An introductory lecture to a course in comparative anatomy, illustrative of Paley's Natural theology / by John Kidd.

AN

INTRODUCTORY LECTURE

TO

A COURSE

IN

COMPARATIVE ANATOMY,

ILLUSTRATIVE OF

PALEY'S NATURAL THEOLOGY.

BY JOHN KIDD, M.D.

REGIUS PROFESSOR OF MEDICINE IN THE UNIVERSITY OF OXFORD.

OXFORD,

AT THE UNIVERSITY PRESS FOR THE AUTHOR.

SOLD BY J. PARKER, OXFORD; AND BY C. AND F. RIVINGTON,
ST. PAUL'S CHURCHYARD, AND WATERLOO PLACE, LONDON.

MDCCCXXIV.

TO

SIR ASTLEY COOPER, BART. F.R.S.

SURGEON TO THE KING,

&c. &c. &c.

My dear Sir,

IT is now nearly thirty years since I commenced my professional studies under the joint auspices of yourself and Mr. Cline; and if it were customary to unite the names of two persons on an occasion like the present, I should feel it difficult to separate the name of the one from that of the other; for they are names which will necessarily be handed down together to posterity, as having contributed in a preeminent degree towards raising the science of Surgery to its highest pitch on the only solid and legitimate basis, the result, namely, of an extensive, long, and successful practice.

Indebted to Mr. Cline, as well as to yourself, for much of the professional knowledge which I possess; and indebted equally to

each, in the persons of different individuals of my family, for the successful exertion of your professional skill; I yet naturally address myself more particularly to you on the present occasion, because, in consequence of a nearer proximity in our ages, I have from the beginning been thrown more into the society of yourself, than into that of your colleague; which circumstance, though it could not diminish my respect for the one, has necessarily strengthened the feelings of attachment to the other.

If the expression of this attachment, and of gratitude for those favourable testimonials of my character which I have received from you on some important occasions of my life, be in any degree acceptable to you, I have a very great pleasure in thus publicly avowing my sentiments towards you, by the inscription of the following pages with your name.

I am, my dear sir,

With the truest respect and esteem,

Your much obliged and sincere friend,

J. KIDD.

OXFORD,
April 12, 1824.

PREFACE.

A FEW words will be sufficient in explanation of some parts of the following Lecture.

It will be at once known to every resident member of the University, that the individuals to whom I have referred in the first page, are the Rev. Dr. Lloyd, Regius Professor of Divinity; and Mr. J. S. and Mr. P. B. Duncan, Fellows of New College: and I have discharged a most willing debt in speaking of them in terms not only justified by my own sentiments, but, which is more to the purpose, by the sentiments of the University at large.

With respect to the translations from Galen, I believe they will be found, if not always literal, yet faithful representations of his language and opinions.

I am well aware that in philosophical investigations the previous consideration of final causes, on which great stress is laid in the following Lecture, is usually and properly excluded: but I am equally

aware, that the rule neither is nor ought to be without an exception; and that in this, as on similar occasions, the reason of the exception corroborates the expediency of the general rule.

I am also aware, that such observations as are introduced on the real nature of monstrous productions, are, in a mere physical point of view, rather calculated to get rid of, than to solve the difficulty. But if reason have its limits, it must be one of its highest prerogatives to know the exact boundary of those limits; and though a relaxation in our exertions to ascertain the general laws of nature, because we may despair of success in some instances, would betray an ignoble or slothful indolence; yet to me it seems in the highest degree probable, that there are some questions, and that the real character of monstrous productions is one of that number, the solution of which exceeds the powers of reason: and if so, impatience of ignorance will in such cases be an indication of intellectual weakness, rather than of strength.

In speaking of Dr. Gall's theory, I have endeavoured to offer a fair statement; and though at the conclusion I have expressed myself freely with respect to the opinion I entertain of its general merits, yet I have purposely abstained from every personal remark, and therefore feel myself clear from the risk

of having given any personal offence. With Dr. Gall indeed I am perfectly unacquainted: but I have a gratification in taking this opportunity of expressing the pleasure I experienced from the short acquaintance which I made some few years since, in Oxford, with his colleague Dr. Spurzheim: of whom, in common with many of the first professional characters in this country, I am disposed to think most highly.

With respect to the following Lecture itself, I do not in the least deprecate the exercise of criticism, however severe, provided it be also candid: but I would beg leave to remind the general reader, that the Course of Lectures, to which the present was introductory, was delivered to an audience, composed chiefly of individuals to whom the pursuit of physical science both is and ought to be a relaxation rather than a study. But I have now no fear of that jealousy which once existed towards this University, in the minds of those who had not had an opportunity of becoming acquainted with its institutions. Oxford is now strong enough to say without boasting, that though clouds soon obscured her bright dawn of natural science, which, originating in the labours and association of Boyle, Hooke, Wallis, Sir Christopher Wren, and others of similar pursuits, subsequently led to the establish-

ment of the Royal Society of England, that dawn has again revived: and I am happy in believing, that mutual communication has produced mutual respect between those who cultivate science in this place and in other parts of this kingdom.

THE natural theology of Dr. Paley is so generally recommended and read in this University, that I need not here insist either on the scope or the utility of the argument so powerfully and at the same time so beautifully enforced in that work. And if philosophy be on all occasions admissible as the handmaid of religion, I need not fear, in employing this argument as the groundwork of a course of academical Lectures, that I have selected a subject unacceptable to an academical audience; especially as this subject has been recommended to me by him, who, from the weight of his personal character and abilities, has within little more than a year been appointed to that chair, from which such a recommendation must come with peculiar propriety. Neither will that chair be disparaged, nor will he who fills it be displeased, if to his authority I add that of two other individuals; brothers not only by birth, and eminently in mutual affection, but still more eminently in their love and encouragement of taste and science, and of every thing that is amiable and virtuous in life.

It will be remembered, that Paley states his argument under the supposition of the different manner in which the mind would be impressed, by meeting with a mere loose stone on the one hand, or an intricate piece of machinery on the other, in the midst of an unfrequented heath; that from the evident marks of contrivance in the latter, suppose it a watch for instance, a conviction would arise in the mind, that the several parts had been put together by de-

sign. And, further, supposing the mechanism of the watch such as to enable it by internal movements to produce another watch like itself, it would increase beyond measure our admiration of the skill which had been employed in the formation of such a machine. He then applies this argument to the examination of the eye and ear of animals, and to the power of propagating their species; and shews from the infinitely superior proofs of skill and contrivance in the works of nature, that if we infer the existence of a contriver from the proofs of contrivance in the works of art, much more must we infer the existence of a Creator from the evidence of consummate skill in the structure and functions of natural objects, as plants and animals. He argues further, that the existence of a Creator is not rendered questionable by occasional irregularities and imperfections; nor by our ignorance of the operation or use of parts: and combats various atheistical notions concerning chance, or a principle of order, or the effect of long continued habit, as equivalent to a creative power. He then proceeds to examine the mechanism and functions of the various parts of animals, and the connected assemblage of these parts in different individuals: and he instances several peculiarities of organization, as the air-bladder of fish, the fang of the viper, &c. He next considers what he calls prospective contrivances, as the formation of teeth within the jaw long before the time of their being called into action, or even making their appearance externally: then the mutual relation of parts, as of teeth to the stomach: and particularly that species of relation called by him *compensation;* in which the defects of one part or of

one organ are supplied by the counterbalancing structure of another part or of another organ. Lastly he examines the instincts of animals: and every where he intersperses his observations with appeals to the understanding of the atheist, against the supposition, that the various phenomena he has been considering are referable to chance, or any other principle independent of a creative power.

As every subject is probably viewed by each individual in some peculiar light, in a light, that is, modified by his habitual train of reflection, I would beg permission, in the commencement of these Lectures, to make a few observations on the application and value of the argument employed by Paley in the work above mentioned.

Being fully persuaded then that the supposition of pure intellectual atheism involves an intellectual absurdity; in other words, that the pure or unmixed application of the intellectual powers, supposing them to be in any degree sufficient for the process of reasoning, can never lead to a conclusion involving the disbelief of a Creator; being fully persuaded of this point, I feel that so far it is unnecessary to hold any argument on the subject; and that Paley, without making an appeal to the understanding of a supposed atheist, might have simply held up to view the manifestation of the power and wisdom of God, evidenced in the works of creation, as a subject worthy both of philosophical and religious contemplation. But atheism apparently exists and has existed in all ages of the world; and is from time to time either openly professed or insidiously recommended by those, whose intellectual powers, however distorted or diseased,

give general proof of original strength and soundness. Nor is it difficult, whether to those who admit the original depravity of our nature, or to those who have simply by observation penetrated the recesses of the human heart, to discover the existence of motives that would lead either to the profession of atheism, or to a wish that the doctrine were true. For, without entering more minutely into a question, the discussion of which belongs rather to others, it is evident from antecedent reasoning, that a profligate man, whose life is systematically at variance with what are generally acknowledged as the moral laws of God, would first wish to escape the punishment consequent on the infringement of those laws; and would thus be led to hope, that the author of those laws had no existence but in the opinion of mankind. And such a wish is probably implied in that passage of the Bible; "The fool hath said in "his heart, There is no God:" for since in the language habitual to Scripture wickedness and folly are convertible terms, and as what we are affirmed to say in our heart may naturally be understood as expressing the object of our affections, rather than the conviction of our understandings; hence those words may be interpreted as implying the hope, rather than the belief of the fool, or wicked man. On the other hand, the outward profession of atheism may be traced to many sources. Those men, for instance, who live a depraved life may choose to profess a disbelief in God, in order to obviate the accusation of inconsistency in living directly in opposition to his laws: or intellectual pride, that absurd yet baneful error of our nature, may lead some to the profession of a doctrine,

on the discussion of which more humble, and therefore to them more contemptible minds may fear to enter. Some, again, may gratify their vanity by the invention or application of specious arguments, for the purpose of influencing others, less wicked perhaps, but still weaker than themselves; while these their disciples may on their part be gratified by supposing, that they see the solidity of the arguments of a favourite leader: for that such reciprocal feeling may take place between opposite characters is manifested on various occasions.

> "Doubtless the pleasure is as great
> "Of being cheated, as to cheat."

To us perhaps the evil of atheistical doctrines is rather an object of wonder than of fear: for during a long period in which the cause of irreligion has been both openly and insidiously advocated, by writers neither unlearned nor unpopular, the infection happily has reached a very few of the thousands who have been educated in this University.

Of any fear to be entertained from the writings of Lucretius, I could never myself see any rational ground. But as I have known that fear expressed by one whose opinion ought not to be treated with indifference on any subject connected with intellectual education, I will take this opportunity of shewing (in one instance for the present) how easily the reasonings of the Epicurean philosophy, if they deserve the name of reasoning, may be combated on this point.

There is not perhaps in the whole poem of Lucretius a more beautifully poetical passage than that, in

which the helplessness of human infancy is contrasted with the early developement of the powers of brutes: and certainly I could not select one more fitted for the present occasion, because it will give me an opportunity of introducing, and also of amplifying, one of Paley's most favourite instances of contrivance in the structure of the human body.

The passage to which I allude is in the 5th book, line 223.

Tum porro Puer, ut sævis projectus ab undis
Navita, nudus humi jacet, infans, indigus omni
Vitali auxilio, cum primum in luminis oras
Nixibus ex alvo matris natura profudit:
Vagituque locum lugubri complet, ut æquum est,
Cui tantum in vita restet transire malorum.
At variæ crescunt pecudes, armenta, feræque,
Nec crepitacula eis opus sunt, nec cuiquam adhibenda est
Almæ nutricis blanda atque infracta loquela:
Nec varias quærunt vesteis pro tempore cœli.
Denique non armis opus est, non mœnibus altis,
Quêis sua tutentur, quando omnibus omnia large
Tellus ipsa parit, naturaque dædala rerum.

