.* 29. of the latter.

" conſtant, equal, *ſlow Stream*, from the *Encepha-*
" *lon* and *Medulla ſpinalis*, in each of the proper
" nervous Fibres, *&c.* That it is fit for nouriſhing
" and reſtoring the Particles that are conſtantly carried
" away from the Solids by the *Vis Vitæ*, Circulation
" of the Liquors, and neceſſary Actions of Life; and
" that the conſtant Flow of the Liquor of the Nerves
" into the Cavities of the muſcular *Fibrillæ* occaſions
" the natural Contraction of Muſcles, by the conſtant
" *Niſus* it makes to increaſe the tranſverſe Diameter,
" and to ſhorten the longitudinal Diameter of each
" Fibre; and that it is only to allow the Mind a Power
" of pouring a greater Quantity of this Fluid, with
" greater Velocity, into what muſcular Fibres it
" pleaſes, to account for the voluntary ſtrong Action
" of Muſcles."

XLV.

To this Opinion we will here ſubjoin *Robinſon.*
that of Dr. *Bryan Robinſon* *; who, after
taking much Pains to prove, that a Hair or Fibre de-
creaſes in Breadth as it increaſes in Length, and *vice
verſa*, concludes that, " if a vibrating Motion be
" raiſed in the *Æther* contained in the Fibres of
" Muſcles, the Diameters of all the Fibres will be
" increaſed, and their Lengths leſſen'd by that Mo-
" tion: All therefore that is neceſſary to give Ani-
" mals a Power of moving their own Bodies, is to
" give them a Power of raiſing a vibrating Motion
" in the *Æther* contained within the Fibres of the
" Muſcles.

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* Diſſertation on the *Æther* of Sir *Iſaac Newton.*

" Muſcles. And this Power they have by the Me-
" diation of the Nerves, which are ſolid uniform
" Threads, ariſing from that Part of the Brain to
" which the Soul is preſent, and terminating in
" the Muſcles: For, a vibrating Motion, rais'd, by
" the Power of the Will, in the *Æther* contain'd
" in that End of a Nerve which terminates in the
" *Senſorium*, or Place in the Brain to which the Soul
" is preſent, will, in an Inſtant, be propagated to
" the Muſcles ſupply'd by that Nerve, and raiſe a like
" vibrating Motion in all its Fibres, from the very
" great Communication there is between the Nerves
" and the fleſhy Fibres of the Muſcles."

XLVI.

At to what Profeſſor *Monro* ſays of the compo-
nent Parts of the nervous Fluid, it would be fit for
the Purpoſes he aſſigns, by a good Analogy drawn
from Plants, *viz.* to nouriſh and ſupply waſted Par-
ticles, as well as to propagate muſcular Motion; pro-
vided it was of a Conſiſtence ſubtile enough to paſs
thro' thoſe extremely minute Tubes, and that the
Maſs of Blood was not the only *Pabulum* deſign'd
by the Creator for affording Nutrition. There is
great Need, in whatever Fluid the Nerves contain,
of a Capacity of acting with the greateſt Celerity
imaginable; and one would think a Mixture of a
ſaline and oleaginous Matter not the moſt fit for ſuch
active Performances as the Will ſometimes deter-
mines, and ſome of which are as ſwift as mere Ex-
ploſions. However this be, our ingenious Author

has not ſo much made it his Buſineſs to account for the Manner in which this Fluid cauſes the muſcular Fibres to increaſe and ſwell, in order to the Contraction of the Muſcle, as to give the true Deſcription and Situation of the nervous Syſtem; than whom none has done it better.

XLVII.

And as to the Opinion of Dr. *Robinſon* concerning the *Æther*, it can hardly give Satisfaction: For ſuppoſing this *Æther* to be the Cauſe of muſcular Motion, there muſt be a *Modus Actionis* to produce the neceſſary Effect; for it is not enough to ſay a vibrating Motion cauſes the Muſcle to contract, without making ſome Attempt to ſhew in what Manner it does ſo. We can underſtand as much, by ſaying at once, The animal Spirits cauſe the Muſcle to move; which was ſaid many Years ago.

But, from a very natural and obvious Argument, one may venture to doubt, whether the *Æther* can have any Share in muſcular Motion; for there can be no Motion, whatever, mechanically performed in One Body, without firſt receiving a certain Propulſion from ſomething elſe; and the Body making that Propulſion ought to be endow'd with Qualities neceſſary for ſuch a Reſiſtance, proportioned to the Body acted upon: Now, if the *Æther* (as Philoſophers have defin'd it) be a *ſubtile Matter* pervading all ſubſtantial Bodies, of whatſoever Solidity, without Lett or Hindrance, it cannot be ſaid to cauſe muſcular

muſcular * Motion, ſince it can meet nothing to oppoſe its Paſſage; and, conſequently, can make no Reſiſtance.

XLVIII.

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* Whatever Neceſſity there is for the Exiſtence of the *Æther* in the Oeconomy of the World, we can hardly ſuppoſe it either the *Cauſe* or *Inſtrument* of muſcular Motion; for the *Soul*, or *Mind*, ſeems to be the very Cauſe of voluntary Motion: And as to its being inſtrumental, it will be extremely difficult to reconcile the Qualities of the *Æther* to thoſe of the Parts we ſhall, in our next Lecture, endeavour to prove are the Inſtruments of that Motion.

The exceſſive Diſtance between the Subtility of this *Element*, and the Groſſneſs of the *nervous* and *muſcular Syſtem*, upon which they are, by this Author, ſuppoſed to act, will admit of no Proportion: Wherefore, to ſuppoſe the Nerves can be impreſſed by the *Æther*, we muſt pre-ſuppoſe Millions of Gradations of groſſer Particles from the extreme Fineneſs and Subtility of this, down to the viſible Groſſneſs and Solidity of the Organs to be moved, in order, as it were, to hand down the Impulſe from the extreme ſubtile to thoſe extreme groſs Particles: All which raiſes in me ſo complex an Idea of that Impulſe, that I cannot find it compatible with the great Quickneſs of both the Reſolution and Impulſe we daily ſee in the Performance of animal Motions.

There is another Argument, which ſeems very powerful againſt the *Æther*'s being inſtrumental in muſcular Motion, drawn from ſome Conſiderations on the *Fire* produced in the *electrical Experiments*, now verify'd by Mr. *Watſon*, a worthy Member of the *Royal Society*, provided this *electrical Fire* be analogous to the *Æther*; which is, That it is certain, this Fire pervades animal or other Bodies, from my own Experience; as I was one of ſeveral Perſons thro' whom it paſſed, without having any ſenſible Effect on me, in its Paſſage to the Point where it was collected into a Body: And alſo, becauſe ſilver *Laminæ* were moved by the excited Tube, even thro' the Sides of a ſtrong Flint-glaſs Veſſel well ſtopp'd.

It ſeems, indeed, a very great Care in the All-wiſe Author of Nature, that this *electrical Fire* ſhould not find Reſiſtance in animal Bodies; becauſe, we ſee, when all that paſſed from the excited Tube, through ſeveral Perſons, was collected in one Column at the End of a Gentleman's Finger, it fired rectify'd Spirits of Wine, and Oil of Orange-Peels; and, conſequently, might produce as direful Effects as the Fire of *Lightning*, when collected and excited to violent Motion, and is reſiſted.

XLVIII.

The laſt Opinion I ſhall trouble you with is that of my Predeceſſor in theſe Lectures, the late learned Dr. *Stuart*; who (in his Explanation of the Experiment upon the Frog, to which I refer the Reader) concludes, "That voluntary muſcular "Motion is begun by the Impulſe of the Mind or "Will on the animal Spirits, thro' the Nerves into "the Muſcles." *Stuart.*

He ſuppoſes (with *Keill*) the Structure of a muſcular Fibre to be veſicular, with a reticular *Plexus* of Blood-veſſels inveſting each Veſicle: His particular Definition of it is this: "It is a nervous Fibre, pro-"duced from its Entrance into the Muſcle, along, "or in the Axis of each carnous Fibre, in the Form "of a Chain of diſtenſile Veſicles, whoſe Sides are "cover'd with a Net-work of elaſtic longitudinal and "tranſverſe Blood-veſſels, *&c.*" Here he makes a Difference between the nervous Fibre in the Form of a Chain of Veſicles, and the carnous Fibre, along whoſe Axis it is produced; whereas Dr. *Keill* ſays, Each Fibre is a String of Veſicles. Our Author endeavours to explain his Syſtem by theſe little longitudinal and tranſverſe Blood veſſels on the Surface of each of theſe Veſicles, which he calls the reticular *Plexus*. I muſt confeſs I do not well comprehend his Meaning; however, the Sum of his Account is as follows:

"In the utmoſt State of Extenſion (of a Muſcle), "the longitudinal capillary Blood-veſſels on the Sur-"face of each Veſicle in the Fibres muſt be extended, "and therefore their tranſverſe Diameters muſt be

"leſſened;

" leſſened; that is, theſe Veſſels thereby become
" ſtraiter, and the Circulation in them therefore
" more difficult; and in this State alſo the tranſverſe
" Blood-veſſels of each Veſicle will be forced into
" ſerpentine Flexures, which muſt render the Paſſage
" of the Blood thro' them ſtill more difficult.

" If the Mind impels but a little more of the
" nervous Fluid than uſual thro' the ſlender Tubes of
" the Nerves into theſe extended Veſicles, they will
" be uniformly dilated.

