

**Class Notes from Dr John Barclay's lectures on Comparative Anatomy
set down between 8th May 1821 and 31st July 1821 at 10 Surgeons Square, Edinburgh
by Dr Robert Edmund Grant (UCL MS ADD 28).**

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Text as written and spelled, with additions in square brackets.

Grant's comments have been italicised.

[Tuesday] 8th May 1821. 11am. Introductory Lecture.

Anatomy gentlemen which Naturally signifies dissection, when applied to the lower animals is termed Comparative - we dissect the lower animals to become better acquainted with the structure of the corresponding parts of man we dissect them at different ages to perceive the changes which take place by the growth - we dissect different species to compare them and see how far they all agree - we examine the remains found in the bowels of the earth to ascertain whether they be of the same kind or species with those found living on the surface - Harvey¹ had recourse to comparative anatomy to confirm his discovery of the circulation - anatomists were once surprised to find the liver on the right side as if it could not as well perform its function as if it had been on the left - in some of the lower animals it is divided one part being on the right and the other on the left - and in some animals is found on the left side - the Royal Society of London [and] the French Academy have always encouraged the study of Comparative Anatomy - an Essay² on this subject was published in a surreptitious manner taken from the lectures of Dr Monro³ the great founder of the Medical School of Edinburgh.⁴ Haller⁵ - no figures or number of descriptions can compensate for the want of the originals in Comparative anatomy which is one cause of it being less warmly cultivated in this country than abroad where there are some sources of information - descriptions and figures on the

¹ William Harvey (1578-1657) was an English physician. He was the first to describe completely and in detail the systemic circulation and properties of blood being pumped to the brain and body by the heart, though earlier writers had provided precursors of the theory. http://en.wikipedia.org/wiki/William_Harvey . Harvey, W. (1628), *Exercitatio anatomica de motu cordis et sanguinis animalibus*.

² [Monro, A.] (1744), *An essay on comparative anatomy*. London: John Nourse.

³ Alexander Monro (1697-1767) (called Monro *primus*) was the Professor of Anatomy at the University of Edinburgh. http://en.wikipedia.org/wiki/Alexander_Monro_%28primus%29

⁴ Recent research suggests that the creation of the Edinburgh Medical School Faculty in 1726 was a political job carried out by the Lord Provost, George Drummond and his leader, Lord Ilay and his friends; Emerson, R.L. (2004), The founding of the Edinburgh Medical School. *Journal of the History of Medicine and Allied Sciences*, 59, 183-218.

⁵ Albrecht von Haller (1708-1777) was a Swiss anatomist, physiologist, naturalist and poet. http://en.wikipedia.org/wiki/Albrecht_von_Haller

Comp[arative] Anat[omy] as maps are to him who wishes to learn the nature and geography of the earth - Cuvier⁶ - Hunterian Museum⁷ - Dr Macartney⁸ - Dr Meas⁹ professor of Comp[arative] Anatomy of Philadelphia - ancients dissected the lower animals to acquire a knowledge of Human anatomy Dr Monro primus and secundus¹⁰ lectured on the subject but only as a secondary object at the end [of] the course of Human Anatomy and gave only a very few - I enter on the subject under very differ[ent] circumstances giving a separate course and exhibiting a great variety of preparations and specimens - this subject [comparative anatomy] was proposed to be introduced into this University¹¹ - but it was opposed by a majority in which however there was not a Playfair¹² a Gregory¹³ nor Dr Duncan Senior¹⁴ - very useful to the Medical practitioner - to the Theologian - to the Geologist [and] useful to the Medical man - Hierophilus¹⁵ and Galen¹⁶ derived their knowledge from the lower animals - Galen recommended medical men to go to Alexandria to see a human skeleton - there is an antipathy to dissection but only to the dissection of human bodies - preserves alive our former recollections of human structure - the surgeon can practice the operation of surgery on with lower animals so as to habituate himself and acquire dexterity - apprentices cannot be allowed to operate on their master's patients from want of experience and are reduced to the necessity of studying the operations on the lower animals from the difficulty of procuring even dead