The helpnessness above described arises in a great measure from the imperfect state of that bony column called the spine, on which the body principally depends for the due exercise of its powers.

I will first therefore shew, how admirably this column is calculated for the intended purpose in the adult state; and, in afterwards examining the state of the same column in the infant, we shall observe, that in the midst of the most decided marks of weakness and imperfection, there is an extraordinary instance of strength and perfect growth in precisely that part of the column, which could not have been left in an

incomplete state without manifest, immediate, and constant danger to the individual. And in reasoning on the subject, we soon perceive how that very helplessness and imperfect state of the physical powers in infancy, so ill understood and appreciated by the Epicurean, contribute to the fuller developement of the moral character, not only of the individual, but of his parents also, and of all his immediate connections. The mutual affection, for instance, that takes place and is cemented between the infant and its mother during the lengthened period in which the latter nurses her offspring—the stimulus which is given to the exertions of the other parent in supplying the increasing wants of those who depend on him for support—and the general feeling and expression of good-will and attachment which binds together the numerous individuals of the same family—all coincide to increase the sum of human happiness and virtue. Whereas, let the Epicurean infant be born with all his powers complete, and let him exert those powers as soon as born, independently of the assistance of parent, or sister, or brother; and what would then remain of those endearing relations but the empty name?

In considering the office of the adult spine, we find the following qualities requisite:—great strength combined with great flexibility, together with a general convenience of form for the attachment and secure lodgment of many important organs. Let us then examine how these qualities are attained; and first with respect to strength.

To this end its pyramidal form is obviously conducive, and the arrangement of the solid matter of

which it is composed is such as to contribute to the same effect: for that solid matter, instead of being collected into one compact mass, is diffused in such a manner as to resemble the structure of sponge; and it is well known with reference to the strength of artificial columns, that the same quantity of matter being given for each, those columns which are hollow are stronger than those which are solid.

Again, the whole column is made up of numerous parts, called vertebræ, which are so bound together by strong and elastic bands or ligaments, as to lessen the chance of its being broken in the act of bending; and these vertebræ being applied to each other throughout by broad horizontal surfaces, are thus best calculated to support the perpendicular pressure of the superincumbent parts.

The effect of general strength is further accomplished by the mutual locking in of the projecting portions or *processes* of the several vertebræ; and the same effect is accomplished to an additional extent among those vertebræ which belong to the thorax or chest, by the mode of articulation between the vertebræ and the ribs; each rib being united, not entirely to the side of its corresponding vertebra, but partially to the upper and lower side of two contiguous vertebræ.

The flexibility of the spine is secured to the utmost requisite extent by the number of articulations or joints which it possesses, and which amount to more than twenty, as well as by by the elasticity of the substance constituting those joints: and the projecting parts or processes of the several vertebræ which serve for the insertion of the muscles and tendons which are

to move the whole, are differently disposed in the neck, the back, and the loins, so as to be accommodated to the degree and kind of motion in each: thus the vertebræ of the neck admit of a lateral motion to a greater extent than those of the back; and the vertebræ of the back admit of flexion and extension to a greater degree than those of the neck; while the vertebræ of the loins, being intended for support rather than flexibility, have their processes so distributed, as to contribute principally to the former of those effects.

The evidences of convenience in form with respect to the accommodation and protection of contiguous parts are not less obvious than of strength and flexibility. Thus while the anterior portion of each vertebra consists of an entire mass of bone, as being intended to constitute a portion of that part of the whole column that is to sustain the weight of the superincumbent and surrounding parts, the posterior portion is hollowed out into a ring through which the spinal marrow passes; the continued series of similar rings in the several vertebræ constituting a bony canal, which at the same time gives lodgment and protection to that important part of the nervous system.

It will be readily seen upon examination that from the annular part of each vertebra three projecting portions, called processes, pass off, two in a lateral direction, the other advancing from the posterior part like a thorn, whence indeed the term spinous process by which it is distinguished. It is remarkable, that in the case of the cervical vertebræ the lateral processes are perforated, and in such a direction, as that

the several perforations form on either side of the neck a continued canal; no such perforation taking place in the lateral processes either of the dorsal or the lumbar vertebræ. Now as through this canal two large arteries are conveyed, which are destined to supply blood to the brain, there can be no doubt that these lateral processes are thus perforated in order to form a secure passage for those important blood vessels. Equal proofs of design are observable in the specific differences of form peculiar to the spinous processes of the vertebræ of the neck and of the back; the extremities of those of the neck being bifid, in order to conduce ultimately to a greater freedom of lateral motion in that part; those of the dorsal vertebræ overlapping each other in such a manner, that the pressure of burdens carried on the back occasions neither the pain nor the inconvenience which must be felt, did those processes project at right angles to the column, as they do in the loins: in which part, on the other hand, by so projecting, they afford a firmer surface of attachment for the insertion of powerful muscles, on whose action the support and motion of the trunk of the body in a great measure depend. It has been stated, that the general form of the spinal column is pyramidal, and that the effective part of the pyramid is formed by the apposition of the bodies of the vertebræ to each other; and it will be observed, that of these bodies those of the neck are smallest in their dimensions, while those of the loins are the largest. Now these are respectively the conditions which would be antecedently expected, inasmuch as the former have a much slighter weight pressing upon them than the latter. Again, in

comparing the dorsal with the lumbar vertebræ it will be seen, that the bodies of the former are compressed in the direction of the lateral diameter, in order to give more room for the play of the lungs on either side of the chest, while those of the latter are rather compressed in a direction from behind forwards, in order to give room to and facilitate the motion of the abdominal viscera.

Nor will it escape observation, that while the posterior surface of the spinous column is broken into a series of projecting rugged points, which serve admirably for the support of the whole, and of the several parts of the column, as well as for insertion of numerous muscles; the anterior part of the column throughout its whole extent affords a smooth surface, over which the soft viscera both of the thorax and of the abdomen are continually moving without danger either of laceration or of impediment.

But the mechanism of the two uppermost vertebræ of the spine are peculiarly deserving our attention, from the evident indications of design which they exhibit in their structure, as accommodated to their respective uses. By means of the uppermost of these, termed the atlas, the head is enabled to move itself either backwards or forwards, and by means of the first, together with the second, the head is enabled to move itself laterally.

For the first of these purposes the uppermost surface of the atlas is hollowed out on either side, for the reception of two corresponding convex surfaces, placed on the lower part of the head in such a manner, as to admit of a motion of the head backwards and forwards, but not laterally; while the lower surface

of the first vertebra is hollowed out for the reception of two corresponding convex surfaces on the upper surface of the second vertebra in such a manner, that a lateral motion may take place between the two vertebræ; which lateral motion is necessarily communicated to the head through the uppermost vertebra, to which it is fixed by means of a ligament, and on which, as has been already stated, it can only move backwards and forwards. But the most beautiful part of the contrivance remains to be mentioned: for in order to afford a firm pivot for the production of the lateral motion just described, a very solid tooth-like process passes up from the middle of the upper surface of the body of the second vertebra, (hence called the vertebra dentata,) so as to be received into a corresponding depression on the posterior surface of the body of the atlas; and in order to keep this tenon in its place, a strong ligament passes behind it, from one side of the body of the atlas to the other; immediately behind which ligament the spinal marrow passes: this ligament thus serving as an effectual security against the compression to which the spinal marrow would be easily liable, were this safeguard removed; which compression would be almost necessarily fatal to the individual in whom it should occur.

Thus far we have seen the conditions of the adult spine, calculated as they are most admirably for flexibility, strength, and security: let us now examine it in the age of early infancy, and we shall see, that at that period, when the conditions of strength and flexibility are not required, inasmuch as the individual is constantly supported in the nurse's arm, the parts in

which those conditions are observable are not yet formed, or not completed; while those parts which are essential to the security of the life of the individual are in as perfect a state as at the age of manhood. In other words, the bodies and processes of the several vertebræ on which the strength and flexibility of the spine depend, are in early infancy still in a soft or cartilaginous state; while the annular portions which constitute the spinal canal are completely ossified, so as to give as great a degree of security to the spinal marrow as at the age of manhood.

The value then of Paley's argument is important, both as tending to counteract the influence of those who would inculcate atheistical opinions, and in assisting those whose reasoning powers may be insufficient to detect the fallacies by which such opinions are supported; or whose information may be too limited to enable them fairly to appreciate either the real character or the true bearings of the facts on which such opinions are grounded.

It is a circumstance well worth noticing, that Galen, one of the most acute and learned of the ancients, and who is said to have been himself convinced of the absurdity of atheism by the contemplation of an animal skeleton, employs, in one of his most elaborate works, the general argument of Paley; and often expresses the same ideas in almost the very words which Paley himself might be supposed to use: and I think it will not be unacceptable, considering the relation which this work of Galen bears to our present subject, and that it is probably but little known in this place, as not forming a necessary part of academical studies, if I offer you a fairer opportunity of

judging of its merits than by a general reference. I have therefore translated two or three chapters of that work, relating to the structure and uses of the hand.

The work itself bears this title. *On the Use of the various Parts of the Body;* and after having defined what is to be understood by the term *part*, or *member*, as applied to an animal body, Galen proceeds in the following manner. "[a] But all these "parts of the body were made for the use of the "soul, that is, the sentient and intelligent principle "which animates the body, and of which the body "is merely the organ: and on this account the com- "ponent parts of animals differ according to the na- "ture of this principle. For some animals are bold "and fierce; others are timid and gentle: some are "gregarious, and cooperate for their mutual suste- "nance and defence; others are solitary, and avoid "the society of their fellows: but all have a form or "body accommodated to their natural dispositions "and habits. Thus the lion has powerful fangs and "claws; the hare has swiftness of feet, but in other "points is defenceless. And the fitness of this arrange- "ment is obvious: for those weapons with which the "lion is furnished are as appropriate to his nature, "as they would be useless to the timid hare; whose "only safety being in flight requires that swiftness "of foot for which she is so remarkable. But to "man, the only animal that partakes of divine intel- "ligence, the Creator has given in lieu of every other "natural weapon or organ of defence that instru- "ment, the hand;—an instrument applicable to every "art and occasion, as well of peace as of war. Man

[a] Lib. i. cap. 2.

" therefore wants not a hoof or horn or any other
" natural weapon, inasmuch as he is able with his
" hand to grasp a much more effective weapon, the
" sword, or spear. Besides which, natural weapons
" can be employed only in close conflict; while some
" of the weapons employed by man, as javelins or ar-
" rows, are even more effectual at a distance. And
" again, though man may be inferior to the lion in
" swiftness, yet by his dexterity and skill he breaks
" in, to his use, a still swifter animal, the horse;
" mounted on whose back, he can escape from or pur-
" sue the lion, or attack him at every advantage.
" He is enabled moreover by means of this instru-
" ment to clothe himself with armour of various
" kinds, or to entrench himself within camps and
" fenced cities. Whereas, were his hands encum-
" bered with any natural armour, he would be una-
" ble to employ them for the fabrication of those in-
" struments and means which give him such a de-
" cided advantage over all the other animals of crea-
" tion. Nor have we yet enumerated the most im-
" portant of those privileges which this instrument
" imparts to man. With this he weaves the garment
" that protects him from the summer's heat or win-
" ter's cold; with this he forms the various furniture
" of nets and snares which give him dominion over
" the inhabitants as well of the water as of the air
" and earth; with his hand he constructs the lyre
" and lute, and the numerous instruments employed
" in the several arts of life; with the hand he erects
" altars and shrines to the immortal gods; and lastly,
" by means of the same instrument he bequeaths to
" posterity in writing the intellectual treasures of his

" own divine imagination, so as to enable us, who " are living at this day, to hold converse with Plato " and Aristotle, and all the venerable sages of anti- " quity."