" By this Diſtenſion of the Veſicles, their *Axes*
" being ſhorten'd, and their Diameters lengthened,
" the longitudinal capillary Veſſels in their Surface
" muſt be ſhorten'd, and thereby their Diameters en-
" larged, and the ſerpentine Flexures of the tranſ-
" verſe Veſſels will be extended; which, in both Kinds,
" will leſſen the Reſiſtance they gave to the *Tranſit*
" of the Blood; which, by the *Diaſtole* and *Syſtole*
" of the Arteries, is continually urged on to its Paſſ-
" age thro' them; and, being thus facilitated, every
" Globule of Blood in its Progreſs, by endeavouring
" to fly off by the Tangents of theſe Veſſels and Ve-
" ſicles, tends to expand them more, and thereby
" opens the Way for the further and eaſier Influx of
" the nervous Fluid, to which the Blood veſſels con-
" tribute, as ſo many elaſtic Levers acted upon by
" the Blood in its Progreſs. Thus, by the Aſſiſtance
" of theſe three Powers, the nervous Fluid, Blood,
" and Blood-veſſels, the Progreſs from Extenſion to
" *Diaſtole* of the Veſicles is made, by which the
" Muſcle becomes tumid and enlarg'd in Bulk, *&c.*

" But, if the Mind deſiſts ſending this Recruit, or
" ſuſpends it, then theſe circular arched elaſtic Veſ-

" ſels,

" ſels, now turgid with elaſtic Blood, whoſe *Area's*
" have been thus forcibly enlarg'd, endeavour to con-
" tract themſelves every Way towards the Centres of
" their *Area's*, which are the Centres of the Veſi-
" cles; and the Mind giving no Reſiſtance, this *Niſus*
" takes Place, to the complete Contraction of each
" Fibre; by which means the Limb affix'd is brought
" into complete Flexion, or Extenſion, according as
" this or the other Antagoniſt has been acted upon.

" In this State the whole Muſcle becomes ſhorter
" and leſs in all its Dimenſions; harder and paler by
" Expulſion of a great Part of its Fluids thro' the
" Veins towards the Heart, and thro' the Extremi-
" ties of the Nerves into the Tendon and *Peri-*
" *oſteum.*"

Here he ſuppoſes the Spirits to fly off to the Tendons and *Perioſteum.*

XLIX.

None of all theſe Authors have conſider'd the State of a Muſcle when at Reſt; which has contributed not a little to aſſiſt my Explanation of muſcular Motion. Our Author has nothing in his View, but the bare Progreſs of the Motion from the utmoſt Extenſion to the utmoſt Contraction of a Muſcle; and, in the Explanation, the whole Progreſs ſeems intricate and tedious. Again he ſuppoſes thoſe longitudinal and tranſverſe Blood-veſſels to be on the Surface of the Veſicles, which do not appear by any Aſſiſtance of the Microſcope we can apply.

L.

He begins this Explanation with the utmoſt Extenſion of a Muſcle; and endeavours to prove, that, in its Progreſs to Contraction, the whole Muſcle muſt grow larger in Bulk every Way, by ſhortening the *Axes*, and lengthening the Diameters of the Veſicles. This he calls their *Diaſtole*, which happens from the Mind's impelling more than ordinary of the nervous Fluid; but ſays, That, when the Will ceaſes that Recruit, the complete Contraction follows by the *Niſus* of the circular Blood-veſſels towards the Centre of their Veſicles.

LI.

Now one would be apt to conclude, from this Way of Reaſoning, that the Veſicles ought to lengthen again by the Reſtriction of the circular Blood-veſſels; for, as their Diameters were lengthened by the Contraction of the longitudinal ones, ſo, by the Contraction of their tranſverſe or circular Fibres, the Length of the Veſicle ought to be increas'd again; and, conſequently, the Muſcle ought to return to its State of Extenſion.

LII.

Here is one ſhort Particular more, that ſeems unintelligible, with which we ſhall cloſe this Introduction: He applies his Experiment on the Frog, to prove, that the complete Contraction of the Muſcle is excited from the *Impulſe* of the animal Spirits into it; whereas here he ſays, " If the Mind *ceaſes* " her Impulſe, the *Niſus* of the circular Fibres of

" the Veſicles takes Place, to the complete Contra-
" ction of the Muſcle." I ſubmit the Conſideration of theſe different obſcure Accounts to Underſtandings more penetrating than mine; and ſhall take an Opportunity of humbly offering, before this learned *Society*, in another Reading, my own Attempt towards an Explanation of muſcular Motion, purſuant to their Command laid on me for that Purpoſe.

The End of the Firſt Lecture.

LECTURE II.

Containing the Author's *Scheme of* MUSCULAR MOTION.

SECT. I.

Read in February, 1743-4.

IN my firſt Lecture, which is an Introduction to this, I enumerated the chief of the Opinions that have been exhibited concerning muſcular Motion, with ſome ſhort Remarks, which I hope will prove ſufficient to ſhew they could not give the neceſſary Satisfaction: And indeed I am far from imagining, that I have brought the Subject to a *Ne plus*, or that what I ſhall advance will prove unexceptionable to every one; therefore if I have been ſo fortunate as to have hit off but one Step, by which any new Light may ariſe in this obſcure Subject, it is all I can expect: In the Proſecution of which I ſhall avoid all Suppoſitions, as much as poſſible, that cannot be drawn from ſomething experimental; and ſhall proceed in the moſt clear Manner I am capable of, in order to entertain you.

II.

There is not the leaſt Motion performed in any Part of an animal Body, which does not depend on a muſcular Structure for its Progreſs, whether in the Fluids or Solids, voluntary or involuntary; and therefore whatſoever Explanation of muſcular Motion is not reconcileable to, and accountable for, every Motion performed in any Part, cannot be the true Explanation.

III.

Of a muſcular Fibre.

The moſt minute muſcular Fibre *, that I was able to ſeparate, ſeems to be tubular, but unequal; that is, having ſome Parts of it more protuberant than others, ſo as to reſemble as many Sailors *Hammocks* one after another, and much in the ſame Proportion in general: We ſhall call theſe Bellies or Hammocks, *Cells*, for the better Explanation of the Subject. Now tho' it is a received Opinion, that Fibres are diviſible *in infinitum*, that is, that each Fibre is compoſed of others, and thoſe again of others, and ſo on; yet this *muſcular Fibre*, as it is a *Tube*, and

* A muſcular Fibre of a middle Size is about equal to the Hair of a Child's Head newly born, at the Strictures or ſmalleſt Parts; the *Cells* being thicker according to the Proportion at TAB. I. *Fig.* 1, 2, 3, *&c.* Yet ſome are larger, and ſome ſmaller; the *Cells* however are not to be diſcerned with a Glaſs of a leſs magnifying Power than the Fifth of a double reflecting Microſcope.

and ſerves to perform an Office peculiar to itſelf, it cannot be divided, without deſtroying its neceſſary Form; as a Trumpet, or any other hollow Veſſel, cannot be divided or cut into other Trumpets, *&c.* (let its Size be what it will) and is therefore, properly, an *ultimate Tube* or *Trumpet*, as this tubular Fibre is an ultimate *muſcular Fibre*; and this is the Caſe with the *nervous Tubuli*. Indeed the *Parietes* of every *muſcular* and *nervous* Fibre may be compoſed of Fibres diviſible, for what I know, *in infinitum*.

IV.

Theſe Cells are not regularly alike, ſome appearing three times longer than others, nor at the ſame Diſtances from each other; nor do the Fibres themſelves ſeem all of a Size, (*Fig.* I. 1, 2, 3, *&c.*) and conſequently each Fibre contains ſome more, ſome leſs of theſe Cells.

V.

The Cells communicate with each other by a Paſſage through the whole Length of the muſcular Fibre, till both Extremities terminate in a Tendon or otherwiſe; which appear'd upon many Experiments both while the Muſcle was moiſt, and after drying a little, having ſeparated them in both Caſes; but after being boiled or roaſted, every Fibre, I examined, ſeemed to have loſt its Cells, and become uniform; whence one would be apt to think the Cells had burſt by the Rarefaction of the *inflating Matter* * they contain'd, and

* Sect. X. a little further.

and their Sides become uniform with the Parts th were, before, more ſlender.

VI.

And as theſe Cells communicate one with another, it may be reaſonable to ſuppoſe, that there is no Neceſſity for any more than one nervous Tube to each muſcular Fibre; ſo that the Number of nervous Fibres in that Bundle that goes to a Muſcle need only to be equal to the Number of muſcular Fibres that compoſe it. From this Structure it is eaſy to conceive, how the muſcular *Cells* are capable of being ſhorten'd, by their being inflated * and increaſed in Diameter: And it is to be further obſerved, that the Bellies or *Cells* of neighbouring Fibres do not lie regularly by the Sides of each other, but promiſcuouſly; that is, the Cells of ſome lie cloſe to the ſlender Parts of others, and ſometimes two ſlender Parts lie together, and ſometimes two Cells.

VII.

Of a nervous Fibre.

The ſmalleſt nervous Fibre I was able to ſeparate ſeems to be a Tube; therefore a Nerve may be defin'd a Bundle of uniform Tubes, whoſe Sides are parallel

* The Authors, mention'd in my firſt Lecture, make uſe of the Word *Inflatio*, and its Verb, to ſignify a Repletion of the Fibres, or their ſuppoſed *Bladders*, *Rhombus's*, &c. with Blood and Spirits, fermented together. On the contrary, I apply it to ſignify a Blowing up of the muſcular *Cells* with an elaſtic *Aura* only, denying that any Blood or Spirits can get into them. *See* Sect. X. and XVIII. following.

parallel to, and in Contact with each other, beginning in the *Encephalon* and ſpinal Marrow, and terminating in Muſcles, Membranes, *Cutis*, &c. for the Propagation of Motion and Senſation *.

VIII.

But becauſe they have not been thought tubular by ſome ingenious Men, it will be neceſſary to give ſome Reaſons for our thinking them ſo. If they are not Tubes, but ſolid Strings, there is no Way of accounting for the Beginning of muſcular Motion, but by their Vibration: Now nothing can be ſaid to vibrate that is not elaſtic, and firſt in a State of Tenſion; but, from known Experiments, there is no Elaſticity in the Nerves; nor can any Anatomiſt ſay he ever found a Nerve in a State of Tenſion.