⁶ Jean Léopold Nicolas Frédéric Cuvier, known as George Cuvier (1769-1832) was a French naturalist and zoologist based in Paris, instrumental in establishing the fields of comparative anatomy and paleontology through his work of comparing living animals with fossils. http://en.wikipedia.org/wiki/Georges_Cuvier

⁷ William Hunter (1718-1783) was a Scottish anatomist and physician. The Hunterian Museum, London and Glasgow; [http://en.wikipedia.org/wiki/William_Hunter_\(anatomist\)](http://en.wikipedia.org/wiki/William_Hunter_(anatomist))

⁸ James Macartney (1770-1843) was appointed lecturer on comparative anatomy and physiology at St. Bartholomew's Hospital, London. His articles on comparative anatomy were published in Abraham Rees's Cyclopaedia. http://en.wikipedia.org/wiki/James_Macartney

⁹ Professor James Mease of Philadelphia (1771-1846) was an early investigator of disease outbreaks. In 1793, he recognized rabies as being caused by the bite of a mad dog. http://en.wikipedia.org/wiki/History_of_veterinary_medicine_in_Pennsylvania

¹⁰ Alexander Monro (1733-1817), called Monro (*secundus*), was a Scottish anatomist, physician and the Professor of Anatomy in succession to his father, Alexander Monro (*primus*), at Edinburgh University. http://en.wikipedia.org/wiki/Alexander_Monro_%28secundus%29

¹¹ This personal problem for John Barclay, which led to the denial to him of a Professorship in Edinburgh University, is dealt with in: Gardiner, A (2007), Elephants and exclusivity; an episode from the 'pre-Dick' history of veterinary education in Edinburgh. *Veterinary History*, 13, 299-309.

¹² John Playfair (1748-1819) was a Scottish scientist and mathematician, and a professor of natural philosophy at Edinburgh University. He did not vote against the introduction of a professorship of comparative anatomy in the university. http://en.wikipedia.org/wiki/John_Playfair

¹³ James Gregory (1753-1821) was a Scottish physician and classicist, who became Head of the School of Medicine at Edinburgh University. He did not vote against the introduction of a professorship of comparative anatomy in the university. [http://en.wikipedia.org/wiki/James_Gregory_\(physician\)](http://en.wikipedia.org/wiki/James_Gregory_(physician))

¹⁴ Andrew Duncan, senior (1744-1828) was a Scottish physician and became Professor of the theory or institutes of medicine (physiology). He did not vote against the introduction of a professorship of comparative anatomy in the university. http://en.wikipedia.org/wiki/Andrew_Duncan,_the_elder

¹⁵ Herophilus sometimes Latinized Herophilus (335-280 BC), was a Greek physician based in Alexandria. He was the first to systematically perform scientific dissections of human cadavers and recorded his findings. His nine works are all lost. http://en.wikipedia.org/wiki/Herophilus_of_Chalcedon

¹⁶ Aelius Galenus or Claudius Galenus (AD 129-c. 200/c. 216), better known as Galen of Pergamon (modern-day Bergama, Turkey), was a prominent Greek-speaking Roman physician, surgeon and philosopher, who contributed greatly to the understanding of numerous scientific disciplines, including anatomy, physiology, pathology, pharmacology and neurology. <http://en.wikipedia.org/wiki/Galen>