In reasoning on the utility of the hand, as characteristic of the human species, Galen thus expresses himself: " [b] Man, being naturally destitute of corpo- " real weapons, as also of any instinctive art, has re- " ceived a compensation, first in the gift of that pe- " culiar instrument the hand, secondly in the gift of " reason; by the employment of which two gifts he " arms and protects his body in every mode, and " adorns his mind with the knowledge of every art. " For since, had he been furnished with any natural " weapon, he would have possessed the use of this " alone on all occasions; or, had he been gifted with " any instinctive art, he would never have attained " to the exercise of other arts; hence he was created " destitute of those insulated and individual means " and arts which characterise other animals, inas- " much as it is manifestly preferable to have the " power of making use of various means and various " arts. Rightly therefore," he adds, " has Aristotle " defined the hand to be the instrument antecedent " to, or productive of, all other instruments: and " rightly might we, in imitation of Aristotle, define " reason, as opposed to instinct, to be the art ante- " cedent to, or productive of, all other arts. For as " the hand, though itself no particular organ, is yet " capable of being adapted to all, and is consequent- " ly antecedent to all other organs; so reason, though " itself no particular art, is yet capable of compre-

[b] Lib. i. cap. 4.

" hending and applying all; and may therefore be
" considered as an art antecedent to all others. Thus
" man alone, of all animals, possessing in his soul this
" general and original capacity, is justly endued in
" his body with this general and original instrument."
" [c] Let us then scrutinize this member of our body;
" and inquire, not simply whether it be in itself use-
" ful for all the purposes of life, and adapted to an
" animal endued with the highest intelligence; but
" whether its entire structure be not such, that it
" could not be improved by any conceivable alteration.
" In the first place, it possesses in an eminent degree
" a leading quality of an organ of grasp; since it rea-
" dily applies itself to, and securely holds, bodies of
" every form and size that are capable of being moved
" by human strength. Shall we inquire then, whe-
" ther it be better for this purpose that it should be
" divided into several parts, or that it should be al-
" together undivided: or is it not apparent without
" further reasoning, that, had it been undivided,
" it could have grasped only just such a portion of
" every object presented to it as was equal to itself;
" but being divided into many parts, it can both ea-
" sily grasp bodies much larger than itself, and can
" accurately search out and lay hold of the smallest
" particles of matter. For to the former it is capa-
" ble of generally applying itself so, as to encompass
" them by the separation of the fingers; while in lay-
" ing hold of very minute objects the entire hand is
" not employed, (from the grasp of which they would
" escape,) but only the tips of two of the fingers.
" Thus then the hand is framed in the manner most

[c] Lib. i. cap. 5.

" convenient for laying a firm hold on objects both
" greater and less than itself. And, in order to enable
" it to apply itself to objects of various shapes, it is
" evidently most convenient that it should be di-
" vided into many parts, as it is: and it seems to be
" better constituted for this purpose than any similar
" instrument; for it not only can apply itself to sub-
" stances of a spherical form, so as to touch them with
" every part of itself; but it also can securely hold
" substances of a plane or of a concave surface, and
" consequently it can hold substances of any form.

" And, because many bodies are of too great a size
" to be held by one hand, nature has therefore made
" each hand an assistant to its fellow; so that the
" two, when together, laying hold of bodies of un-
" usual bulk on opposite sides, are fully equivalent
" to a single hand of the very largest dimensions:
" and on this account, the hands are inclined towards,
" and in every point are made equal to each other;
" which is at least desirable, if not necessary in in-
" struments intended to have a combined action.

" Take then any one of those unwieldy bodies,
" which a man can only lay hold of by means of both
" his hands, as a mill-stone or a rafter; or take one
" of the smallest objects, as a millet-seed, or a hair,
" or a minute thorn; or, lastly, reflect on that vast
" multitude of objects of every possible size, interme-
" diate to the greatest and the least of those above
" mentioned, and you will find the hands so exactly
" capable of grasping each particular one, as if they
" had been expressly made for grasping that alone.
" Thus the smallest things of all we take up with
" the tips of the forefinger and thumb; substances a

" little larger we take up with the same fingers, but
" not with the tips of them; substances still larger
" we take up with three fingers, and so on with four,
" or with all the five fingers, or even with the whole
" hand: all which we could not do, were not the
" hand divided, and divided precisely as it is. For,
" suppose the thumb were not placed, as it is, in op-
" position to the other four fingers, but that all the
" five were ranged in the same line, is it not evident
" that in this case their number would be useless.
" For in order to have a firm hold of any thing, it
" is necessary either to grasp it all round, or at least
" to grasp it in two opposite points; neither of which
" would have been possible, if all the fingers had
" been placed in the same line: but the end is fully
" attainable, simply in consequence of the present
" position of the thumb, which is so situated, and
" has exactly such a degree of motion, as by a slight
" inclination, to be easily made to cooperate with
" any one of the other four fingers. And no one can
" doubt, that nature purposely gave to the hands a
" form adapted to that mode of action which they
" are observed to have: [d]while in the feet, where
" extent of surface is wanted for support, all the toes
" are arranged in the same line. [e]But, to return to
" a point which we were just now considering, it is
" not merely necessary in laying hold of minute ob-
" jects to employ the extremities of two fingers op-
" posed to each other, but that those extremities
" should be exactly of the character they are,
" namely soft, and round, and furnished with nails:
" for if the tips of the fingers were of bone, and not

[d] Lib. ii. cap. 9. [e] Lib. i. cap. 6.

" of flesh, we could not then lay hold of such minute " bodies as thorns or hairs; or if they were of a " softer and moister substance than flesh, neither " then could such small bodies have been secured: " for in order that a body may be firmly held, it is " necessary that it be in some degree enfolded in the " substance holding it; which condition could not " have been fulfilled by a hard or bony material. On " the other hand, a material too soft would easily " yield to substances it attempted to lay hold of, and " would continually let them escape; whereas the " extremities of the fingers are just of that interme- " diate degree of consistence which is calculated for " their intended use.

" [f] But, since tangible substances vary much in " their degree of hardness, nature has adapted the " structure of the extremity of the fingers to that " circumstance: for they are not formed either en- " tirely of flesh, or of the substance called nail, but of " a most convenient combination of both: thus those " parts which are capable of being mutually brought " in apposition, and which are employed in feeling " for minute objects, are fleshy; while the nails are " placed externally, as a support to the former. For " the fingers are capable of holding soft substances, " simply by the fleshy, or soft parts of their ex- " tremity; but they could not hold hard substances " without the assistance of nails; deprived of the " support of which the flesh would be forced out of " its position.

" And on the other hand, we could not lay hold " of hard substances by means of the nails alone;

[f] Lib. i. cap. 7.

" for these being themselves hard, would easily slip " from the contact of hard bodies. Thus then, the " soft flesh of the tips of the fingers, compensating " for the unyielding nature of the nails, and the " nails giving support to the yielding softness of the " flesh, the fingers are hereby rendered capable of " holding substances that are both small and hard. " And this will be more evident, if you consider the " effect of an unusual length of the nails; for where " the nails are immoderately long, and consequently " come in contact with each other, they cannot lay " hold of any minute object, as a small thorn or a " hair: while, on the other hand, if, from being " unusually short, they do not reach to the ex- " tremities of the fingers, minute bodies are inca- " pable of being held through defect of the requi- " site support: but if they reach exactly to the ex- " tremity of the fingers, they then, and then only, " fulfil the intention for which they were made.

" The nails, however, are applicable to many other " purposes besides those which have been mentioned; " as in polishing, and scraping, and in tearing and " peeling off the skin of vegetables or animals. And, " in short, in almost every art where nicety of exe- " cution is required, the nails are called into action."

In appealing to the sophists of his time, the language of Galen is as follows:—" [g] Whoever admires " not the skill and contrivance of nature, must either " be deficient in intellect, or must have some private " motive which withholds him from expressing his " admiration. He must be deficient in intellect, if he " does not perceive that the human hand possesses

[g] Lib. iii. cap. 10.

" all those qualifications which it is desirable it should " possess; or if he thinks that it might have had a " form and construction preferable to that which it " has: or he must be prejudiced, by having imbibed " some wretched opinions, consistently with which " he could not allow that contrivance is observable " in the works of nature." Galen adds: " Such per- " sons we are bound to pity, as being originally in- " fatuated with respect to so main a point; while at " the same time it behoves us to proceed in the in- " struction of those happier individuals, who are not " only possessed of a sound intellect, but of a love of " truth."

On another occasion, in reprobating the vices and the scepticism of the Epicureans, he says: " But if " I waste more time on such profligates, virtuous " men might justly accuse me of polluting this sa- " cred argument which I have composed as a sin- " cere hymn to the praise and honour of the Crea- " tor; being persuaded that true piety to him con- " sists not in the sacrifice of whole hecatombs of " oxen, nor in the offer of a thousand varieties of " incense; but in believing ourselves, and in declar- " ing to others, how great he is in wisdom, power, " and goodness."

Galen then sums up this part of the argument with the same sentiment, and nearly in the same words, which Solomon uses on a similar occasion. " [h]The contrivances of nature," he says, " are so va- " rious and so consummately skilful, that the wisest " of mankind, in endeavouring to search them out, " have not yet been able to discover them all."

[h] Lib. x. cap. 10.

Let us compare with the foregoing the following passage in Ecclesiastes[i]: "Then I beheld all the "work of God, that a man cannot find out the work "that is done under the sun: because though a man "labour to seek it out, yet he shall not find it; yea "farther; though a wise man think to know it, yet "shall he not be able to find it."

I will only detain you by one other extract, taken from the 7th chapter of the 11th book; in which chapter, after having noticed many evidences of design in the construction of the human body, particularly the adaptation, in the number and size of the parts, to the effect to be produced, he breaks out into this remarkable apostrophe: "How can a "man of any intelligence refer all this to chance, as "its cause: or if he deny this to be the effect of fore-"sight and skill, I would ask, what is there that "foresight and skill do effect? For, surely, where "chance or fortune act, we see not this correspon-"dence and regularity of parts. I am not very "solicitous about terms; but if you choose to call "that chance which has so nicely constructed and "so justly distributed all the parts of an animal "body, do so; only remember and allow, that in "so doing you do not fairly exercise the privilege of "framing new terms: for in this way you may call "the meridian splendour of the sun by the name of "night; and the sun itself, darkness. What! was "it chance that made the skin give way so as to "produce a mouth? or, if this happened by chance, "did chance also place teeth and a tongue within "the mouth? For, if so, why should there not be

[i] Chap. viii. verse 17.

" teeth and a tongue in the nostrils or in the ear?" Or, to carry on a similar appeal[k], " Did chance dis- " pose the teeth themselves in their present or- " der; which, if it were any other than it is, what " would be the consequence? If, for instance, the " incisors and canine teeth had occupied the back " part of the mouth, and the molar or grinding " teeth had occupied the front, what use could we " have made of either? Shall we then admire the " skill of him who disposes a chorus of thirty-two " men in just order; and can we deny the skill of " the Creator, in disposing the same number of teeth " in an order so convenient, so necessary even for " our existence?"