IX.

The GREAT CREATOR ſeems to have wiſely avoided any Tenſion in a Nerve, for ſeveral probable

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* Altho' I think it not the Buſineſs of this Lecture to touch upon Senſation, yet I am induced in this Place to make the following Reflection: If the *Soul* dwells, or exiſts in every individual ſolid Part of the Body (which I am inclined to believe, rather than confine her to any one particular Place), ſure ſhe may inſtantly be appriſed of every *Contact* producing the different Senſations, that can happen, whereſoever there is a *nervous Expanſion*; without our being under a Neceſſity (by placing her only in the Brain) of bringing to her Aſſiſtance an *Undulation* of animal Spirits to and from the Brain; a Vibration of the Nerves; or, with ſome Authors, contrary Motions of thoſe animal Spirits in the ſame Tube, ſerving to Motion and Senſation; all which are productive of many Abſurdities, which we have not Room here to enumerate.

ble Reaſons: 1. The Origins of the Nerves in the *Encephalon* and ſpinal Marrow are a mere Pulp, very ſoft and tender, before they unite to form the Nerve, and very looſe in their Contexture; ſo that a Vellication in any one, produced by Tenſion, would pull it out by the Roots, and would diſorder the Parts of its Inſertion too: 2. Suppoſing the Places of the Origin and Inſertion of a Nerve to be firmly fixed, and in no Danger from Vellication, there could ſtill be no Tenſion in the Nerve, becauſe no Nerve could be brought into right Lines; the very Structure of the Parts, through which they paſs, would hinder it; for the Courſe of the nervous Trunks of the Limbs, *&c.* being along the Interſtices of Muſcles, *&c.* if a Tenſion was produced in them, the Sides of the Muſcles, by which they run, would be preternaturally preſſed, and become ſo many Angles or Centres of that Vellication, to the great Detriment of their ſeveral Functions: 3. If a Vellication was produced in the *intercoſtal Nerve* or *Par vagum*, which communicate with ſeveral of the principal Nerves in the Body, would there not be great Confuſion brought about, in all the Parts to which ſuch communicating Nerves lead; and would not their proper Actions be much impeded?

From theſe and ſuch-like Reaſonings, we muſt conclude the nervous Fibres to be Tubes, capable of tranſmitting ſomething to the Parts into which they are inſerted, from the Brain and ſpinal Marrow.

X.

Theſe nervous Tubes contain a Fluid *, whoſe Nature and Property is not ſo much to nouriſh as to inflate ;

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* This Opinion leads me to the following Queries:

1. Is it not well known, that confined Air is capable, by a proper Impulſe, of performing more violent and ſwift Motions, than any *Succus* or *Liquor* that can be conceiv'd?

2. Are not animal Spirits a *Quid occultum*?

3. Is not the Blood the ſole Maſs from which every Liquor of the Body is ſecreted? If ſo, may we not as rationally ſuppoſe, that any exalted or refined Liquors, for whatſoever Purpoſes deſign'd, may be ſent off through exquiſitely minute Canals, to anſwer their ſeveral Ends, immediately from the Maſs, as to *imagine* ſuch are only ſecreted in the Brain? For, by the Aſſiſtance of the ſolar Microſcope, ſuch exquiſitely minute Canals, as could not be diſcerned even by the double Microſcope in a full View of the Circulation in the Meſentery of a Frog, appear'd to be fill'd with a clear Liquor paſſing rapidly from the Veſſels wherein I ſaw the Blood circulate, and which ſeemed to me ſome Hundreds of times ſmaller than thoſe Veſſels from which they ſprung.

4. Is not the Blood full of Air, and is it not daily ſupply'd by Inſpiration in the Lungs? If ſo, why may we not as well ſuppoſe, that the Blood carries to the Brain, and there depoſites, a ſufficient Quantity of an *Aura* to ſupply the Nerves and muſcular Cells, in order to their Motion, as we ſhall explain it by-and-by, as that animal Spirits are ſecreted there? any Liquor, as we have ſaid before, being leſs likely to ſerve to ſwift Motions than Air.

Now till the Negative to theſe Queries can be proved, I cannot help thinking, that nothing but this *inflating Aura* can enter into the Cavities of the muſcular *Cells*; and conſequently muſt conſider the Brain as deſtined only for treaſuring up this *inflating Aura*, and the nervous Fibres as Pipes to convey it to the muſcular Fibres, into whoſe Cells they alone can open; that no Nutrition can proceed any other Way than immediately from the Blood-veſſels to the Parts that require it; and that therefore it may, with ſome Probability, be concluded, that the *Encephalon* and *ſpinal Marrow*, *Nerves*, and *muſcular Fibres*, are a Set of mechanical Organs, exempt from any other Office, than to cauſe Motion and Senſation by *Inflation* only, ſo that every Muſcle that moves may juſtly be ſaid to be blown up into Motion.

inflate; and conſequently whenever the Nerves are impreſs'd by the Soul, there is an immediate *Inflation* of all the Cells, in the Fibres of that Muſcle which is to perform a voluntary Motion.

XI.

And theſe muſcular Cells, together with the nervous Tube that opens into each muſcular Fibre, are conſtantly full of this *inflating Matter* to a certain Degree; that is, fill'd to a *Medium* between their utmoſt Compreſſion or Emptineſs, and their utmoſt Capacity of Repletion. By this means, the muſcular Fibres, when at Reſt, are in a *Medium* between Diſtenſion and Contraction; but are diſtenſible to near a Third longer, and contractible to near a Third ſhorter, than when in a State of Reſt; the former, by the *Retraction* of Part of the *inflating Matter* back into the Nerves; and the latter, by its *Impulſion* or Inflation into the *Cells* from the Nerves.

XII.

There is no Neceſſity for imagining, with ſome Authors, that the Soul makes her Impulſe in the Head rather than any other Part, in order to impel from thence the inflating Matter of the Nerves to this or that Muſcle: Becauſe, by ſuppoſing the Nerves always thus full, the ſmalleſt Impulſe on the Part of a Nerve leading to this or that Muſcle will be ſufficient to perform what is neceſſary; whereas, if we confine the Power of the Will to the Brain, may there not be Danger of Irregularities like Exploſions, from thence into the different Diviſions of a Nerve, and

ſo of cauſing confuſed Motions in ſeveral Parts at a time, like an Epilepſy? Or if an Impulſe be made on the Trunk of a Nerve, the Diviſions ought all to be ſubject to the Effect of that Impulſe. It will therefore be better for our Purpoſe to think the *Mind* makes her Impulſe where ſhe pleaſes, and chuſes that Part of a Nerve only that leads to the particular Muſcle to be moved.

XIII.

This ſeems to be corroborated greatly by the Motions we ſee in Inſects after being cut to Pieces, as Worms, Flies, *&c.* and in more perfect Animals, as Poultry, Frogs, *&c.* which move, and ſhew Signs of Pain, a conſiderable time after their Heads are cut off; which could not happen, if the Impulſe was only made in the Brain. We can carry this Argument yet further, even to human Nature, if what *Diemerbroeck** relates be true: He ſays he ſaw a Man executed at *Leyden*, who, after his Head was ſtruck off, roſe upon his Feet, and ſtood for a little Time. And Dr. *Stuart*'s Experiment upon the Frog (which is, after the Head is cut off, and the Limbs hanging looſe, to compreſs the ſpinal Marrow with the End of a Probe made flat, whereby the Limbs are immediately contracted, and with ſome Violence) ſhews, that if the Impulſe was made in the Brain, the Motion would be confuſed and general; ſince all the lower Parts were moved by the ſingle

* *Anat. corp. hum.* lib. viii. cap. i. *de nerv.*

ſingle Impulſe upon the ſpinal Marrow of the Frog.

XIV.

Another Reaſon for ſuppoſing the Soul capable of chuſing any Part upon which her Impulſe may be made, is, that if it was made in the Brain alone, there might be ſome Impediment or Interruption to her Intention, produced in the *Ganglions* of the Nerves; which, ſome Authors think, do the Office of ſo many Brains, but which, more probably, ſerve as ſo many *Fulcra* or *Stays* to keep the Nerves firm, and to favour their further Directions to the different Parts of the Body.

XV.

Of Interſtitial Air.

The Air-Pump ſhews us, that, in all flexible Bodies, ſuch as Fleſh, ſmall Animals, and the like, there is a ſufficient Quantity of Air, lodg'd in the Interſtices between the muſcular Fibres and the Blood-veſſels, *&c.* to reſiſt the Preſſure of the ambient Air; which Preſſure being taken off in the Air-Pump, this interſtitial Air will expand itſelf, and ſwell the Fleſh, Animal, *&c.* to an incredible Size. This may be conſidered as a general *Æquilibrium* kept up between the ambient Air, and that in an animal Body, for the Safety and Preſervation of the Animal: And theſe Air-Globules, which we ſhall throughout this Eſſay call *interſtitial Air*, are conſtantly in a middle State between their utmoſt *Contraction* or *Condenſa-*

tion, and their utmoſt elaſtic *Expanſion*, except chang'd into either State by ſome adventitious Cauſe.

XVI.

Of the Circulation of the Blood in the minute Veſſels.

The Blood appears, by the Microſcope, to flow from Arteries into Veins immediately *, Which is eaſily ſeen in the Webs of Frogs, Tails of Fiſhes, *Mytuli*, and the like; and, I doubt not, would appear ſo in Muſcles, if they were thin enough to become tranſparent for Viewing with Glaſſes. Therefore the Arteries and Veins may be conſidered as continued Tubes, terminating in nothing; but as the Arteries ariſe immediately from the Heart, ſo they run to the Extremities of the Lungs and Body, ramifying and decreaſing in Diameter, till they become inviſible to the naked Eye, and gradually become Veins, which unite into Trunks, increaſing in Diameter till they arrive at, and open into, the Heart again. So that Nutrition and the Secretions are carried on by minute Twigs, from theſe continued *capillary Canals* † ſent off to the Glands, and to the Parts to be nouriſhed.