bodies - the foundation of many of the theories developed in the lectures in the Institutions of Medicine is comparative anatomy – Harvey observed and studied the real use of the valves in the lower animals - Asselius¹⁷ saw the lacteals first in the dog¹⁸, and Bacon¹⁹ saw the lymphatic duct in a dog - some animals discharge electric shocks and are found to contain an electric battery in their bodies - Galvani²⁰ discovered the existence of a fluid which Sir Humphry Davy²¹ has made a new instrument of Chemical analysis so powerful as to start a new era on the science of Chemistry - shows that some functions are connected with different organs and the same organs are connected with different functions in different classes of animals - much remains to be discovered and described in Comparative Anatomy and much to be illustrated in Human Anatomy by means of the dissection and examination of the lower animals - Although the founder of the University[sic] the first Dr Monro had highly commended the study of Comparative anatomy as a branch of Medical knowledge, it is now a days considered that the introduction of such a subject would interfere with the course of Natural History or with the course of the present Professor of Comparative anatomy (*of anatomy I suppose the Dr means*), or that it would be beneath the dignity of this University to be dissecting dogs and such other animals - or that it would not bring a sufficient class to requite the pains of a Course of lectures - these are the sentiments which are entertained now a days in the medical school of Edinburgh - I for my part altho[ugh] it has rather taken some thing from than added any thing to my pocket I am resolved to go on with this subject for [al]tho[ugh] it may somewhat diminish my purse it may ultimately add to our stock of knowledge (*the arrangement of this lecture was extremely confused, and the delivery of it was very languid from the class being but thinly attended*).

2nd Lecture - Wednesday 9th May 1821. 11 o'clock am.

I yesterday pointed out the importance and usefulness of the study of Comparative Anatomy to the Medical practitioner - to encourage this study still more among you I have caused the dissecting room down stairs to be cleared for your use gratis and I shall attend there regularly to assist you gratis - the naturalists arrangements of animals are taken from the anatomical structure of these

¹⁷ Gaspare Aselli or Assellio (1581-1626) was an Italian physician and became Professor of Anatomy at Pavia University. He discovered (or rediscovered) the lacteal vessels of the lymphatic system. http://en.wikipedia.org/wiki/Gaspare_Aseli

¹⁸ Domestic dog species: *Canis lupus familiaris*

¹⁹ Sir Francis Bacon, 1st Viscount St. Alban (1561-1626) was an English philosopher, statesman, scientist, jurist, orator and author. http://en.wikipedia.org/wiki/Francis_Bacon

²⁰ Luigi Aloisio Galvani (1737-1798) was the Italian physician, physicist and philosopher who discovered that the muscles of dead frogs' legs twitched when struck by a spark. Galvani, L. (1791), De viribus electricitatis in motu musculari commentarius. *De Bononiensi Scientiarum et Artium Instituto atque Academia Commentarii*, VII, 363-418.

<http://en.wikipedia.org/wiki/Galvani>

²¹ Sir Humphry Davy (1778-1829) was an English chemist and inventor. http://en.wikipedia.org/wiki/Humphry_Davy

animals - my friend Mr Wilson²² of the Wernerian society from not attending sufficiently to Comp[arative] Anat[omy] made an arrangement of Hawkes by which he classed the young hawk, the female hawk, & the male hawk all as different species from not taking the general characters of the species for thus distinguishing the animals - some pretend to great eminence for splitting known species of animals into a variety of species which they consider as discoveries of new species - some even distinguish the human race into distinct species - Lord Kames²³ defends this hypothesis of the distinct species of men - he sneers at the account of Moses' account²⁴ of the formation of man from our pain - Cuvier admits all animals to be of the same species which can procreate and propagate their species - the figure of the skeleton of an elephant²⁵ given by Buffon²⁶ is very incorrect, and the drawing²⁷ given of the skeleton of the elephant by Blair²⁸ is pronounced by Blumenbach²⁹ to be very correct tho[ugh] it had many gross faults - so much for Blumenbach's observations and yet this is the man who finds so many species of the human race - high encomium of Ballingall³⁰ and on the perfection and accuracy of his elephant³¹ skeleton - the hardness of the elephant's trunk is the reason why we still find them undecayed over the whole globe while these skeletons of men and many other animals are too quickly decayed to be preserved in a fossil state - a want of attention to the natural distance of the intervertebral spaces is a great cause of inaccuracy both in the construction of the skeletons of the lower animals and in representing them and I think that the skeleton of the Mammoth³² of Philadelphia³³ is too much lengthened in its spine - the Comp[arative] anatomy does not teach us how to account for the nature of Canine madness (or Epigastric as the