He then extends the argument to the teeth of other animals, as corresponding with the nature of their food; and also to the form of their feet, as having a relation to the character of their teeth. " Never," says Cuvier, one of the most philosophical physiologists of the present day, " never do you see in " nature the cloven hoof of the ox joined with the " pointed fang of the lion; or the sharp talons of " the eagle accompanying the flattened beak of the " swan."

In corresponding expressions Galen exclaims, " How does it happen that the teeth and talons of " the leopard and lion should be similar; as also the " teeth and hoofs of the sheep and goat; that in " animals which are by nature courageous, there " should be found sharp and strong weapons, which " are never found in those animals that are by na- " ture timid: or, lastly, that in no animal do we

[k] Chap. viii. and chap. xi. the last sentence.

" meet with a combination of powerful talons with
" inoffensive teeth? How should this happen, but
" that they are all the work of a Creator, who ever
" kept in mind the use and mutual relation of parts,
" and the final purpose of his work."

Before we proceed to examine the proofs of contrivance and of foresight in the structure of individual animals, let us consider what is the essential character of an animal in the abstract—a point which is not so easily to be ascertained as at the first view might appear.

All the objects of the material world are usually distributed into three kingdoms, as they are called; the animal, vegetable, and mineral. To these might with propriety, I think, be added a fourth, and be called the atmospherical.

In examining the general characters of the individuals belonging to these kingdoms, we shall find that upon the whole they are very different from each other.

In the atmosphere we have the *air* which we respire, a form of matter so subtle in all its states as to be invisible; and, diffused through this, we have an *aqueous vapour*; a portion of which is always retained in close combination with the air; and, like it, in an invisible state. We have also diffused through the atmosphere those still more subtle agents, *heat* and *electricity:* these four, severally and generally, existing in a loose state of aggregation, in consequence of the mutual repulsion of their particles. But all these, though of so subtle a substance, are in their effects the most powerful agents

of nature. For, omitting the silent but wonderful operation of air and moisture and heat and electricity, as exhibited in the process of vegetation, and many other processes which are continually going on, let us consider the occasional effects of *air* in the violence of a tornado; or of *moisture*, in the inundation of a rapid river, produced by protracted rain: or let us contemplate the effect of either an indefinite increase or diminution of *heat*—on the one hand, all the processes of nature stopped by the effect of cold, so that the imbedded mammoth remains at this moment in the same state that it was four thousand years ago, and in which it may be ten times that space hereafter: on the other hand, the possibility of the dissipation of all the constituent parts of matter, or their fixation in the state of glass, resulting from the agency of intense heat: or, lastly, let us consider the awful effects of condensed *electricity* in the form of lightning; and we shall necessarily acknowledge, that, though in their usual state the constituents of the atmosphere are the most tranquil agents of nature, yet, when their power is concentrated, they are the most tremendously energetic.

In the mineral kingdom, the most characteristic property of the several species appears to be a disposition to a peculiar mode of mutual attraction among the particles composing the individuals belonging to them; from which attraction, when exerted under the most favourable circumstances, result that symmetry and regularity of form, to which the term crystal has been applied. The transparency and degree of hardness of crystals are various, and de-

pend upon external circumstances. The form is fundamentally the same for each species, though capable of being modified according to known laws; and the substance is chemically the same throughout its whole extent. Every atom of a mass of gypsum consists of water, lime, and sulphuric acid, united in the same proportions, as those in which they exist in the whole mass.

The individuals of the vegetable kingdom differ very remarkably from those of the mineral, both in form and substance. In their form we see nothing like the mathematical precision of crystallization; and in their substance they differ widely according to the part of the vegetable which is examined: so that independently of previous knowledge of the species, we could hardly discover any natural relation between the several constituent parts of the individual. What is there in the insulated leaf of a peach tree, or a rose, that would lead us to expect the fruit of the one, or the flower of the other?

But the most remarkable line of distinction between vegetables and the individuals of the preceding kingdom consists in their mode of increase and reproduction. Minerals can only increase as such by the apposition of particles specifically similar to themselves; and can only be reproduced, when destroyed, by the immediate combination of their constituent elements. But vegetables have an apparatus within them, by means of which they can assimilate the heterogeneous particles of the surrounding soil to their own nature; and they have also the power of producing individuals specifically the same as themselves: in common language, they are ca-

pable of contributing to their own growth, and the propagation of their species. And as they produce these effects by peculiar organs adapted to the purpose, they are hence denominated organized bodies.

The individuals of the animal kingdom very closely resemble those of the vegetable in the two properties just described. The respective organs differ, as we might expect, in their form and position; but in their function or mode of action there is a strong analogy and even similarity throughout.

But animals differ from vegetables more remarkably than these do from every unorganized form of matter, in being endued with sensation and volition; properties which extend the sphere of their relations to such a degree, as to raise them immeasurably above all other forms of matter in the scale of existence.

In distributing the individuals of the material world among these four kingdoms of nature, there occasionally prevails considerable obscurity, not only with respect to the true place which an individual ought to occupy in the scale of a particular kingdom; but even with respect to the question, under which of the four kingdoms it ought to be arranged; this obscurity arising of course from the points of resemblance apparently balancing, or more than balancing the points of difference. In the atmospherical kingdom, for instance, take a fragment of a perfectly transparent crystal of pure ice; and, excepting from the effect of temperature, it would be difficult, either by the sight or the touch, to distinguish it from a fragment of transparent quartz, or rock crystal: in-

deed the transfer of the original term κρύσταλλος, from the one to the other, shews the close resemblance of the two. Some minerals again approach so nearly in form to vegetables, as to have given rise to specific terms of appellation, derived from the vegetable kingdom; as flos ferri—mineral agaric, &c: and even within the last few years, and in the present advanced state of science, one of the most splendid and gigantic flowers in the vegetable kingdom was mistaken for an animal, a species, namely, of sea-anemone. And, lastly, many of the animals called sea-anemones so far resemble the flower called by the same name, that their real character is at first very doubtful to those who are unacquainted with the animals of that genus. But, omitting these rare and equivocal instances, and avoiding the confinement of abstract definitions, which are scarcely applicable to any subjects but such as are mathematical, we may safely assume that animals in general are capable of being considered under three distinct points of view; namely, either simply as organized beings, endued with the powers of contributing to their own nutrition, and the reproduction of their species: or secondly, as endued also with the powers of locomotion: or lastly, as possessing, in addition to the other two, the powers of sensation and volition.

In grounding these Lectures then on Paley's work, I shall so far deviate from his arrangement, as to distribute the examples intended to be produced under the three preceding heads. And in order to make the Lectures as comprehensive as possible, I shall exhibit the facts according to the classification of animals most approved at the present day. The

principle of this classification is the degree of similarity of their internal organization to that of the human body, disregarding the occasional dissimilarity of their external form: on which principle we find the bat and the whale placed in the same class with those animals that most nearly resemble man; though from their external form they are rather to be considered, the one a bird, the other a fish.

On this principle of classification, the term "com-"parative anatomy," to which Dr. Paley objects, (p. 241.) is perfectly appropriate; since by comparing the anatomy of each species with that of man, its true place in the scale is ascertained. It will be consistent with the intention of these Lectures, to give an outline of this classification; but it is not necessary to take up your time, by giving more than a mere outline of it.

Cuvier, who is in a great measure the author of this classification, distributes animals first into *four* great divisions; each of which he successively subdivides into classes, orders, genera, and species: and where several genera in the same order are more than usually allied in the characters of their structure, he collects them into one group, under the name of family and tribe.

The first great division comprehends only those animals which have a brain and spinal marrow; which spinal marrow being contained in a spine, or backbone made up of several vertebræ, has given rise to the term animalia vertebrata. This division contains four classes, namely, the mammalia, or animals which suckle their young, birds, reptiles, and fish.

The second great division consists of animals, which

having neither a vertebral canal, nor a skeleton altogether, are called animalia mollusca. It contains six classes, which are described according to the situation of their feet, or those parts which serve the purpose of feet.

The third great division comprehends all those animals whose bodies are divided very regularly into distinct parts, hence called animalia articulata. It is distributed into four classes.

The fourth great division comprehends, among others, all those animals which, from their branching or radiated form, are called zoophytes, and animalia radiata. It is distributed into five classes.

Before we proceed to examine those instances of mechanism and contrivance which characterize particular species of animals, it will be desirable to consider such points in the mechanism and contrivance of animal life in general, as from their almost universal occurrence demand some previous attention: the common phenomena for instance, connected with the three powers above enumerated; that is, digestion, and the propagation of the species; the muscular or locomotive powers; and the nervous system.

The process of digestion, as far as we are acquainted with it, is soon described: the organs in their simplest state consisting merely of a membranous bag, which by means of a fluid that exudes from its internal surface, has the power of reducing all the varieties of food on which animals live to a soft homogeneous pulp, from which the nutritive particles are absorbed into the system, and perfected into the state of blood.

The instruments of the circulation of the blood are the heart, and the several systems of vessels con-

nected with it. The blood itself is primarily produced, as was just now said, from the food on which the animal lives: but omitting for the present the consideration of the apparatus by which this is effected, I would only observe as worthy of admiration, and indicative of the uniformity and power of nature, (by which term, I mean the Deity, or controller of nature,) the similarity in the character of this fluid, through a long series of animals of very different orders, and living on very different kinds of food. And when we come to examine the mode of its distribution through the body, and the uses to which it is applied, we have equal cause of wonder in the artificial manner in which it is conducted from part to part, and in the varying character of the compounds that are separated from it. The resemblance between the distribution of the blood-vessels, and the distribution by a skilful engineer of the pipes and conduits which are to convey water to the several parts of a large city, has been often remarked: but in the distribution of the blood, there is this additional cause for admiration, that whereas, in the case of the artificial distribution of water, the same unaltered fluid is drawn off from each individual reservoir to which it has been conveyed, in the case of the blood it is far otherwise: thus what passes into the kidney as blood, passes out as urine; from the lacrymal gland it passes out as tears; from the glands of the mouth, as saliva; from the liver, as bile; and so on with respect to all the glands of the body.

And throughout all the species of the more perfect animals, as quadrupeds, birds, reptiles, and fish, there does not appear to be one exception to this

mode of distribution; so that, whether you examine the smallest of the fry of the smallest species of minnow, the aggregate quantity of whose blood would hardly be sufficient to leave a sensible moisture on the tip of your finger; or whether you examine the largest of the whale tribe, the main vessel of whose body is a foot in diameter, and whose heart is said to throw out fifteen gallons of blood at a stroke; in either case the mode of distribution and the apparatus by which it is effected are essentially the same, as well as the final result: the minutest fish has its heart and arteries as artificially arranged, and the secretions from the blood as distinctly elaborated, as those of the elephant or whale. And this is another instance of the truth of that observation, that great and little are as nothing in the hands of God.

Those who have not considered the subject must be surprised at the quantity of blood which passes through the heart of any moderately sized animal in the course of twenty-four hours. In ourselves the quantity of blood existing in the body at any given moment is probably from 30 to 40 pints. Of this, an ounce and a half, or about three table spoonfuls are sent out at each stroke; which multiplied into 75 (the average rate of the pulse) is 112.5 ounces, or seven pints, in a minute; i. e. 420 pints, or 52.5 gallons, in an hour; and 1260 gallons, i. e. nearly 24 hogsheads, in a day.