XVII.

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* Without the Intervention of any Veſicles, ſuch as *Mayow* ſuggeſted. *See* TAB I. *Fig.* 3.

† Where the Arteries degenerate into Veins.

XVII.

And it further appears, by microſcopical Obſervations, that theſe capillary Canals run parallel to, and by the Sides of, the muſcular Fibres in general, or to Fibres of whatſoever Nature, where theſe capillary Canals exiſt, This ſeems a very wiſe Contrivance in every Degree; for if their longitudinal Direction was croſs the other Fibres, the Circulation could not be ſo ſmoothly nor ſecurely carried on; and therefore would be liable to great Impediments, from a tranſverſe Preſſure of the muſcular Fibres upon them; whereas, in this parallel Direction, they are ſecured from any Impediment, but what proceeds from the Preſſure of the Sides of the muſcular Cells upon their Sides, in the Performance of muſcular Motion: We are here to take notice, that the muſcular Fibres receive Twigs from the Arteries to nouriſh them, and from the Veins to carry back the *Reſiduum* into the parallel Canals, as we have hinted before.

XVIII.

Hence we muſt conclude, that no *Veſſel*, of any kind whatſoever, opens into the Cavities of the *Cells* of the muſcular Fibres, but Nerves.

XIX.

Of the Æquilibration and Motion of Muſcles.

From what we have premiſed, let us endeavour to ſhew how muſcular Motion is performed, and how

how the ſeveral Principles juſt laid down are applicable to it.

XX.

The Force of the *inflating Matter* contained in the *Cells*, is only equal to the Force of the *interſtitial Air*, while the Muſcle is at Reſt. This may be called the peculiar *Æquilibration* of a Muſcle in itſelf; but, by the Impulſe of the Will on the Nerve, an additional *Inflation* is made to the *Cells*, and then their Force becomes ſuperior to the *interſtitial Air* Globules; and again becomes equal when that Impulſe ceaſes, and the Muſcle is at Reſt. But if, upon the Ceſſation of that Impulſe in one Muſcle, there is an Impulſe made on the Antagoniſt at the ſame time, in order to move it, then the Force of this *interſtitial Air* in the ceaſing Muſcle, exceeds that of the *inflating Matter* in the *Cells*, compreſſing their Sides, whereby they are lengthened beyond their Tone of Reſt; as we ſhall more fully explain it, when we ſpeak of the Æquilibration between antagoniſtic Muſcles.

XXI.

From this *Inflation*, which is perform'd as quick as Thought, the *Cells* inſtantly increaſe in Diameter, and grow ſhorter, compreſs the venal Canals, and obſtruct them. Hence the Blood ſtops, and the Arteries, by Propulſion from the Heart, increaſe in their

their Diameters, while the Veins are ſqueezed quite empty, and the whole Muſcle is ſhortened, and its Action performed.

XXII.

The Degree of Contraction in a Muſcle is always as the Force neceſſary to perform ſuch or ſuch an Action; and this is determined by the Degree of the *Inflation* of the *Cells*; that is, if the Force required be but inconſiderable, then the Impulſe of the Mind will be but inconſiderable, and conſequently the *Cells* will have but an inconſiderable *Inflation*; therefore the Preſſure of the *Cells* on the minute Veins will be in Proportion: So that of the arterial Blood, tho' it flows always in the ſame Quantity into the Muſcle; yet, becauſe the Preſſure of the *Cells* on the Veins is but ſmall, a proportional Part will go on, and return by the Veins; and therefore the Repletion of the Muſcle, and its Contraction, can be but inconſiderable: Whereas, when a violent Motion is to be performed, then the Degree of *Inflation* of the *Cells* will be very great, the Blood totally ſtopped in the Veins, the Arteries increaſed in Diameter, and the Muſcle ſhortened even to its ultimate State of Contraction, if requiſite.

XXIII.

While the Circulation is thus hindered in the acting Muſcle, there can be no Diſorder occaſioned, either in the Oeconomy of the Circulation in other Parts of the Body, nor in the particular Conſtitution of the Muſcle itſelf. The former Caſe is certain from our daily Experience of Amputations; wherein,

tho' a Limb be cut off, and the Space in it immediately wanting, and although the ſame Quantity of Blood, ſupply'd by Digeſtion every Day, is carried into the Veſſels, yet their Diſtenſibility is ſuch, that the only Change they can ſuffer is further Repletion. And as to the Muſcle itſelf, if, during a violent Action, there ſhould happen any Danger of Injury, it would be perceived immediately by the Mind, and remedied by ceaſing her Impulſe on the Nerve and *Cells*, and thereby granting a free Circulation inſtantly.

XXIV.

As to the Æquilibration between two antagoniſtic Muſcles, Dr. *Stuart*, in his Lectures *, thinks, that "As each Antagoniſt has its diſtinct Nerve or Nerves "without Communication, and the antagoniſt Muſ- "cles communicate one with another by one com- "mon Trunk of an Artery, and one common Trunk "of a Vein; they are like two antagoniſt Scales *in* "*Æquilibrio*, over which the Mind has a diſtinct "Power, by diſtinct Nerves, for determining the "animal Spirits, and thereby the Blood, to either "Side at Pleaſure, without affecting the other: And "concludes from thence †, that if what is taken "from one be added to the other, the *Momentum* "of the Motion will be doubled."

XXV.

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* Lect. III. pag. xliii. Sect. 9.
† Sect. 17. pag. xliv.

XXV.

Now there does not ſeem to be Occaſion for taking away any Blood from one Muſcle to be determined to the other; nor has the Doctor explain'd how it may be brought about by the Mind; nor, indeed, can I conceive it poſſible to hinder the Motion of the Blood in the arterial Trunk, leading to one Muſcle, while it is ſent to the other; except we could ſuppoſe the Mind capable of making a Ligature, or other Stricture, on the Ramification leading to it, leaving the other open at the ſame time. But no Nerve can have ſuch a Power from the Mind to act upon the main Trunk of an Artery; and therefore the *Effect* of the Mind's Impulſe upon the Nerve can only be produced, as I have ſaid, on the moſt minute venal Canals; where they are capable of being preſs'd by the Bellies or *Cells* of the muſcular Fibres that lie by their Sides, and where alone the mechanic Structure of the Parts admits of it: Beſides, the arterial Pulſation muſt of Neceſſity go on, to carry Blood to every Part of the Body, being propell'd by the ſame conſtant Force always, in healthy Bodies. Hence the Convenience of this our Syſtem of muſcular Motion is apparent, ſince it is carried on at the ſame time that the Heart and Arteries do their Offices without Interruption to either.

XXVI.

Again, if it was abſolutely neceſſary to muſcular Motion, that Blood ſhould be taken from an Antagoniſt, in order to be ſent to the acting Muſcle to break the *Æquilibrium*, ſome Muſcles, that ſerve

to involuntary Motion, could not have any Motion at all, having no Antagoniſt. Therefore, in general, Motion muſt be caried on more ſimply, and in the Manner explain'd above.

XXVII.

Yet an *Æquilibrium* between a Muſcle and its Antagoniſt is abſolutely neceſſary; but it is only ſo in order to preſerve the Equipoize between them, while both are in a State of Reſt. Now there are two Sorts of *Æquilibriums* proper to Muſcles, the one which is peculiar to each Muſcle in itſelf, explained before, and the other that which is between two Antagoniſts. Let us ſee how the latter is broke, in order to Motion.

XXVIII.

We are to conſider two Antagoniſts exactly equilibrated, before any Action is begun in either. The Mind, now reſolving to act with one Muſcle, makes an Impulſe upon the Nerve leading to it. The *Cells* in that Muſcle are inſtantly inflated beyond their Tone of Reſt, to the Degree neceſſary for the particular Action intended: The Blood is ſtopp'd, as mentioned before, in the little *venal parallel Canals*; and the Muſcle is contracted beyond its Tone of Reſt. And at the ſame Inſtant that the Mind impels the *inflating Matter* into the *Cells* of the Muſcle in Motion, ſhe remits to determine any to the Antagoniſt, which cauſes a *Retraction* of it into the Nerves: By this means, the interſtitial Air, in this, exerts its elaſtic Force, compreſſes the Sides of the *Cells*, whereby

whereby they are reduced to oblong Forms, and the whole Muſcle is drawn beyond its Tone of Reſt.

XXIX.

It is thus alone the *Æquilibrium* is altered between two Antagoniſts in an Inſtant, without a Neceſſity of taking one Drop of Blood from the one to add to the other: And it is even ſo far from it, that, during all this Action, the Quantity of Blood in both Muſcles, while one is contracted, and the other dilated, is nearly equal; for altho' the Blood is ſtopped in the acting Muſcle, by the Mechaniſm above explain'd, and the Veins are all compreſſed, ſo as to contain none during a violent Contraction; yet the Arteries may be ſaid to contain a double Quantity, propell'd into them by the conſtant Pulſe, as they are elaſtic, while the Circulation is carried on pretty equally in the Antagoniſt; and conſequently both Arteries and Veins in this can contain no more than the very Arteries in that: Therefore a Muſcle is neither larger nor leſs, in general, by Contraction or Extenſion, than when in a State of Reſt, the Proportion being conſtantly kept up; that is, when ſhorter, a little thicker; when longer, a little more ſlender.

XXX.

Our Explanation of the *Æquilibrium* between the interſtitial Air, and the muſcular *Cells*, will enable us to attempt accounting for the ſwifteſt *gentle* muſcular Motions that can be perform'd; ſuch as are neceſſary in an *Allegro* Part on an Inſtrument of

Muſic.