²² James Wilson (1795-1856) was a Scottish zoologist. He joined the Wernerian Society when just 17, and became a Fellow of the Royal Society of Edinburgh. [http://en.wikipedia.org/wiki/James_Wilson_\(zoologist\)](http://en.wikipedia.org/wiki/James_Wilson_(zoologist))

²³ Henry Home, Lord Kames (1696-1782) was a Scottish advocate. He wrote 'Sketches of the History of Man: progress of men in society' in 1734. http://en.wikipedia.org/wiki/Henry_Home,_Lord_Kames

²⁴ Genesis chapter 3, verse 16.

²⁵ African bush elephant *Loxodonta africana*. <http://www.ebay.com/itm/BUFFON-Rare-DUTCH-ED-Engraving-ELEPHANT-SKELETON-/370433826300>

²⁶ Georges-Louis Leclerc, Comte de Buffon (1707-1788) was a French naturalist, mathematician, cosmologist, and encyclopedic author. http://en.wikipedia.org/wiki/Comte_de_Buffon

²⁷ An Account of the Accidental Death of an [Asian] Elephant in Dundee in the year 1706, described by an Engraver resident in that Town. Together with some Short Remarks on the Hall of Rarities, and the Life of Dr Patrick Blair, including Extracts from his remarkable Essay Osteographia Elephantina Taodunensis published by The Royal Society of London in 1710. http://www.andydrummond.net/Images/elephantina_unclothed.jpg

²⁸ Patrick Blair, M.D. (c.1680-1728) was a Scottish surgeon and botanist. [http://en.wikipedia.org/wiki/Patrick_Blair_\(surgeon\)](http://en.wikipedia.org/wiki/Patrick_Blair_(surgeon))

²⁹ Johann Friedrich Blumenbach (1752-1840) was a German physician, naturalist and physiologist. Blumenbach, J.F. (1797), *Handbuch der Naturgeschichte*. Fünfte Auflage. Göttingen: J. C. Dieterich. http://en.wikipedia.org/wiki/Johann_Friedrich_Blumenbach

³⁰ Sir George Ballingall (1780-1855) was a Scottish physician and surgeon who became Regius professor of military surgery at Edinburgh University. http://en.wikipedia.org/wiki/Sir_George_Ballingall

³¹ Indian elephant species: *Elephas maximus indicus*; Ballingall, G. (1820), *Memoir of the Skeleton of an Elephant, dissected in Bangalore in 1813, and now deposited in Dr Barclay's Museum (with two plates, from Mitchell's Engravings of the Human Skeleton, &c.)*. Edinburgh: printed by George Ramsay & Co.

³² Mammoth species: *Mammut americanum*

³³ <http://www.google.co.uk/imgres?imgurl=http://media.smithsonianmag.com/images/Mammoths-skeleton-drawing.jpg&imgrefurl=http://www.smithsonianmag.com/multimedia/photos/?c%3Dy%26articleID%3D87144012%26page%3D12&h=378&w=520&sz=55&tbnid=u1zdM1UwEY8j0M:&tbnh=90&tbnw=124&zoom=1&usq=LmfkfitFp3IY0JDuf-1KPjNii3s=&docid=Da9nVsnXT4jtpM&sa=X&ei=VuyYUtyNE5GVhQeG-YGQDg&ved=0CDkQ9QEwAQ>