Now if we recollect that the whale is said to send out from its heart at each stroke 15 gallons, the imagination is overwhelmed with the aggregate of the quantity that must pass through the heart of that animal in twenty-four hours. It is a general

law, that the pulse of the larger animals is slower than that of the smaller: but even if we put the pulse of the whale so low as 20 in the minute, the quantity circulated through the heart, calculated at 15 gallons for each pulsation, will be 432,000 gallons, equal to 8000 hogsheads in twenty-four hours. The consideration of this amazing quantity is however a subject of mere empty wonder, if not accompanied with the reflection, that in order to produce the aggregate amount, the heart is kept in constant motion; and that in fact it is incessantly beating, as it is termed, or throwing out the blood into the arteries, from the first period of our existence to the moment of our death, without any sensation of fatigue, or even without our consciousness, excepting under occasional corporeal or mental agitation.

With respect to the phenomena connected with the propagation of animals, the inconceivable extent of the result in some instances, and its limitation in others, open a wide field for contemplation: but neither the time nor the data of which we are in possession permit me to do more than point out one or two of these instances; much less to insist on the consequences dependent on the relative proportions of animal existence in different orders and genera, and in different parts of the globe. It is an old and a trite observation, that while the larger and fiercer animals produce only one or two at a birth, the smaller animals are much more prolific: and the final cause of this difference is considered as sufficiently obvious, inasmuch as the smaller animals are upon the whole the prey of the larger; and that without this arrangement, the larger animals would soon extinguish

the races of the smaller, and would then themselves fail for want of food.

A favourite instance of the fecundity of animals is taken from the class of fish, and is estimated from the aggregate number of the ova in the roe of the cod. Lewenhoek reckoned, that in the roe of a cod-fish there were more ova, each destined to produce a fish, than there are human beings on the face of the earth.

The most remarkable fact with which I have yet met, connected with the present subject, relates to a minute species of medusa, an animal belonging to the class called sea-nettles. [1] The number of these medusæ in some parts of the Greenland seas is so great, that in a cubic inch taken up at random there are no less than 64; in a cubic foot this will amount to 110,592; and in a cubic mile (and there can be no doubt of the water being charged with them to that extent) the number is such, that allowing one person could count a million in a week, it would have required eighty thousand persons from the creation of the world to complete the enumeration.

In this part of the subject will be properly considered the case of those monstrous productions called lusus naturæ.

This term is applied to those natural productions, which vary in any remarkable degree, with respect to form, colour, structure, size, &c. from the general character of the individuals of the same species.

The term, literally taken, implies a sportive effort of the creative power of nature; and, for the purpose

[1] Jameson's Journal, vol. ii. p. 12.

of general description, there is no objection to this term; being, as it now is, familiarized by long continued use. But as we have no ground for supposing that nature, or, to use the more proper expression, that the providence of God, ever acts without some wise and beneficent purpose, we must consider the term, in a philosophical point of view, as expressing an effect, of the natural cause of which we are ignorant.

On the present occasion I propose to inquire briefly, and with that diffidence and caution which the subject demands, what is the real character of those unusual productions which are denominated lusus naturæ, or monsters; or in other words, for what end Providence ordains that such productions should be formed and subjected to our observation.

It will be found then, upon even a cursory examination, that in a lusus naturæ the character of the species, however obscured, is never lost. An individual sheep may have two heads, or two bodies, or double the usual number of extremities: but you will never find that one of those heads shall be the head of a sheep, the other the head of a horse. Nor will you ever find that the head shall be that of one species of animal, and the extremities those of another. There is no ground, in short, for supposing that nature has ever produced such an individual as a chimera or centaur. So that Lucretius's scepticism in this point is justified by a physiological truth:

> Sed neque centauri fuerunt, nec tempore in ullo
> Esse queat duplici natura et corpore bino
> Ex alienigenis membris compacta potestas.
>
> Lib. v. 876.

And we have good reason for believing, that these productions are regulated in their form and structure by some previous design.

In pursuing this investigation it will be natural to ask, what are the limits which separate a lusus naturæ from the ordinary individuals of the same species? And we shall soon find that these limits are in the majority of instances undefinable.

If indeed, in comparing the several organs, agreement with respect to number be the criterion, the limits are for the most part fixed. Thus the human hand so very generally consists of five fingers, that an instance of an individual having more or less than five fingers would be justly esteemed an instance of a lusus naturæ. But even number is not always an acknowledged criterion; for with respect to the teeth, though 32 is the usual number in the human subject, yet the instances of persons having only 28 are so frequent, that we scarcely class them as deviations from the common law.

But if size, or colour, or form, be made the criterion, we evidently cannot then fix the limits; for in all these points there is an endless variety in individuals of the same species: so that it might perhaps be truly asserted, that out of the countless myriads of human beings that inhabit the earth, nay even out of all that have existed since the creation, no two individuals would be found to resemble each other exactly in even any one of those points. And, in this, the infinite superiority of the Deity over human power is seen: for the most accomplished artist, as soon as he ceases to copy an actual individual, falls into that general similarity of outline

by which we are enabled to ascertain his style upon the first view.

If, in the pursuit of our inquiry, we appeal to the distribution of the internal organs of the body, we shall find, that though with respect to many the position is determinable with considerable precision, yet with respect to others the variation is endless.

If we consider the uses of the parts with reference to the precision of their position, we shall find, that the position of those is most constant, the uses of which are most important; while the distribution of those parts, the position of which may be varied to a considerable extent without inconvenience to the individual, is found to be continually varying.

Now, as this law of nature does not seem at all to result from the construction of the parts themselves, and as the result is necessarily connected with the well being and even the life of the individual, we cannot consider this result as the effect of chance: for if chance could be admissible as the cause, why should one set of phenomena be so much more frequent than the other? And with equal or still greater force we may apply the argument to the existence of those productions emphatically called monsters. Perhaps then, or rather assuredly, these monstrous productions are to be considered as proofs of a particular or constantly superintending Providence; and, like the storms that occasionally ravage the surface of the earth, may awfully recall to our minds the power of the Deity, while they at the same time convince us, by the rarity of their occurrence, of the merciful beneficence of his nature.

Of such a constantly operating care and beneficence, the contemplation of physiological phenomena affords us frequent proofs; from among which I shall, on the present occasion, mention only two.

The first is taken from the history of a particular tribe of insects.

Insects in general are oviparous. The aphides, or plant-lice, are, however, viviparous in the summer; but in the autumn they are oviparous; and for the following reason, viz. The eggs which they lay are not hatched till the next season, and thus the species is preserved: for the eggs are capable of withstanding the winter's frost, which the animal itself would not[m].

The second proof is derived from the history of our own species, and relates to the equality of the sexes; which equality is wonderfully preserved in reference to communities, though in individual families there shall be sometimes no children but of the male sex, in others none but of the female.

In the lying-in hospital of Dublin there have been delivered, from 1757 to 1807, i. e. in half a century, 59,354 women; and the proportions of the sexes were as follow:

Boys - 31,559 Girls - 28,882

And male children appear in most, if not all parts of the earth to preponderate; for men are more exposed to the accidents of life than women are[n].

The second point of view under which it has been stated that animals may be considered, has a reference to their power of locomotion; of the organs of

[m] Lond. Med. Rep. vol. xi. p. 375. [n] Edinb. Med. J. vol. xv. p. 163.

which I shall now offer such a general description as is applicable to the present purpose: but less need be said on this point, Paley having occupied that field so amply. These organs are the muscles, with their appendages the tendons; and the bones, with the various articulations or joints, to the formation of which they contribute.

It is clear that the motions of the several parts of the body could not be either produced or defined, were it not for the existence both of the bones themselves, and of that mutual adaptation of the extremities of the bones called joints: and thus in those parts where protection and no motion is required, the bones are applied to each other without the intervention of joints, as in the head; and although it might at first be asked, why, as in the case of the head, a number of distinct bones should contribute to the formation of that firm case which might have been of fully sufficient strength if formed of one bone, yet on a little consideration it will be seen, that two important points are gained by the present mode of formation: for in the original deposition of the osseous matter, the centre of each portion formed a separate nucleus, round which ossification commenced; and the more of those nuclei there were, the sooner of course would the ossification of the whole skull be completed. And again, the lines of interrupted ossification often serve to arrest the progress of a fracture occasioned by a violent blow, the force of the blow being diffused along the line of interruption. Where, on the other hand, any degree of motion is required, there the joint is constructed in such a manner as best to accomplish the degree

of motion required: thus, in the arm, where very great extent of motion is required with comparatively little strength, there the extremity of one of the bones is a very large portion of a solid sphere, while the extremity of the other which is adapted to it, presents a small extent of surface, and that very slightly concave. But in the articulation of the thigh at the hip, where great strength is required with comparatively little motion, the hemispherical head of the one bone is completely hidden in a corresponding cavity of the other.

And in the remarkable instance of the articulation between the two jaws, where occasionally an unusual degree of force is required in the action of the joint, as in the biting some hard substance, the action of the lever is assisted by the interposition of a moveable piece of gristle, called the interarticular cartilage.

The muscles, with their appendages the tendons, which constitute the other branch of the locomotive apparatus, are to the bones what ropes in machinery are to the weights which are to be moved; and for instances of their mode of action, Paley may be consulted. I would only observe by the way an occasional contrivance by which their line of action is changed from a parallel to an angular direction, in order to increase the force of their action. This is done by causing their tendons to pass over distinct insulated bones, which are often enveloped in the substance of the tendon. Such a mechanism is observable in the anterior part of the knee, where the tendon of the rectus muscle of the thigh envelopes the bone called the kneepan; and still more deci-

dedly in the case of the tendons, which move the hoof bones of the ox, where the bones which serve to change the line of direction of the tendons are perfectly distinct from the tendons which pass over them.

Lastly, we have to consider the general character of the nervous system, or the organs of sensation and volition; those mysterious instruments which are apparently the means of communication between the material world and the immaterial principle of our present existence. In ourselves, and in all the animals of the higher classes, these organs are the brain and nerves: and without at present deducing any conclusion from the observation, it may be stated as a fact, that the degree of approximation of the brain of brutes to that of man bears a very obvious relation to the degree of intelligence observable in the various classes of animals: so that, in just reasoning, it must be admitted to be the instrument by which the various degrees of intelligence are manifested; in those animals at least in which it exists.

But it is of importance to observe, with reference to those physiologists who maintain, that the material condition of the brain is necessary to or actually confers the power of thinking, that the evidence of the exertion of that power is as strong, nay even stronger, in some animals that have no brain, as in those whose brains are developed in a very high degree; I had almost said, as strong as in ourselves: and, if we look to the habits of many of the insect tribe, (the bee may be taken as *instar omnium*,) I should probably be justified in the assertion.

Every one present is doubtless aware, that attempts have frequently been made to build the doctrine of materialism on the foundation of physiological observations; and though it is not my intention on the present occasion to occupy your time with a full examination of this question, yet to save myself from any misconception on the part of those who hear me, with respect to this subject, I beg leave to state, that the term *materialism* may be used, and appears to be so used actually, to imply the result of two very different modes of reasoning with respect to the phenomena of matter. According to one mode it has been inferred, that there is an inherent and independent power, in certain modifications of matter, of exerting various energies; and those who make this inference maintain, among other points, that the brain is capable of exerting the energy of thought, independently of any power communicated to it *ab extra*. Such an inference I for myself entirely disclaim.

According to the other mode of reasoning, it is inferred, that where such and such modifications of matter are presented to view, they are merely to be acknowledged as evidence that the Deity manifests such and such powers: but though the terms employed in describing the phenomena and the results may be the same in both instances, yet they are only adopted in the latter instance for the purpose of preventing the delay and formality of a periphrasis. For instance, when I say that the magnet attracts iron; that a piece of resin heated by friction attracts light bodies; or that the planets attract each other; I by no means intend to assert that these pheno-

mena are independent of the power communicated by the Deity. And if I say that the brain has the power of thinking, I only mean, that I recognise in that organ the material instrument by which the process of thought is manifested.