Muſic. Thus: The Mind intends moving a Finger to perform a ſwift Shake; the firſt Motion is a Preſſure of the Finger upon the String, by the Contraction of the *Flexor* of that Finger: The ſucceſſive Motion then will be only a Remiſſion of that Preſſure, without any Neceſſity for a Re-action in the antagoniſt Muſcle, becauſe the Motion required is but inconſiderable: And this Preſſure and Remiſſion, by being nimbly repeated, will become a kind of alternate *Tremor* of the Finger upon the String; becauſe, after the firſt Inflation of the muſcular Cells, which cauſes the Contraction of the Finger, the inſtant Remiſſion of the Inflation becomes a kind of Retraction of it, as I have ſaid before: Then the interſtitial Air follows it with an elaſtic Expanſion beyond its Tone of Reſt, and compreſſes the Cells; then a new Inflation of the Cells ſucceeds; and, in fine, an Action and Re-action between the interſtitial Air and Cells is carried on as long as the Shake is required to continue: This amounts to an alternate *Syſtole* and *Diaſtole* between them, like two Springs acting by alternate Repulſion.

XXXI.

Of involuntary Motion.

The Performance of the common Actions of Life depending upon the voluntary Motion of the Muſcles alone, Authors have almoſt neglected to give any Explanation of involuntary Motion; and therefore have chiefly attended to the former: Whereas the latter as well deſerves the Attention of the Learned,

and depends as much upon the ſame mechanical Principles and Structure, differing only in this, that voluntary Motion is urged by the Will, and the other is carried on without her Impulſe.

XXXII.

It appears, by what we have already ſaid, that the Diſpoſition of muſcular Fibres to contract depends on an additional Inflation of their Cells, but that this cannot be done without an impelling Power upon the Nerve to cauſe it. Now, in the Performance of voluntary Motion, the Will muſt be ſuppoſed to make this Impulſe; but we muſt endeavour to find ſome other impelling Cauſe of Motion in the Muſcles of involuntary Motion to ſet them to Work: For the mechanical Structure of all Muſcles is alike.

We will produce two Examples; the *Heart*, and *inteſtinal Canal*.

XXXIII.

By a very natural Analogy between Vegetables and Animals, I am apt to believe, the Parts of the Animal are perfectly formed in the *Ovum*, before its Egreſs from the *Ovarium*, only wanting *Explication* and *Expanſion*; but that theſe two Effects cannot be produced, till after it has changed its Place, and is depoſited in ſuch a Receptacle as may favour the Propagation of theſe Effects. Juſt ſo it is by the Seeds of Vegetables.

This being the Caſe, in order to come at our Purpoſe concerning involuntary Motion, we muſt now conſider the *Fœtus* in the *Uterus*, tho' very

ſmall,

ſmall, as having all its Parts complete, but motionleſs, or in a State of Reſt.

XXXIV.

Now the Heart is the firſt Part that can have any Motion at all; and, being in a State of Reſt, muſt be ſuppoſed in a *Medium* between its Dilatation and Contraction. The firſt Motion in the Heart then will be a compulſory Motion, which is its *Diaſtole*; and the firſt Motion performed by itſelf will be its reſtitutive Motion or *Syſtole*. Till this is done, there probably can be no Accretion of Parts, becauſe nothing can be propell'd to the Extremities but by the Contraction of the Heart. And this is much earlier brought about than many Authors have imagined, and in the Manner following.

XXXV.

It is certain, that Fluids paſs from the Mother to the Child very early, by the Veins of the *Funis umbilicalis*, and at length arrive at the *Vena cava*.

The Auricles and Ventricles are now in a State of Reſt; but the Fluids falling into the right Auricle, with a Gravity and Force it was not liable to before, it is fill'd and dilated beyond its former Tone; whereby the muſcular Cells are laterally compreſſed, and become longer by the diametrical Preſſure, and the interſtitial Air is alſo compreſſed into narrower Limits than before, and the whole Auricle is upon the Stretch: Thus its *Diaſtole* is compulſory.

XXXVI.

XXXVI.

Now this ſudden Repletion, at the ſame time that it dilates the Auricle, makes ſuch an Impulſe upon its nervous Syſtem, that an Inflation ſucceeds in the Cells, whereby they increaſe in Diameter (the interſtitial Air now concurring by its *Niſus* to reſtore itſelf); and theſe two Powers together, which, in performing voluntary Motions, are Antagoniſts to each other, are now forced to become joint Antagoniſts to the dilating Force of the intruding Fluid from the *Vena cava*, whereby the Auricle is conrracted, and the Blood driven into the neighbouring Ventricle. Thus is the Motion propagated from Auricle to Ventricle, and frouu the Ventricles to the Arteries thro' the whole Body, which is carried on during Life.

XXXVII.

And as to the Inteſtines, as there can be no periſtaltic Motion, till Deglutition is firſt performed, it is carried on by the ſame Mechaniſm: For, when the firſt Food is ſwallowed, being driven into the *Oeſophagus*, it forces it open, and dilates the circular muſcular Fibres beyond their Tone of Reſt, compreſſing both the interſtitial Air, and the Cells of the Fibres; which, reſtoring themſelves gradually, again contract themſelves ſucceſſively downwards, till the Food is convey'd to the Stomach, and thence to the Inteſtines: And this is alſo carried on till Death, when once begun. I ſhall only trouble you with one ſhort Section more, which is:

XXXVIII.

Of depraved Motions.

Palſies, Cramps, and Epilepſies, may be accounted for by this Syſtem.

May not the muſcular Cells become rigid and hard, and not be capable of being dilated to the Degree neceſſary to carry on the Action and Re-action between them and the interſtitial Air, in an equal manner; and therefore produce ſuch irregular Attempts to Motion, as would amount to a paralytic *Tremor*? Frequent Drinking ſpirituous Liquors will render the Cells of the muſcular Fibres rigid, and cauſe the ſame Effects; and in Fevers, with what is called a *Subſultus Tendinum*, a common Symptom ariſes, which is an imperfect Attempt to pull the Bed-cloaths, attended with a *Tremor*. and proceeds from the ſame Cauſe; for the violent Heat of the *Fever* has render'd all the Fibres and their Cells rigid, and, therefore, incapable of due Inflation; for that Motion is not made in the Tendon which we feel, but is produced by the irregular Twitchings of the muſcular Fibres of that Tendon.

XXXIX.

Or may not theſe Cells be too lax and weak, and ſo loſe much of their Elaſticity, and yield to the Entrance of too great a Quantity of the *inflating Matter* of the Nerves, whereby the interſtitial Air may be conſtantly compreſſed, and the peculiar *Æquilibrium* deprav'd, ſo as to produce Spaſms,

Spaſms, if partial; if total, an Epilepſy? Painful Cramps are occaſioned by the Inflation of ſome of the muſcular Fibres, while others are not affected in the ſame Muſcle; and an unequal *Drag* or Contraction is painful, when a total one is more tolerable.

XL.

And as to the Decay of a Limb, it does not ſeem to me to happen from the Want of a nervous Juice, by way of Nouriſhment, as has been the common Opinion; but becauſe, whether they be Muſcles of voluntary or involuntary Motion, the *inflating Matter* not being able to reach the *Cells*, from an Obſtruction in the Roots or any other Parts of the Nerves, ſo as to fill them up to an *Æquilibrium* with the *interſtitial Air*, this Air will expand itſelf beyond its *Medium*, and compreſs the little Twigs of the *parallel arterial Canals*, that go off to nouriſh the *Cells* of the muſcular Fibres, and lie conſtantly upon them, and ſo ſtop their Nutrition from the Blood; while the *parallel Canals* themſelves, being too conſiderable to be affected by the Preſſure of the interſtitial Air, continue on their Stream: Thus a Decay of the Limb, and Loſs of Motion, is effected, while there is a Circulation continued thro' the Body of every Muſcle in the Limb.

XLI.

The Hearts of certain Animals, taken out of the Body, will continue to move a conſiderable Time, becauſe the Action and Re-action cannot ceaſe at

once between the *muſcular Cells* and the interſtitial Air, no more than a pendulous Body can ceaſe at once, after having been ſwung beyond its Point of Reſt. The Reaſon is, that as long as the Heart remains warm, the elaſtic Force of the interſtitial Air, and that of the inflated *Cells*, will have the ſame alternate Effect upon each other, till the external Cold, and Want of the gradual Supply of the inflating Matter, cauſe the Action and Re-action to become unequal, and ſo by degrees fix both: But, when the Motion ceaſes, it may be again excited for a little time by Pricking. This ſeems to make a new Impulſe on the Matter yet remaining in the muſcular Cells, which, acting by their Expanſion, will compreſs the interſtitial Air, and receive a Repulſe from it for a few times faintly: But this Experiment will not anſwer, when the Heart is quite cold; but then, if warm Water be pour'd on it, there will be Motion again excited. This happens, becauſe the interſtitial Air, before condenſed by the Cold, is now inſtantly rarefied and expanded, and therefore preſſes the *muſcular Cells*; which alſo being warmed, the remaining inflating Matter will exert itſelf in its turn, and ſo continue an alternate Motion for a few times, till the Heart grows cold again. But this Experiment will not often anſwer; becauſe, altho' the ſame interſtitial Air remains, it is a Doubt whether the Matter of the *Cells* does not exhauſt by degrees; in which Caſe there can be no more Re-action. I have two or three times obſerv'd, when the Skin of an Ox has been taken off, the muſcular Fibres continued to move in Spaſms, and ceaſed at Intervals; then re-aſſumed their Motion, going on thus till the whole

Surface

Surface grew cold, and the inflating Matter of the Cells, for want of a Supply, was quite overcome by the Preſſure of its Antagoniſt, the interſtitial Air.

XLII.