French call it) it may teach to treat that disease in a less empirical manner - useful to the Lawer [sic] - to the Logician is reasoning about the nature of the soul - insects change their characters entirely at different periods of their life - the soul can only act without organs in a future state - interesting to the Physico theologians presenting many fine and agreeable reflections - Newton's high opinion of Anatomy in showing more than all the rest of the material world the existence of a supreme being³⁴ - Kirby's Entomology³⁵! Payley's Natural theology³⁶! Cuvier's discoveries of the revolutions of the earth from the different species of animals found in the diff[erent] strata of the rocks in his Fossils Remains - it is by knowing perfectly the form of the skeletons of all the presently existing species of animals that he is enabled to perceive the differences often minute between these and the skeletons found in a fossil state - from finding these skeletons, often of carnivorous animals, huddled in an unnatural manner into one place he considers that they must have been driven so together and embedded in the rocks by some revolution which then happened on the surface of the earth - from finding successive layers of these fossil bones lying above each other in different and distant strata of rock he infers that the earth must have undergone repeated revolutions and at distant intervals - an inorganized or minimal body found in these situations embedded in other strata might have grown there in the very spot in which it was found, but an animal found there obliged to infer that that part must have once been the surface of the earth when the animal then lived - from finding the remains of animals totally different from any which now exist imbedded in the deepest most compact and ancient secondary strata when no remains of any existing species either of plant or animal has been found Cuvier infers that these revolutions happened to the globe prior to the existence of any of the present species, either of plants or animals and from finding human skeletons only in the most recent and superficial strata and never in a fossil state he infers that these numerous revolutions have happened to the earth previous to the existence of the human species - and thus you perceive how useful Comp[arative] Anatomy may prove to the speculations of the Geologist and so tomorrow I shall institute a comparison between the human skeleton and that of the lower animals and thereby show you that however diff[erent] the various species of animals may appear they are all formed after the same general scheme, they are all merely modifications of our general plan.

3^d Lecture [Thursday, 10 May, 1821]

³⁴ Isaac Newton (1642-1727) was an insightful and erudite theologian. http://en.wikipedia.org/wiki/Isaac_Newton

³⁵ William Kirby (1759-1850) was an English entomologist and priest. [http://en.wikipedia.org/wiki/William_Kirby_\(entomologist\)](http://en.wikipedia.org/wiki/William_Kirby_(entomologist))

³⁶ William Paley (1743-1805) was an English Christian apologist, philosopher, and utilitarian. He is best known for his exposition of the teleological argument for the existence of God in his work *Natural Theology*, which made use of the watchmaker analogy http://en.wikipedia.org/wiki/William_Paley

- Comparison of the Human skeleton with that of the lower Animals - In a course of lectures on Comp[arative] Anatomy we cannot always procure the animals at the time we would require them - and as I have procured an angler fish³⁷ I shall so far interrupt the course to show you this animal which is not very common here - you perceive that it has a very forbidding aspect fishes with its tentacula as with a fishing line which has caused its name of Angler fish - has two tentacles - is carnivorous - I once saw it eat its own young rather than touch some vegetable matter which I had placed beside it - all animals are formed after the same plan - a knowledge of the bones is like the lines to the Geometer with which he constructs all his problems I shall perpetually compare these skeletons and other parts of animals with the corresponding parts of man as we find all these parts in a more perfect state in his system - difference in the consistence - colour - situation - articulations &c of bones in the different classes of animals - those who have attended the Course of lectures on human Anatomy will perceive that the present lecture is nearly the same as the general view of the animal frame with which I commenced that course - bones which are situated within and are covered with muscles have nearly the same colour in all animals - articulations - synovia to lubricate the joints - ligaments- membranes - muscles - the muscles of the human body amount to about 400 which in some of the Molluscs there are only two muscles - eulogium on Myology - nerves in Vertebrate animals all terminate in the spinal marrow functions of the nerves - voluntary nerves are not entrusted with any of the functions upon which the preservation of the individual or of the species immediately depends - a vital principle distinct from any Chemical or Mechanical power resides in the embryo when only a small visible speck - I shall afterwards show you in the incubated ovum that the blood moves in a circular direction before any organ whatever is yet formed - so that any attempt to explain the Circulation of the blood on Mechanical principles which are applicable to the full grown adult is quite absurd when applied to the embryo - the blood circulated there before any organ whatever is formed the thoracic duct is only observed in man & quadrupeds to terminate in the same way in the left subclavian vein – Harvey, in 1602, began a series of experiments to show that the processes observed by Fabricius³⁸ in the veins were not osteola venarum but were actually valves forcing the blood [to] always continue in one direction through these vessels, and prevents the returning of the blood backwards as had been asserted by his master Fabricius who imagined that they only retarded the course of the blood in its movement backwards and forwards in the veins - Hewson³⁹, Hunter & Monro primus completely established the true functions of the