It was the opinion of Locke, that the Deity may probably have added to the brain, its parts being appropriately disposed for the purpose, the power of thought. This opinion was opposed by Stillingfleet, on the ground of the consequent difficulty of proving the immateriality of the soul.

Such a difficulty is of too serious a character to be disregarded; and on many occasions it would be better to avoid the question, and disregard the minor difficulty which leads to it, namely, in what way animals exert the power of thought, than to incur the hazard of encountering one so much greater.

But I will state the ground from which the question springs; and, though I see no intrinsic objection to the admission of Locke's opinion, and some good reasons for adopting it, yet I am happy in seeing a way of getting rid of it in a manner unobjectionable to all who believe in the existence and power of God. The difficulty in which Locke's opinion originates is this. Brutes, as far as we can judge from their actions, have the faculty of thinking: and the following dilemma naturally occurs to the mind on this subject. Either the brain of brutes is so constituted by the Deity as to have the power of thought; or there is united with their bodies an immaterial principle, which uses the brain as an instrument by which the power of thought is manifested. It does not appear to me that there is any

danger in the admission of either of those conclusions; for, provided we do not make the power of thought independently and necessarily inherent in the brain, and provided we do not suppose the implied immaterial principle of brutes to be self-existent, and indestructible, and endued with moral responsibility, I do not see that the conclusions are either absurd, or in the slightest degree impious; unless indeed we dogmatically assert them.

But we may avoid either conclusion, and solve the difficulty by the direct admission of the omnipotence and universal presence of the Creator.

Why may not every instinct and action of brutes be resolved into an immediate exertion of the power of God? Some one perhaps may be scandalized at the supposition of such trivial interferences of God's power; and may ask, "If then a horse start at a sud-" den sound, do you imagine that his muscles are set " in motion for that purpose by the hand of the " Deity?" I would answer that I do; and I see no absurdity or impropriety, even humanly speaking, in supposing, that he who in his previous *wisdom* has determined to manifest a train of particular instincts and habits as characteristic of particular species of animals, should by his immediate *power* ordain, that the same instincts and the same habits should uniformly be manifested in the same species and on similar occasions. We might ridicule as trifling, or doubt the common sense of that statesman, or that general, who should be at the pains of attempting to inform himself of the name and qualities and habits of every individual placed under his direction: and why? because from the natural limitation of our

powers we are unable to grasp in our comprehension or retain in our memories a vast multitude of objects; and therefore it behoves us to restrict the application of our faculties to those things that are of most importance.

But this argument is completely annihilated, or rather absolutely excluded in the case of the Deity: and I feel convinced that we should do well constantly to keep in mind, and literally to believe, those words of our Saviour; "that the very hairs of our "head are all numbered, and that not a sparrow falls "to the ground without the knowledge and permis- "sion of our heavenly Father."

The question respecting the nature of the soul, and even respecting its existence, which has been mixed up with the foregoing, and which has been discussed occasionally with a degree of freedom that makes one shudder, I leave to the examination and defence of abler advocates. With respect to myself, satisfied of its incorporeal nature, and separable existence from the body, however mysteriously united to it for a specific time and purpose, I should in the first place throw the *onus probandi* on those who maintained the identity of the two: but, even if I thought the proof of their identity could be established, I should have no fear for the consequences; for unless the materialist could also prove that the incongruous compound were self-existent and indestructible, I do not see that he would have gained any ground on which he might take his stand with more assurance than before.

With respect to the attempts of those to whom I have alluded, I would observe, that if ridicule or

irony were weapons which the defence of so fundamental a truth as the existence of the Deity required, they might be employed with peculiar force against such sophistry as has disgraced the cause of science on this point: but while I deprecate the use of those weapons on any, but especially on such an occasion, I know no terms of honest indignation too severe to mark our abhorrence of the profligacy of the attempts in question, provided they have been deliberately made.

But on this point I beg leave to offer a few observations, which, if made with a conciliatory spirit, may come with propriety from the person who holds the appointment of Lecturer in Anatomy and Physiology in this University.

I have already stated the intention of these Lectures; namely, to set before you the indications of wisdom and power in the Creator deduced from the skill and contrivance observable in his works. And I at the same time added, that although it should be admitted, that intellectual atheism had no real existence in the world, and that the profession of it was an evil scarcely to be apprehended in this place; yet the simple manifestation of the power and wisdom of God, evidenced in the works of creation, is a subject worthy both of philosophical and religious contemplation.

I shall not presume to insist farther on this topic, than to point out what appears to me an occasional deficiency in the mode of conducting the discussion respecting the question of professed or implied atheism. As far as my observation has gone, those who attack the positions of atheistical writers satisfy

themselves by an exertion of their power in exposing the fallacies of their opponents and reprobating the tendency of their conclusions: and it must be granted that the cause of religion, and consequently the good of society, has been essentially benefited by their exertions: nor does the occasion, logically considered, call for an extension of the argument.

But it will not, I think, be denied in this place, that however important the establishment of natural religion may be, the advancement of revealed religion should be constantly the leading object of all our endeavours.

Now it is very possible to conceive, and they must be very young, or must have inattentively made their observations on mankind, who are not convinced, that, in the process of reasoning on any subject, an ardent feeling and imagination may incautiously entertain opinions, the conclusions from which were neither anticipated, nor would have been antecedently admitted by their author. It is possible also to conceive, that from the mere vanity and weakness of human nature, and without any sinister or malevolent intention, a writer might be induced to admit a conclusion which he would have originally abhorred, rather than give up a position which he had once maintained: and in order to give authority to this assertion, I would call to your minds an observation of Bishop Stillingfleet applicable to the present point. He says, that there are two great dangers in philosophizing; namely, either for the sake of error, to disregard the truth; or through the fear of injuring truth, to admit or retain an error. The first of these dangers has been represented in the case above

supposed; the second was exhibited to the world at the time that the papacy condemned formally and imprisoned the philosopher who maintained the motions of the heavenly bodies to be such as they are now universally acknowledged to be. And some of the positions of geology which are now acknowledged, without any fear of their being at variance with the scriptural history of the creation and the universal deluge, were once in the same predicament.

It is also very possible to conceive, that if a writer who has maintained a position that may involve an atheistical or any less objectionable conclusion, should be harshly taxed with the intention of insidiously recommending such a conclusion, an opposition to the cause of truth might arise in his mind simply from the offensive manner in which his intentions had been represented; a feeling of resentment to the person of his accuser might be converted into an opposition to, or hatred of, the cause. I do not justify, I even wonder at the contracted feelings of any one engaged in philosophical investigations, which would lead to such an expression of resentment; what I mean to insist on is, that if, by avoiding to give offence unnecessarily, we may be enabled to prevent the rise of any misconception, or any angry feeling in the breast of another, it is our duty to do so.

Although therefore, to return to a former point, we are not called upon, in the logical conduct of our argument, to extend the subject from the consideration of atheism to that of revelation; yet if, by conducting it in a mode recommended by the principles of revealed religion, we can be instrumental in recall-

ing another from a feeling of hostility to revelation, we are, in my opinion, bound to do so.

It is due to the cause which ought ever to be uppermost in our minds, openly to state, that in making these remarks I have in my view a well known physiological work, which has given, and justly given, much regret, if not offence, to all those who are sincerely desirous of maintaining that cause. Though personally unacquainted with the author of that work at the time of its publication, I naturally perused it, and not without a considerable degree of attention; and the brief opinion of it which I am about to express, I am so far from fearing should meet the author's eye, that did I think this representation would prevail more with him than his own reflections, I would not hesitate to make a personal appeal to him; satisfied that the mode and terms in which I should make that appeal could not possibly be construed as an intention of giving offence. Of the general language and style of that work; of the extensive acquaintance which it evinces with the numerous writers on the subject of which it treats; of the clear exposition of the facts there recorded; and of the author's mode of arguing in general, it would be superfluous for me to say more, than that on those points he deservedly enjoys the approbation of the scientific world. I have a pleasure also in stating that in many parts he directly asserts, not only the existence, but even the power and wisdom, and I may add the beneficence of God; and he maintains, with a constancy and an ardour which would do credit to the most zealous defender of the scriptures, the position, that all mankind have descended from two in-

dividuals: and though I admit that this conclusion is a necessary consequence of his own physiological views, yet an uncandid reasoner might have kept that conclusion out of sight, or at least might have avoided to bring it so prominently forward, had he wished to invalidate the authority of the scriptures.

But here I am constrained to add, *O si sic omnia;* and his most devoted admirers and even advocates must admit, that in some parts of his work there is a levity, and even apparent malevolence of expression, on occasions where every word and even every tone ought to be in unison with feelings of good-will to our fellow-creatures, and of reverence to God. Bishop Butler, a writer more powerful perhaps in argument than has ever existed, has said of the Bible, "that a book received as a revelation, by a great "part of the civilized world, demands, as if by a "voice from heaven, to have its claims most serious-"ly examined into; and that, before such examina-"tion, to treat it with any kind of scoffing and ridi-"cule, is an offence against natural piety." Now as the author whose physiological work I am considering admits the existence of the Deity, it is not begging the question, and certainly he cannot be offended with me, if I presume that he possesses the feeling of natural piety. Since then the Bible affirms the divine origin of a priesthood, and inculcates the belief of the separate existence and the immortality of the soul, to insinuate that the teaching of such a belief is merely the trick of priestcraft, is certainly, both in itself and in its terms, a species of scoffing offensive to natural piety. And to ridicule the belief in the existence of the soul as united to the body,

merely from the natural difficulty that must occur in the attempt to ascertain the precise moment when that mysterious union takes place, is equally unworthy, not only of the feeling of natural piety or of philosophical seriousness, but even of good sense and good taste. I purposely abstain from bringing forward the passages or expressions to which I here allude, because from their total want of harmony with the style and spirit of this place, I might be supposed, in so doing, to be desirous rather of establishing a triumph over an enemy, than of ingenuously reminding one, whom I would wish to consider as a friend, of his error. But I do not hesitate to say, that the passages to which I allude have been seriously detrimental to the good order of society: for it is a fact too well known, that the work containing them has been edited in a form, and disseminated with an industry, that shew some general end was expected to be attained from its distribution: and it is clear, that that end was likely to tend towards the subversion of morality and religion, from the mere character of its editors; even if we did not consider that, with the exception of the passages in question, there is scarcely a fact or a sentence in the whole book that would interest or even be intelligible to any one of that mass of readers before whom it has been so industriously brought. Too late for the remedy of this part of the mischief, it is not yet too late for the confession of his error: and if the author be not averse to the noble humiliation of acknowledging a fault, he may still prevent much of the future evil which may otherwise result to the junior members of his profession, from the perusal of new editions of that

work; and, to suggest no higher motive, may secure the undivided approbation of his seniors and equals.

But to return to our subject, namely, the consideration of the nervous system, we are under the necessity of confessing, that there is no part of animal physiology involved in greater obscurity than this. For we cannot infer the use of the brain and nerves, either from their structure or from any changes apparent in them during their action; whereas the uses of the bones, the muscles, the blood-vessels, and many other organs, are easily deducible from the circumstances above mentioned. Nor can we, from the effects ostensibly produced by the action of the brain and nerves, collect any data which are calculated to elucidate the nature of that action. And, to complete the difficulty, the effects produced are frequently of directly opposite characters. Thus apoplexy is sometimes fatal without any apparent deviation from the healthy state of the brain; while speedy recovery sometimes succeeds the severest apoplectic symptoms. And again, with respect to paralysis, though commonly the diseased appearance in the brain is on the opposite side to that of the paralysed parts of the body, yet sometimes the paralysis is on the same side with the diseased appearance in the brain.