There might be many more Obſervations made upon this Plan, with regard to the Diſeaſes *commonly* called *nervous*; but as theſe Lectures were confined to *Phyſiology* alone, we ſhall make no Excurſion from the Deſign of the Founder; and ſhall be extremely happy, if this moſt learned *Society* ſhall approve of this Eſſay I have now made, in Obedience to their Commands.

The End of the Second Lecture.

LECTURE

LECTURE III.

SECT. I.

Read in October, 1745.

IN performing the Lectures of laſt Year, beſides laying open the Opinions of the moſt remarkable Authors who have endeavour'd to account for muſcular Motion, I have given my own Eſſay towards its Explanation, which will appear to differ from every Opinion before it. And as I have there produced every thing I could ſay upon the Subject, touching the *Cauſe* and *Manner* of a Muſcle's being moved, I muſt confine this Lecture to the Deſcription of certain particular Organs, which, tho' not *commonly* thought ſo, I ſhall endeavour to prove to be Muſcles: And theſe are, 1. The *Uterus* itſelf; 2. The *Fallopian Tubes*; and, 3. The Parts commonly called *Ligamenta rotunda.*

II.

Of the Uterus.

Whoever conſiders the Offices and Uſe of the *Uterus*, will hardly heſitate to pronounce it a *Muſ-*

cle with *me*. Beſides which, the very Structure of its Subſtance, from many Obſervations, prove it ſufficiently, having diſcerned its interlaced muſcular Fibres, as plainly as thoſe of any other Muſcle in the Body: However, its Definition and Uſe, as we ſhall now mention them, will ſerve further to illuſtrate and confirm our Aſſertion.

III.

The *Uterus* is an Organ deſtined, by the Wiſe AUTHOR of Nature, not only to receive, cheriſh, and increaſe the *Ovum*, which contains the *Fœtus*, till it arrives at due Maturity, but alſo to promote its *Expulſion*, when the Time of Geſtation is fulfilled.

IV.

In a *virgin* or *empty* State, it is very ſmall, as it appears at TAB. II. *Fig.* 2.; and being laid open, its Subſtance and Cavity are no more conſiderable than *Fig.* 3. repreſents; yet, in proportion to its Size, its *Parietes* are thicker and more compact, than at any time during its Geſtation, whatſoever may vulgarly be thought of it by thoſe who have only read of, and not obſerved it. This Subſtance, then, conſiſts of fleſhy Fibres and Blood-veſſels, both Arteries and Veins; and is cloathed internally by a Membrane, whoſe whole Surface is ſet thick with *valvulous Holes*, and externally by the *Peritonæum*: Theſe, no doubt, ſerve to ſtrengthen its Subſtance, and hinder its muſcular Fibres from being driven too far aſunder, by the Diſtenſion or Enlargement of the Blood-veſſels

(which

(which are very great and numerous thro' its whole Subſtance), while it is diſtending gradually, by the Increaſe of the lymphatic Fluid *, and Growth of the *Fœtus, Placenta, &c.* in it.

V.

In this virgin or empty State, the muſcular Part is ſo ſqueezed and compreſſed together, that the Arteries and Veins are quite cloſed up, and utterly incapable of receiving a Drop of Blood during that State; except ſome few ſmall Veſſels, which only ſerve for the Continuation of Nutrition: But as ſoon as the *Ovum* is lodged in the *Uterus*, and begins to increaſe in Bulk by the Intruſion of the *Liquor Amnii*, it forces the *Uterus* to diſtend by degrees, till it arrives at the Bulk we ſee in the latter Months of Pregnancy. By this gradual Diſtenſion, the muſcular Fibres are forced further aſunder, and conſequently the Blood-veſſels are gradually freed from the Preſſure, till at length they increaſe to their full Dimenſions.

VI.

All this time the muſcular Part, being compell'd to dilate, can perform no Function proper to a Muſcle, until the *Cervix Uteri* is ſo ſhortened, as to become thinner than the reſt of the *Uterus*; which does not happen till about the Completion of the ninth

* *Liquor Amnii.* The Manner of the Secretion of this Fluid, which is much controverted, ſhall be ſoon accounted for in a Treatiſe on the *Nutrition* of the *Fœtus*, which ſhall be publiſhed in *Some Eſſays on the Diſeaſes of Women.*

ninth Month (a little ſooner, or a little later). Now a Word or two of the *Cervix* here, ſince we are obliged to mention it, will render our Explanation more clear, and will alſo ſhew the infinite Wiſdom of the *Great* CREATOR in the Formation of this Organ, for the Purpoſes it is deſign'd for.

VII.

The *Cervix* of the *Uterus* is a compact Part, narrower than the Body, and about an Inch long (more or leſs), as at TAB. II. *Fig.* 3. It has two Orifices proper to it while in this State; the one called the *internal*, which opens into the Cavity of the *Uterus*; and the external Orifice, commonly called the *Os Tincæ*, which opens into the *Vagina*. Its Subſtance is very hard and ſolid, and it has a very ſmall Paſſage from the one Orifice to the other, having on its Surface many Glands, which ſecrete a denſe glutinous Subſtance, and many *Striæ*, to which this *Gluten* adheres; ſo careful is Nature to keep the *Uterus* cloſe, in order to prevent the Ingreſs of even the Air.

VIII.

Now this *Cervix* is made thus long and compact, that its Reſiſtance to the intruding Waters of the *Amnium** ſhould be greater than that of the *Parietes* of the *Uterus*, while it is dilating: This gives Time enough and Room for the *Fœtus* to grow to Perfection; and near the Time in which this is brought about, then this, which was before a *Cervix* with an Orifice at each End, is now become ſo much

 ſhortened,

* Ἀμνίον. ν. τὸ. The Name of one of the Membranes that contain the Child, *&c.*

ſhortened, as to acquire a greater Thinneſs than the *Parietes* of the *Uterus*, and conſequently to bring both Orifices into one.

IX.

By this time the *Fœtus* being come to Perfection, and the Reſiſtance being leſs at this Orifice than at the other Parts: The *Uterus* now begins to act in its muſcular Capacity, beginning by degrees to contract itſelf alternately, till the Waters and *Fœtus* are determined downwards to the Orifice; which, the more it dilates, the more Power the *Uterus* ſtill acquires, by its natural Diſpoſition to contract; until the Muſcles of the *Abdomen* are at length drawn into Conſent, and the *Conatus*, or Pains, as Women call them, which begin by the involuntary Motion of the *Uterus*, are aſſiſted by the voluntary Contraction of the abdominal and other Muſcles towards the Extruſion of what it contains *.

X.

Nor does the *Uterus* reſt, after it is rid of every thing, but ſtill continues alternately to contract; until, in ſome Days ſooner or later, it has ſqueezed out the Fluids from the Blood-veſſels, called *Lochia*, compreſſed them cloſe, and at length acquir'd its former Size and Compactneſs, or very near it. This is what

* This regards the natural Delivery of a Woman in due time. As to what relates to Abortions at different Times, it is a Subject reſerved for another Place.

what cauſes thoſe Pains, which are commonly called After-Pains.

XI.

Thus is this wonderful *Phænomenon* bronght about by the muſcular Structure and Mechaniſm of the *Uterus*; and it may ſecurely be affirmed, that if *it* was not a very Muſcle, this Effect could not come to paſs, no more than the Blood could be driven from the Ventricles of the *Heart*, if it were not a *Muſcle*, or the Urine from the Bladder (without a muſcular Coat, and a *Detruſor* Muſcle), which are forced to diſtend by the Intruſion of Urine from the Ureters, till, by its Repletion, the Reſiſtance becomes leſs at the Orifice than in the *Detruſor*, This is more fully explained in my Deſcription of the Bladder; which ſee.

XII.

Of the Fallopian Tubes.

Theſe Organs were known to, and well deſcribedby, *Hierophilus* and *Ruffus Epheſius*, as the late learned Dr. *Douglaſs* has very juſtly obſerved; altho' they are called by *Fallopius*'s Name by ſome not well verſed in the Hiſtory of Anatomy. They are ſoft pliable Bodies, and are properly enough called Tubes or Trumpets, becauſe they ariſe ſmall on each Side from the Angles of the *Uterus*, and run larger by degrees, till

 they

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* *Bibliographiæ Anatom. Specimen*, p. 126.

they approach the Extremity, and growing again a little more narrow, terminate in ragged *Fimbriæ*.

XIII.

The Cavity of each is alſo ſo ſmall at their Origin in the Angles of the Womb, that a ſmall Hog's Briſtle can hardly be introduced; but it enlarges gradually, till, at the other Extremity, it is capable of admitting the End of a Gooſe-Quill.

XIV.

Theſe Tubes are in a ſtrait Direction for a little Way from the *Uterus*; but as they enlarge, they grow into vermicular Curves or Flexures, terminating downwards, and a little backward, with their Mouths opening upon the *Ovaria*, altho' not at all attached to them; and are ſuſtained and ſtrengthened by their Situation in the Duplicatures of the *Peritonæum* on each Side, which ſerves to keep them in their curved State (as the Meſentery ſuſtains the Guts) during the unimpregnated State of the *Uterus*: And theſe Duplicatures (which alſo ſtrengthen, and in ſome meaſure cloathe, the *Ligamenta rotunda*, and which we ſhall ſpeak to preſently) are what are commonly called the *Alæ Veſpertilionis*.

XV.

Theſe Tubes are made up of muſcular Fibres, which are partly longitudinal, and partly are ſituated obliquely, and ſomewhat circular; from which Structure they have a Motion which may be called a compound Motion, and which amounts to what we

count

count the vermicular Motion in the Guts; but this Motion is not begun, till there is a Neceſſity for it; which is as ſoon as an *Ovum* is impregnated.

XVI.