³⁷ A north European species (with one long filament from its head) is *Lophius piscatorius*. One possible species name for the Angler fish with two tentacles: *Diceratias bispinosus*

³⁸ Hieronymus Fabricius or Girolamo Fabrizio or by his Latin name Fabricus ab Aquapendente also Girolamo Fabrizi d'Acquapendente (1537-1619) was a pioneering anatomist and surgeon known in medical science as "The Father of Embryology." http://en.wikipedia.org/wiki/Hieronymus_Fabricius

³⁹ William Hewson (1739-1774) was an English surgeon, anatomist and physiologist. He showed the existence of lymph vessels in animals and explained their function. http://en.wikipedia.org/wiki/William_Hewson

lymphatics which are only a sort of vein - in plants the absorbents open from without while these vessels in the more perfect animals open from within the body -

4th Lecture [Friday, 11 May, 1821]

- Comparison of the skeleton of diff[erent] animals - exhibition of the cuttle fish⁴⁰ the sepia of the Greeks a kind of starfish with eight radii and hence called octopus - these radii are covered with small cups called suckers - was known to Aristotle⁴¹ - is described by Hipocrates⁴² who used it as a medicine - discharges a dark coloured ink which cannot be effaced and of which China ink is made - is used some times as an article of food - is very nutritious to those who can digest it - Swammerdam⁴³ has accurately described this fish - the loose part of its body is called its mantle by the French le manteau - the French use this fish as an article of food but it requires much condiment to conceal its harsh taste - discharges the ink according to some in order to confuse its prey and according to others that [ink] is discharged thro[ugh] fear, as we sometimes see the sphincters of man and animals relaxed from fear - names of the diff[erent] parts of the human skeleton - the coxygeal vertebrae of the rat⁴⁴ are more numerous than all the rest of the vertebrae of the body - in man they are very few - some observations on the principles of nomenclature- Butler⁴⁵ from the confusion of anatomical nomenclature makes one of his heroes be wounded on the north-east side of the neck / a the neck is a very common part among almost all perfect animals - in some animals as in the Cameleopard⁴⁶ and in birds the neck is very long - the birds as I shall afterwards show you are a class between quadrupeds and fishes - in all warm blooded animals the cervical vertebrae are 7 in number - all animals which have clavicles can expand their atlantal extremities - birds have and require large clavicles the polar bear⁴⁷ I have seen expanding its atlantal extremities and yet it has no clavicles - if we had a complete set of skeletons of all animals we then would see that the transition is almost imperceptible thro[ugh] the whole range of animals - the fins of whales correspond in structure to the atlantal extremities of the other mammals they have scapulae and the other bones of the extremity and are not like the fins of other fishes - the intestine in most animals passes out at the distal extremity of the pelvis, but in afterwards see in the mole⁴⁸ that for a particular reason the intestines has its exit on the fore part of the abdomen - birds have an additional bone connected

⁴⁰ Cuttlefish: Marine mollusc belonging to the class Cephalopoda (squid, octopuses and nautilus)

<http://en.wikipedia.org/wiki/Cuttlefish>

⁴¹ Aristotle (384 BC-322 BC) was a Greek philosopher <http://en.wikipedia.org/wiki/Aristotle>

⁴² Hippocrates of Cos (c.460 BC-c.370 BC) was an ancient Greek physician <http://en.wikipedia.org/wiki/Hippocrates>

⁴³ Jan Swammerdam (1637-1680) was a Dutch biologist and microscopist. http://en.wikipedia.org/wiki/Jan_Swammerdam

⁴⁴ Black rat species: *Rattus rattus*

⁴⁵ Samuel Butler, (1613-1680) was a poet and satirist. The satirical poem was entitled *Hudibras*.