Neither are we assisted in our inquiry by the contending theories of different physiologists. The functions of the nervous influence, as stated by Dr. Wilson Philip, are, to convey impressions to and from the sensorium; to excite the muscular fibre; to separate and recombine the elementary parts of the blood in the formation of the secreted fluids;

and to evolve caloric from the blood. Dr. Philip finds, moreover, experimentally, that after all signs of sensation and voluntary power have disappeared, and the animal is what we call dead, the nerves are still capable, by artificial stimuli, of conveying impressions to the muscles, and the muscles of performing their functions. The nerves also still possess the power of decomposing and recombining the elementary parts of the blood, and also of evolving caloric from that fluid.

Dr. Allison, on the other hand, says, that it appears to be established, that no muscle of voluntary or involuntary action derives any thing from the nervous system which enables it to contract: so that the terms "nervous influence," and "nervous ener-"gy," in this their commonest sense, are absolutely without meaning.

There is evidently, however, a close connection between the nervous and arterial systems; for we continually see that they reciprocally affect each other: and it is an anatomical fact, that the arteries in general are surrounded by a net-work of nerves.

The evolution of animal heat is also apparently under the control of the nervous system; for respiration has no power of generating heat, unless the functions of the brain are entire: and yet respiration, even though artificially supported, produces the usual change in the colour of the blood, and the usual proportion of carbonic acid also, although the functions of the brain are entirely suspended.

It is evident, moreover, that the nerves are the medium of sensation: for if a nerve be divided, the

part to which that nerve is distributed becomes insensible: or if a nerve be mechanically compressed, the same effect is produced during compression. We know also that habit renders nervous impressions dull; and hence the love of novelty. And, lastly, we know that we can voluntarily augment the vivacity of our sensations: for who is not conscious of the difference between simply hearing and listening, and between simply seeing and gazing; in other words, between the active and passive exertion of the senses?

The nervous system is capable of a threefold division, consisting of the brain; the spinal marrow; and the ganglia, as they are called, of the viscera: and these three parts respectively correspond to that division of the animal character which was adopted in a former part of this Lecture: the visceral ganglia being principally appropriated to those parts, with reference to which we may be considered as simply organized beings; the spinal marrow, to our locomotive powers; the brain, to our powers of sensation and volition.

Of the ganglial and spinal system, I do not propose to speak more at large at present: but I shall enter a little more minutely into the consideration of the cerebral system, from the obvious superiority of its importance.

Of all the parts of the nervous system, taken collectively, the brain has been most generally considered as the organ of the intellectual powers: and it has long been a favourite speculation, to endeavour to ascertain what part of the brain is subservient to the existence and exercise of that degree of intellect and mental feeling which, in a greater or

less degree, is possessed by many other animals as well as man. Of the existence of intellectual powers in brutes, no one, I conceive, can doubt, who has been at all accustomed to observe the characters and habits of animals: so that when in common language it is asserted, that man differs from other animals in possessing reason, while they are irrational, the term reason must be taken in its most extended sense, as implying the aggregate faculties of man, both moral and intellectual.

I will not here insist on the evidence of the intellectual powers of brutes, as deducible from the effects of what we call instinct; because, in all those actions which are the result of instinct, animals appear to be guided by a natural and irresistible impulse from within, which leads them to seek or to avoid that which will be either useful or injurious to them, and enables them to perform the most complicated acts, as the building of a nest, or the construction of a hive, though they may never even have seen the same acts performed by other individuals of their species. I would rather insist on that evidence of their intellectual powers, which is derived from their conduct, when, in consequence of having been removed from their natural sphere of action, they are impelled by external and accidental circumstances. Thus the wariness of old animals in avoiding the pursuit or arts of an enemy, and the sagacity with which a practised hound will cut off an angle in order to shorten his distance, may be considered as proofs of a considerable degree of intellect in brutes.

The playfulness of the young of most quadrupeds

may be regarded as no obscure proof of the exercise of the intellectual faculty which we call imagination; for the play of such young animals almost always consists in the representation of mutual hostility, though the real disposition at the time is any thing but hostile. A young puppy, under such circumstances, snarls and bites, but with evident intention not to hurt.

Of the existence of mental feelings in brutes, there is still more decided proof than of the existence of intellect. Thus the expression of joy in a dog at sight of his master is not to be mistaken; the expression of fear in a horse at the sound of the whip is equally unequivocal in its character. Again, animals become attached not only to individuals of their own species, but to individuals of even a different Order or Class: and they evidently feel regret upon separation from their companions.

On the supposition that the brain is the organ of the intellectual powers, physiologists have been led to compare the proportions of the whole and of various parts of this organ in man and brutes. It has been supposed by some, that the intellectual faculties may be in proportion to the absolute size of the brain; such an opinion being grounded on the fact, that the human brain is larger than that of the horse or ox. But, on the other hand, the brain of the whale and of the elephant is larger than that of man; though the intelligence even of the elephant bears no proportion to that of the human mind. Again, the brain of the monkey and of the dog is smaller than that of the ox or the ass; yet the former come much nearer to man with respect to their intellec-

tual faculties. Neither do the dispositions or qualities of animals appear to be connected with the absolute size of their brain; for animals most different and even opposite in disposition may be ranged in the same class in respect to the size of their brain. For instance, the tiger and the deer; and, among birds, the hawk and the pigeon.

It would appear at first sight, that the comparison of the size of the brain with the size of the body would give a more uniform result. Thus, a crocodile 12 feet in length, a serpent 18 feet in length, and a turtle that weighs from 300 to 500lbs. have each of them scarcely a sufficient quantity of substance in their brain to weigh one drachm; and the slight degree of intellectual power manifested by these animals corresponds with these proportions. But it will presently be shewn, that the proportional size of the brain is not a more certain criterion than the absolute size.

Cuvier considers the brain in the human subject as equalling from about $\frac{1}{25}$ to $\frac{1}{35}$ of the bulk of the whole body. Dr. Gall thinks it equals from $\frac{1}{40}$ to $\frac{1}{60}$ of the bulk of the whole body. If we take the mean of those numbers, it will be about $\frac{1}{45}$.

In comparing the inferior animals with man in this respect, it appears that the proportion of the size of the brain to the size of the body is,

Among the mammalia.

In the orang-outang,	as 1 to 96.
In some species of monkey,	1 — 35.
In the bat, - - -	1 — 96.
mole, - -	1 — 36.
dog, - - -	1 — 50—300.

In the fox,	- -	as 1 to 200.
rat,	- - -	1 — 76.
mouse,	- -	1 — 43.
elephant,	- -	1 — 500.
ox,	- - -	1 — 860.
sheep,	- -	1 — 270.
horse,	- - -	1 — 400.
ass,	- - -	1 — 254.
dolphin,	- -	1 — 50.

Among birds.

eagle,	- - -	1 — 160.
goose,	- - -	1 — 360.
duck,	- - -	1 — 250.
sparrow,	- -	1 — 30.

Among reptiles.

tortoise,	- -	1 — 2240.
turtle,	- - -	1 — 5688.
snake,	- - -	1 — 800.
frog,	- - -	1 — 170.

Among fish.

shark,	- - -	1 — 2496.
tunny,	- - -	1 — 37440.
pike,	- - -	1 — 1300.
carp,	- - -	1 — 560.

It appears from the foregoing statement, that not only do different genera of the same order differ very widely from each other in the proportion of their brain to their body, as the bat and the fox; but that the proportion is sometimes inversely as the degree of intellect of the animal: thus, as far as we are capable of judging, the intellect of the fox is infinitely greater than that of the bat, and yet the brain of the former, proportionably to its body, is only one half

the size of the latter. The brain of the elephant, again, is smaller, in proportion to its body, than that of almost any other quadruped; and yet what quadruped exceeds the elephant in sagacity? In some instances the disproportion is still greater in different species of the same genus, and even in different varieties of the same species: thus, in some dogs the brain compared with the body is as one to fifty, while in others it is as one to three hundred; a disproportion six times as great as that between the bat and the fox.

Again; animals having been classed by modern physiologists in a scale regularly graduated from man, according to the degree of their resemblance to him in some of the most important organs, it appears that the brain of some of the genera of the lowest orders is proportionably larger than that of some of the genera of the highest orders. Thus, in the first class, or the mammalia, the brain of the dolphin, which animal is in the lowest order of that class, is in proportion to its body four times as large as the brain of the fox, which is an animal of one of the highest orders. And the brain of the mouse and of the mole are nearly if not quite as large, in proportion to their body, as that of man. And the same circumstance occurs even in the second class, or birds; for the brain of the sparrow is in proportion to the body as large as, nay even larger than that of man.

Lastly, though it is unnecessary, and would be tedious to enter further into the detail of this part of the subject, there does not appear to be any connexion between the degree of the intellectual facul-

ties and the mutual proportions of the two constituent parts of the brain, the cerebrum namely, and the cerebellum; or between the degree of the intellectual faculties and the mutual proportions of the brain and the nerves. So that it appears, from a review of what has been advanced, that no criterion of the degree of intellect is found in the relative size of the brain of different animals; nor in the size of the brain compared with that of the body; nor in the relative size of the cerebrum either to the cerebellum or to the nerves.

In the midst of these difficulties, a new theory, or at least a newly modified theory, arose, a few years since, under the auspices of Dr. Gall, a physician of Vienna: and as the consideration of his system excited a great degree of attention among physiologists, it will be right here to mention it.

The simple enunciation of Dr. Gall's theory is this, that "the brain in general is the instrument by "which the intellectual faculties, and the moral "sentiments and propensities, are manifested; par-"ticular parts of it being the organs of those several "faculties, sentiments, and propensities: and that ac-"cording to the state of these organs at any given "period of a man's life will be the faculties, senti-"ments, and propensities of each individual."

To those who have objected to this theory, that it leads towards the doctrines of fatalism, and the material nature of the soul, it has been answered; first, that as, according to the theory, no individual who is endued with intellect is deficient in the organs of those moral sentiments, which if cultivated will be sufficient to counteract whatever bad propensities

he may have, the theory cannot consistently be accused of inculcating the doctrine of fatalism: and secondly, that without inquiring what the soul is, or in what manner it is united to the body in this life, (which Dr. Gall considers as questions not only beyond the comprehension of human reason, but totally unconnected with his inquiries,) the theory merely investigates the material conditions of that part of the body by which the soul is affirmed to manifest itself to our observation.

In examining the theory of Dr. Gall, I shall first state his opinions respecting the anatomical structure of the brain and nerves; and then, some of the facts on which his theory is founded.

He rejects the terms cortical and medullary, as applied to the substance of the two distinct parts of the cerebrum and cerebellum; and calls the former, simply from its colour, the *grey* substance; in which he is justified from the fact, that it occurs in several parts in the interior of the brain, and thus therefore loses its analogy to the bark of a tree: the latter, or medullary part, he calls *fibrous* substance, from its structure; of the character of which he has satisfied other anatomists as well as himself; and which, in some parts of the brain, may be readily demonstrated even to those who have never been previously accustomed to dissection. The grey substance he considers as the matrix or source of the fibrous; and he draws this conclusion from the analogy of ganglia, which, being themselves of the same nature as the grey substance, he finds are always large in proportion to the white nervous fibres which issue from them; which statement is corroborated by Scarpa and other

able anatomists: and he supports his opinion by the additional fact, that in other parts of the nervous system, both in the spinal marrow and in the brain, wherever the fibres are enlarged or multiplied, there is a correspondent supply of the grey substance.