At the Inſtant that this Impregnation happens, the Orifice of the *Fallopian* Tube claſps itſelf cloſe upon the Part of the *Ovarium* next to it, by contracting; and receives into it the *Ovum*; which, as ſoon as it has enter'd, thoſe oblique circular Fibres, or, as we may term the Extremity, the *Sphincter* of the Tube, incloſes and puſhes it farther in towards the *Uterus*, which is by degrees forwarded by the periſtaltic Motion of the Tube, till at length it is puſh'd into its Receptacle the *Uterus*, in the Manner explained in my laſt Lecture, where I endeavoured to account for involuntary Motion: And when the *Ovum* is thus ſettled, then the Cauſe of this Motion ceaſing, the Tube is at Reſt; and in proportion, as the *Uterus* grows more tumid afterwards, both Tubes loſe their vermicular Flexures, and at laſt grow quite ſtrait and pendulous, as at Tab. III. *bb*, by the general Diſtenſion of the *Peritonæum*: But when the *Uterus* is emptied, and again is contracted to its former Dimenſions, then the Duplicature of the *Peritonæum* is contracted in proportion, and theſe Tubes are conſequently reſtored to their former vermicular Flexures, and therefore rendered capable of receiving an impregnated *Ovum*, as before.

XVII.

From hence it is eaſy to conclude, that what has been thought, by many old Authors, and indeed by ſome

ſome Moderns, concerning Superfetation (any conſiderable Time after the *Uterus* has received one (or more) impregnated *Ovum*) is altogether groundleſs: For, when the *Tubes* are grown flaccid, after having conveyed the *Ovum* to its Receptacle, and loſt their vermicular Flexures, they can no more embrace the *Ovaria* during that Pregnancy; and alſo becauſe the *Ovarium* on each Side is driven by the Diſtenſion of the *Uterus* to a greater Diſtance (out of its former Situation) from the *Vagina*, and conſequently out of the Reach of Impregnation.

XVIII.

Therefore, whenſoever it happens that two *Fœtus's* are brought forth at different Times, they both come within the common ſtated Time of Geſtation; that is within nine Months, or thereabout, from the *Coit* that produced the Fecundation: In which Caſe, tho' one may be perfect, and come at the full Time, the other is imperfect, and ſometimes waſted, and comes before the due Time, being both begotten at the ſame Inſtant, or within a very little Time of one another. But becauſe one ſhall have more Nutrition determined to it, the other leſs, the latter, which is always ſituated neareſt the Orifice, will of Neceſſity ſuffer Abortion. Thus, different Emiſſions of Children happen, not becauſe they are begotten at different Times, but becauſe, Nutrition being unequally diſtributed, the defrauded *Fœtus* is extruded by the other, who often keeps his Place till he arrives at due Perfection.

XIX.

XIX.

Before we quit this Part of our Subject, it will not be unſeaſonable to mention a Caſe here, which was in ſome meaſure, objected to what I had laid down againſt a Poſſibility of Superfetation, when I read this Lecture.

A Gentlewoman in *Charles-Town* in *South Carolina*, about the Year 1714, was brought to Bed of Twins, one immediately after the other, in the ſame Labour. The one proved to be a *Negro* Child, and the other a white one; which very much ſurpriſed thoſe that attended about her. So flagrant a Teſtimony of her Infidelity to her Husband, made her confeſs before them, that a *Negro* Servant, immediately after her Husband had left her one Morning, came to her; but ſhe pleaded, as an Excuſe, that he threatened to kill her, if ſhe did not comply with his Deſire; and that accordingly ſhe was forced to admit him into Bed.

XX.

Now, in order to remove this Objection, it muſt be obſerved, that what I have aſſerted is, that when the *Fallopian* Tubes are grown flaccid, and have loſt their vermicular Flexures, and the *Ovaria* are driven to a greater Diſtance from the *Vagina* by the Enlargement of the *Uterus*, that then they are out of the Reach of Impregnation.

Whereas, in the Caſe before us, there could be no ſuch Change brought about in the *Uterus*; for, altho' one Tube had received an impregnated *Ovum* by the *Coit* of the Husband, and convey'd it to the

Uterus,

Uterus, whereby it may have loſt its Flexures, yet the other Tube had not; nor could the *Uterus* be enlarged by the one in ſo ſhort a time; for it appears the *Negro* cohabited with her immediately after her Husband; ſo that the *Ovum* impregnated by him was from the other *Ovarium* thro' its neighbouring *Tube*; which might have happened in a ſecond *Coit* with her Husband, as well as with the *Negro*.

From this Structure and Office in theſe *Tubes*, we may venture to be of Opinion, that they are truly *Muſcles*.

XXI.

Of the Ligamenta rotunda.

There have been various Conjectures concerning theſe ſlender Bodies amongſt Authors; but the greater Part accounted them as Ligaments.

Spigelius, and after him *Diemerbroeck*, had a Notion, that they were *Vaſa deferentia*, which they thought carried ſeminal Matter from the *Ovarium* to the *Clitoris* in Females: But this cannot be the Caſe; firſt, becauſe they have no Cavity, that I could find, and are therefore impervious to any Matter: Again, their Situation would not admit of it, ſuppoſing they were tubular, becauſe they ariſe from the Angles of the *Uterus* a little below, and forward of the Ligaments that ſuſpend the *Ovaria*, as at TAB. II. *Fig.* 1. (*f*); and, paſſing along thro' the Duplicature of the *Peritonæum* on each Side, riſe over the Edges of the *Os Pubis* nearly in a Line above the Fore Parts of the *Acetabula*; and then running

rnnning thro' the Rings in the *Peritonæum*, and Tendons of the oblique Muſcles, *&c.* turn downwards and forwards, towards each other, on the *Oſſa Pubis*, till they are loſt in the Fat of the *Mons Veneris*, and ſometimes in the Groins; and conſequently could not ſerve to any ſuch Uſe, having no Communication with either *Ovarium* or *Clitoris*.

XXII.

The celebrated *Winſlow* thinks them vaſcular Cords, ariſing from the Communication of the ſpermatic and hypogaſtric Veſſels; and ſays, they ought to be eſteemed as a particular Continuation of the Spermatics; and that he ſuſpects they furniſh the Matter which is ſecreted from the *Lacunæ*. Now theſe Cords are made up of muſcular Fibres alone; for, by the moſt ſtrict Examination I could make, the Fibres appear to me fleſhy, and have a longitudinal Direction from one End to the other; and as to their being vaſcular, it is impoſſible, from their Situation, they ſhould be ſo, becauſe they have not the leaſt Communication with theſe Blood-veſſels he mentions, and have only minute Twigs, as every other Muſcle has, for their Nouriſhment: And as to the *Lacunæ*, which are Glands on the Surface of the *Vagina* in ſeveral Parts, they are remote enough from any Communication with the Fibres of theſe muſcular Cords, where they are loſt in the Fat of the *Groin*, and *Mons Veneris*; and therefore muſt be deſigned for ſome other Uſe.

XXIII.

From what I have ſaid of theſe Cords, I muſt concur in the Opinion *Veſalius* had of them, concerning their being *Muſcles*, who is quoted by *Santorini* on that account; and theſe, with our celebrated Anatomiſt Doctor *Nichols*, are the only Authors that I know of, that have mentioned them as Muſcles; yet none, I believe, have aſcribed the ſame Uſe to them that I think they are employed in; and that only reſpects the diſtended *Uterus*, as follows:

XXIV.

While the *Uterus* is in its contracted State, theſe *muſcular Cords* are alſo in a State of Reſt, forming the curved Direction we have mentioned, as at TAB. II. (*f*); and as the *Uterus* grows larger by its Pregnancy, they are pull'd upward and outward over the *Oſſa Ilia*, being more and more diſtended, in proportion with the *Uterus*, till they form nearly right Lines from their Origin to their Inſertion, and are in many Women in the laſt Month 15 or 16 Inches long, more or leſs (*See* TAB. 3. *d d*,). Whereas, when they are in their State of Reſt, they ſeldom exceed from 7 to 9 Inches. From hence it may be rationally concluded, that when Delivery is over, they aſſiſt the *Uterus*, by their equally contracting on each Side, the more regularly to contract itſelf, becauſe many Evils might be produced by an unequal Contraction of it; but, as they are Part of its Diſeaſes, they can have no Place in this Lecture. And as the muſcular Cords can in no wiſe be ſaid to ſuſpend the *Uterus*, we cannot conſent at all to call them *Liga-*

ments;

ments; nor can we conceive any Uſe of them while the *Uterus* is unimpregnated at any time. Therefore we muſt think they are *Muſcles*, reſerved for the Purpoſe juſt mentioned; and neither *Vaſa deferentia*, Blood-veſſels of any kind, nor Ligaments.

XXV.

Thus I have finiſhed the Task, which the worthy Preſident and Council of this learned *Society* were pleaſed to charge me with: I return them my Thanks for the Honour they have done me; and make no Doubt but, whoſoever ſhall be appointed to ſucceed me in theſe Lectures, will add conſiderably to whatever I have been able to advance upon theſe Subjects.

The End of the Third Lecture.

TABLE I.

Fig. 1. 1, 2, 3, 4, ſhew the Forms of ſeveral muſcular Fibres, conſiderably magnify'd by the double Microſcope, where they appear to differ in Size, as well as in the Number and Diſtance of their *Cells*, as it is mentioned in their Deſcription before.