[http://en.wikipedia.org/wiki/Samuel_Butler_\(poet\)](http://en.wikipedia.org/wiki/Samuel_Butler_(poet))

⁴⁶ Giraffe species: *Giraffa camelopardalis*

⁴⁷ Polar bear species: *Ursus maritimus*

⁴⁸ European mole species: *Talpa europaea*

with the clavicle to give a greater attachment to its strong muscles - as we depart from the trunk towards the extremities we see the deviations in the skeleton of diff[erent] animals become greater - and the traits of resemblance between the skeletons of different classes of animals are always more numerous in the trunk of the skeleton than in more distant parts.

5th Lecture. Monday 14 May 1821.

Linnaeus arranged the mammalia according to the teeth & feet, &c - statement of the classes of animals according to Linnaeus⁴⁹ and the characters of each - Blumenbach's arrangement - Cuvier's arrangement of animals founded chiefly on the characters and habits of the animals - Cuvier's arrangement upon the whole then list - human skull and the names of the different bones forming it in the skull proposed after the French manner having large interstices between the separate bones different cavities formed by the bones of the skull - bones of the human skull exhibited separately - the mesial plain is not entirely an imaginary line - we do not see any muscles passing the mesial plain - four bones of the skull lying on the mesial plane and four bones in pairs - in the dog the frontal bone is divided on the mesial plane into two parts as we sometimes see in the human species by the continuation of the sagittal suture of the bones of the skull are separate from each other only in the young subject for the sake of demonstration because in the adult the sutures are indented into each other inseparably and in many skulls there are no sutures at all in the human species - the coronal suture of the dog is partly a squamous suture the parietal bone in that animal lying over the frontal bone in the dog the occipital bone sends forward a process long and small between the parietal bone - the cells of the diploe⁵⁰ in birds contain air - the cells of the diploe are immense in the elephant skull - mercury thrown into the cells of the diploe of a hawk shown to flow out at the meatus auditorium externus on both sides of the head this shows that the organ of hearing in birds is very extensive and shows a reason why the bones of the skull are so soon united in birds in order not to have these general cavities interrupted by sutures - the frontal bones of the baboon⁵¹, say, and other animals fall immediately backwards so that man only has properly a forehead - Shakespeare says the ape in the Tempest⁵² had a forehead villainous low.

6th Lecture. [Tuesday 15 May 1821]

⁴⁹ Carl Linnaeus (1707-1778), was a Swedish botanist, physician, and zoologist, who laid the foundations for the modern biological naming scheme of binomial nomenclature. <http://en.wikipedia.org/wiki/Linnaeus>

⁵⁰ Diploë is the spongy bone structure of the internal part of short, irregular, and flat bones.

⁵¹ Superfamily: *Hominoidea*

⁵² "And all be turn'd to barnacles, or to apes, With foreheads villainous low." "The Tempest Act 4 Scene 1" by William Shakespeare.