With respect to the several nervous systems of the body, namely, the visceral ganglia, the spinal marrow, the nerves of voluntary motion, the nerves of the senses, and lastly, the great mass of the brain, he supposes that, though all connected by branches of communication, they are otherwise independent of each other.

His arguments relating to the independence of these several parts are as follow: first, as the visceral ganglia are the only part of the nervous system, in general, possessed by some animals, they cannot in those animals be derived either from a spinal marrow or a brain: and as the visceral ganglia are distributed to the same parts in those animals which they supply in man, and in numerous orders of other animals, it hence becomes probable, that they are in man also independent of the spinal marrow and brain: besides which, the fibres of the visceral system are evanescent both at their upper and lower extreme points, and thus do not appear to arise from any other source than themselves.

That the spinal marrow is not a continuation of the brain, he argues both from the want of proportion in the brain to the spinal marrow, and from the irregularity of its diameter in different parts: whereas were it a continuation of the brain, it ought to diminish in its diameter in proportion as it sent off fresh branches of nerves.

With respect to the several pairs of nerves which are seen upon exposing to view the lower surface of the brain, it is admitted by many anatomists of acknowledged accuracy, that none of them, excepting the olfactory and optic, originate from the hemispheres of the cerebrum or cerebellum: but Gall thinks that even these are not derived from either of those parts.

By anatomists in general the olfactory nerves are supposed to originate from the corpora striata; the optic nerves from the thalami nervorum opticorum: but it is asserted by Dr. Gall, that in some animals, even of the higher orders, which have not the sense of smelling, the corpora striata are yet present; in which case it cannot be said that those parts are destined to supply the nerves of smell: and with respect to the thalami nervorum opticorum he observes, that in the horse, ox, and stag, the thalami themselves are much smaller than in man, though the optic nerves of these animals are much larger, which would hardly happen were those parts the source of those nerves: besides which, it may be clearly shewn from the brain of birds, that the optic nerves do not belong to the parts called the thalami. Experiments also have been made on living animals, shewing that the loss of those parts from which the nerves of smell and sight are supposed to originate does not affect those senses. Thus the greatest part of the hemispheres of the brain was cut out in the instances of some hens, pigeons, and rabbits, and yet the animals manifested distinctly the sense of hearing and seeing.

It appears then, that, with the doubtful exception

of the olfactory and optic nerves, not a single nerve of the whole body is derived from the hemispheres of the cerebrum or cerebellum; for the organs of the other senses, and all the muscles of voluntary motion, together with the whole mass of the intestines, and the heart, and the lungs, &c. are supplied either by the visceral ganglia or the spinal marrow, or that portion of it called the medulla oblongata.

Either then the great mass of the brain is allotted in a most anomalous disproportion to the two senses of smelling and seeing, which in many animals are comparatively weak; or, if it does not supply the nerves of seeing and smelling, there is no part of the body which it does apparently supply with nerves: and then the conclusion, which is by no means peculiar to Gall, and which the best and wisest men have admitted, presses upon us with peculiar force, that the brain is exclusively the instrument of the immaterial part of our present existence.

In examining the various orders of animals, it is observable that there are some in which not any nerves are discernible: there are others in which only visceral ganglia are found: as we rise in the scale of animal life, nerves of voluntary motion are added; afterwards a spinal marrow and a brain of very simple construction, which by the superaddition of parts becomes gradually more complicated, till at length it closely resembles that of man: but still there are parts of the brain in man which are not found in other animals; though man has all those essential parts which the most perfect animals possess.

Whatever be the cause, it is very evident, that, while

in most of those animals which have no brain, there are few if any signs of intelligence; in those animals which have a brain, the signs of intelligence are stronger and more obvious in proportion as they resemble man in the structure of their brain. And in man himself, if those parts by which he essentially differs from the brutes in the structure of his brain be defective, the manifestations of his feelings and intellectual faculties are also in general defective, as is the case with idiots. But if the brutes approximate in the degree of their intelligence to man, in proportion as they approximate to him in the structure of certain parts of their brain; is it not fair to infer, or rather does it not necessarily follow, that those parts of the human brain which are not found in other animals are subservient to the peculiar faculties of man? It is in the hemispheres that the human brain exceeds in size the brain of all other animals, even of the elephant; the total size of the brain of which animal is only greater than that of man, because certain nervous fasciculi which are appropriated to particular parts, are enlarged correspondently to the energies of those parts. Thus the nerve communicating with the trunk of the elephant is nearly as thick as a man's arm.

There are many interesting conclusions, particularly with respect to paralytic affections, which Gall has drawn from his view of the anatomical structure of the brain, the consideration of which belongs not particularly to the present subject: but as from Gall's dissection it appears that the several organs of the faculties are double, corresponding organs being found in each of the hemispheres of the brain, it has

been objected to his system, on that ground, that facts militate against his theory, inasmuch as consciousness, or the exercise of any particular faculty or sentiment is single, while the organs are double: but his answer appears satisfactory; for is it not so with the senses of hearing and seeing, the organs of which are double, but the impressions on the mind single?

There are many phenomena connected with the moral and the intellectual faculties of man, both in a healthy and diseased state, which by shewing the mutual influence of the two distinct parts of our nature, the soul and the body, render it probable that the energies of the one, although it be itself immaterial, may be manifested by means of a material instrument.

The existence of that mutual influence above mentioned, which indeed we might expect from their close though mysterious union, cannot be denied. Thus, grief or expectation destroys appetite; mental application to any favourite pursuit makes us insensible of the want of food; insanity renders us insensible of cold: and on the other hand, a disordered state of the digestive organs evidently impedes the free exercise of the mental powers. Intoxication confuses the memory and judgment; and the repeated abuse of wine permanently debilitates the mind, and often terminates in confirmed insanity. The state of the air affects many individuals to a degree inconceivable to those who are not thus subject to its influence. Endemic ague and epilepsy have been each cured by the effect of fear.

The idea that this connexion of the soul and body may be traced in the conformation of the latter is

by no means new; as is evident from the anecdote of the unfavourable judgment passed on the disposition of Socrates from the character of his countenance, which is too generally known to need a repetition. And Aristotle has even entered into some details on the forms and shades of colour in the hair and features, as indicative of particular temperaments or constitutions of the mind. And it is hardly a question, whether every individual is not accustomed in some degree to decide on character from the features, the colour of the hair, &c. independently of that expression of the countenance which rather marks the actually existing state of the mind than the latent disposition of it. Shakespear has several references to indications of personal character, as depending on the form of the countenance, or colour of the hair, &c. [o]

In attempting to point out distinct organs for the several intellectual faculties and moral sentiments and propensities, Dr. Gall has advanced much beyond his predecessors. And though, as far as I can judge, he has failed in all but one or two instances, yet he has supported the general principle of his theory by arguments which it seems difficult to refute: and that principle indeed, namely, that there are distinct organs for the several faculties, had been previously admitted by Haller, and also by Willis, who was of this University in the reign of Charles the First; both of them not less distinguished for their private virtues and religious character, than for their knowledge and intellectual talents. The

[o] Vide Tempest, Act IV. Scene 3. Two Gentlemen of Verona, Act IV. Scene 4. Ant. and Cleop. Act III. Scene 4. with Steevens's note.

same doctrine appears to have been broached also long ago by the Arabian physicians. Dr. Cooke, in his Treatise on Nervous Diseases, has a note in page 20, vol. i. in which this fact is stated on the authority of Laurentius in the following words: "Universa Ara-" bum schola *mansiones* multas in cerebro statuit, et " singulis facultatibus singulas sedes assignat."

It appears from Gall's own account that he was originally led to his peculiar train of thought by observing the difference of talents and character in his own brothers and sisters, and in other children with whom he happened to be at school; some of whom, though under perfectly similar circumstances of education with the rest, were much quicker in apprehending what was taught them: and further, by observing in different individuals of the same species of animals, as dogs, that some were fierce, some mild. Again, in birds of the same species, that some continued to sing their own notes only, while others would listen to and imitate artificial music.

In the last mentioned instance particularly he argued, that the difference could not arise from the greater or less degree of perfection in the organ of hearing, which was the same in both, but must be looked for in the brain, to which the organ of hearing conveys sounds; which are judged of in the brain, and not in the ear itself. There are, moreover, numerous instances which shew, that the sense of hearing is by no means in proportion to the degree of perfection in the construction of the ear.

The dog hears with indifference the sweetest melody; and yet the construction of his ear is more perfect than that of any, even the most musical

birds. And on this point Gall asks, if the organ of hearing determined the power of singing, why should the female bird be mute, seeing that in this part of its bodily construction it differs not from the male? It is equally observed, that in men the talent for music is not in proportion to the delicacy of the organ of hearing.

In alluding to such manifestations of partial talent as are occasionally exhibited in certain individuals at an early period of life, who have been observed to be children in every thing but in the exertion of their peculiar talent, Dr. Gall asks, how should the different faculties of the mind be in unequal proportions in the same individual, if there were only one and the same organ for all the faculties?

Dr. Spurzheim on the same point observes, "One "man has an excellent verbal memory, but is inca- "pable of combining two philosophical ideas. An- "other is a great painter, but a bad musician: and "so on. But if the same organ manifested every "faculty, how should the mind, by means of the "same instrument, manifest one faculty in its per- "fection, and another in a very limited manner?"

Partial insanity and partial idiotcy are among the circumstances which Gall considers as favouring his doctrine. The frequency of the former must be a fact well known to all; the latter is not uncommon; and even persons of considerable intelligence occasionally exhibit very obscure traces of this or that particular faculty.

He also draws an argument in support of his theory, from the partial fatigue produced on the mind

by long protracted study, which fatigue is relieved by changing the object of study. Now, if the brain, he adds, were a single organ performing all the functions of the mind, why should not the organ be more fatigued by this new form of study?

Other arguments in favour of his system he draws from the temporary effects produced by inflammation on the state of the mental powers: in the case, for instance, of idiots, who, during the inflammatory action, have manifested a considerable degree of understanding; but after the cessation of the inflammatory action, have relapsed into their former state of fatuity. In such instances the mental faculties, which had been previously in a state of fatuity, are possibly rendered for the time rational in consequence of a degree of excitement which, in individuals not labouring under fatuity, would have probably produced delirium: but, as a rational state of the faculties may be considered, to use a mathematical expression, as a mean proportional to fatuity and delirium, it might be expected that the same cause which would raise a rational state of the faculties to delirium, would raise an idiotic only to a natural state. In the same manner, wine is observed to modify the characters of individuals of different temperatures.

> "It keeps the unhappy from sinking,
> "And makes e'en the valiant more brave."

It would require many hours to enter into the detail of this most interesting part of Dr. Gall's system. I must be content, therefore, to have introduced the subject to the minds of those who happen

not to have reflected on it before: and with respect to the merits of that system, I think it may be affirmed with truth, that, considered as an abstract philosophical speculation, it is highly ingenious and interesting, and founded upon unobjectionable principles; that in the extent to which the author has carried those principles, the doctrine becomes ridiculously absurd; and that in its general application, it is not only useless, but of a positively mischievous tendency: for without the help of this system every man of common sense has sufficient data from which to judge of the character of those with whom he associates; and it is evidently more safe to judge of others by their words and actions, and conduct in general, than to run the risk of condemning the character of an individual from the indication of some odious organ, the activity of which may have been subdued by the operation of religious motives.

With respect to ourselves indeed, the study of the system may be attended sometimes with the happiest consequences: for if, from the contemplation of it, we can be strengthened in our conviction of the fact, which both reason and revelation teach us, that each individual is liable to particular temptations depending on his specific temperament, we shall thus have one additional memento of our frailty, one additional incentive to watch over and combat the sin which doth so easily beset us.