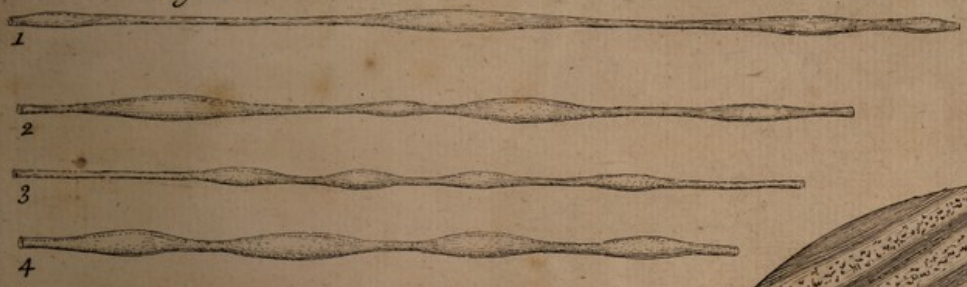
Fig. 2. is a View of ſeveral muſcular Fibres, with thoſe minute Blood-veſſels which I have called the *Parallel* or *Capillary Canals* (ſee *Lect.* II. *Sect.* XVI. and XVII.) lying in their parallel Directions, in order to anſwer the Ends of Nature; which are explain'd in the Courſe of that Lecture.

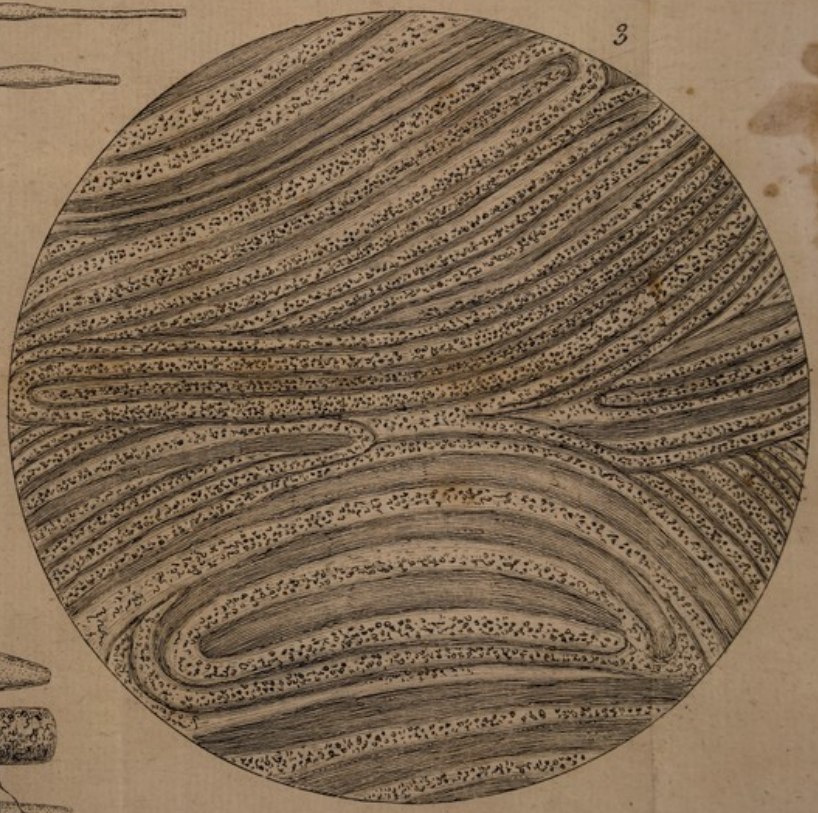
Fig. 3. is a Repreſentation of the Circulation of the Blood in a little Piece of the *Mytulus*, not exceeding a Quarter of an Inch every way in its natural Dimenſions; wherein it appears, that thoſe minute Veſſels are in a Direction parallel to other Fibres of whatſoever Nature.

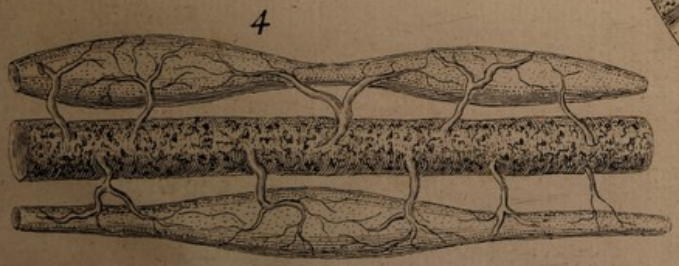
Fig. 4. ſhews Part of a *Capillary Canal*, with Part of a *Muſcular Fibre* on each Side; to demonſtrate how the minute Twigs are ſent off from the Canal to the muſcular Fibres to nouriſh them, as is hinted in the laſt Section above-mentioned. This is view'd by the greateſt Magnifier of the double reflecting Microſcope.

TAB. I.

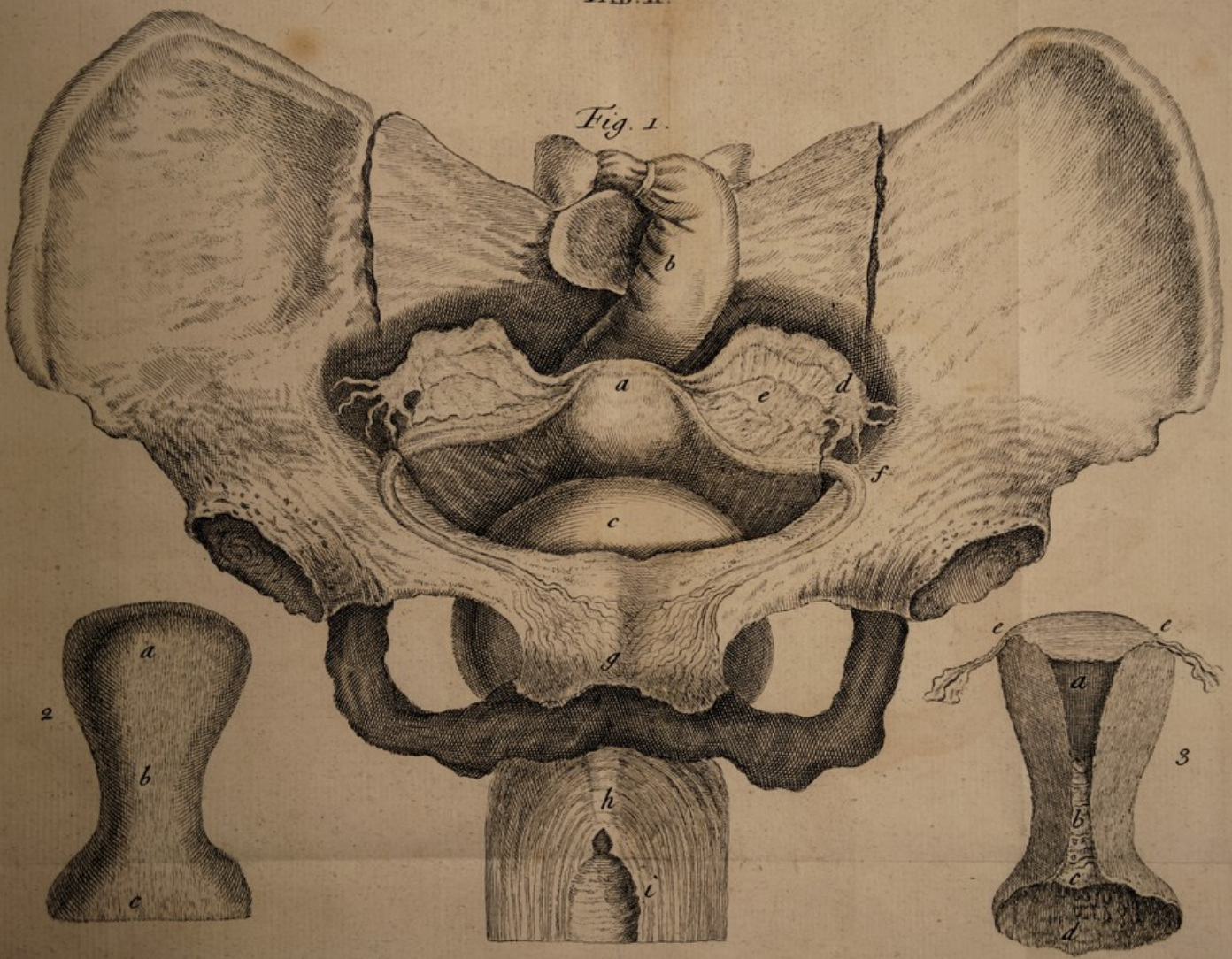
Fig. 1.







TAB. II.



J. Mynde sc.

TABLE II.

Fig. 1. is a View of the *Pelvis*, with the internal feminine Parts of Generation *in Situ*.

a, the Body of the *Uterus*.

b, the *Rectum*, turned over the upper *Vertebra* of the *Os ſacrum*.

c, the Bladder.

d, the *Fallopian* Tube.

e, the *Ovarium*.

f, the *ſlender muſcular Cord*, commonly called *Ligamentum rotundum*, riſing from the Angle of the *Uterus* on each Side, and ending by ſeveral *Fimbriæ* at *g* in the Fat of the *Mons Veneris*.

h, the *Meatus urinarius*.

i, the Orifice of the *Vagina* deprived of the Integuments.

Fig. 2. is a View of the Shape of an unimpregnated *Uterus*, all the Appendices being cut off.

a, the Body of the *Uterus*.

b, the *Cervix*.

c, Part of the *Vagina*.

Fig. 3. ſhews one Half of the ſame *Uterus*, the other being cut off laterally and longitudinally, whereby its Cavity (*a*), the inner Surface of its *Cervix* (*b*), one Lip of its *Os Tincæ* (*c*), and Part of the inner Surface of the *Vagina* (*d*), come into View.

e, the ſmall Paſſage from the Angle of the *Uterus* into the *Fallopian* Tubes.

TABLE III.

Shews a View of a pregnant *Uterus* of ſeven Months.

a, the Body of the *Uterus*.

bb, the *Fallopian Tubes* relaxed and pendulous.

cc, the *Ovaria* alſo pendulous.

dd, the *Muſcular Cord*, called *Ligamentum rotundum*, upon the Stretch.

e, the Bladder.

F, F, the *Oſſa innominata*.

FINIS.

TAB. III.