In those animals which have horns as the sheep⁵³ the goat⁵⁴ &c the sagittal suture connecting the parietal bones is soon obliterated and these two bones form one - because in these animals this os frontalis is divided into two & if the parietal bone were also divided the sides of the head might be easily separated because these animals strike with their horns - in the hog the frontal is united to the parietal bone by [a] flat surface a suture neither serrated nor squamous - in man and some of the monkey⁵⁵ kind the sphenoidal bone reaches up to the temples and is connected with the parietal bone but in the lower animals it does not reach so far as the parietal bone - the foramen magnum always distinguishes the occipital bone - the medulla oblongata is seen at its commencement to be composed of four distinct parts lying in contact - in fact - the proportion of the cerebellum is larger in man than in any other animal - the brain often is larger in proportion to the size of the spinal marrow than in any other animal - estimate of comparative weight of the brain and of the whole body in man and animals leads to no useful or correct conclusion - this manner of estimating the capacities of man and animals ridiculed. Soemmering⁵⁶ estimated the capacity of man & of animals by the size of their brain compared with the spinal marrow which it sends off - the animals are most tenacious of life which has the largest spinal marrow and smallest brain - instanced in the turtle⁵⁷ which is remarkably tenacious of life and in which the cavity for the brain is no broader than the structure for the spinal cord - the turtle will live a month without its brain and for several days without its head - I was once obliged to kill the head of the turtle after being separated from the body and lying on the table to prevent its injuring the students by its continually snapping its teeth - the same small marrow cavity for the brain seen in the crocodile⁵⁸ which is also very retentive of life - in these animals the spinal marrow is the most essential part of the nervous system - the tentorium cerebelli is osseous in the cat tribe⁵⁹, in the tiger⁶⁰ the panther⁶¹ &c - in fishes we lose the resemblance of distinct bones and sutures of the cranium the bones of these animals are like mere crystallizations - in the walrus⁶² the sutures are very distinct when the animals are young but they are very soon completely obliterated - the age of the animal can be guessed by the deepness of the indentations made by the temporal muscles - in the young animals the skulls are more rounded and in advanced life they become ridged and round by the action of muscles - this remark applies to man and quadrupeds but not to birds and fishes -

⁵³ Domestic sheep species: *Ovis aries*

⁵⁴ Domestic goat species: *Capra aegagrus hircus*

⁵⁵ At that time in the English language, no very clear distinction was originally made between "ape" and "monkey"

⁵⁶ Samuel Thomas von Sömmerring (1755-1830) was a German physician, anatomist, anthropologist and inventor.
http://en.wikipedia.org/wiki/Samuel_Thomas_von_S%C3%B6mmerring

⁵⁷ The turtle is a sea dwelling member of the superorder Chelonia.

⁵⁸ The crocodile is a member of the subfamily: Crocodylinae

⁵⁹ The 'cat tribe' belong to the family: Felidae

⁶⁰ Tiger species: *Panthera tigris*

⁶¹ Panther species: *Panthera pardus*

⁶² Walrus species: *Odobenus rosmarus*

7th Lecture [Wednesday 16 May 1821]

Relative situation of the Foramen magnum in different animals - in man the head is ballanced [sic] on the foramen magnum so that he requires little muscular exertion to keep his head erect - as we proceed lower down we see the foramen magnum receding backwards towards the inial aspect of the cranium - I here introduce some of the remains I did during the winter course of human anatomy, but I do not introduce so much human anatomy as I did of comparative anatomy in that course - in the turtle and the crocodile the foramen magnum appears even more to the coronal aspect of the cranium this alters much the position of the head with regard to the body of these animals - the organs of the senses are all supplied from cerebral nerves except the sense of touch - and yet the only organ of sense situated in the bones of the cranium is the organ of hearing which [is] wholly situated in the bones of the cranium - even the organ of sight is partly formed by the bones of the face as well as by those of the cranium - most naturalists have asserted that bats⁶³ can direct their course in flying and can see after their eyes have been completely destroyed - this experiment I have never tryed - graminivorous⁶⁴ animals are directed by an instinctive sense of smell to that particular kind of food which is proper for their nourishment - one sense wonderfully and inexplicably supplies the Want of another - this is illustrated in the exquisite feeling of the blind by which they distinguish stones, walls &c at some distance from them in their way - organ of hearing - in consequence of education we lose the power of moving the external ear - but the Tartars and Arabs can move their auricle and the lower animals always direct this part to the part whence the sound comes, as we see in cats⁶⁵, dogs, horses⁶⁶ &c - whatever moves the malleus must stretch or relax the membrane of the tympanum, and there are muscles which move this bone - the reason why the eustashion [sic] tube opens into the throat and not externally onto the surface of the head is that in the latter case the delicate parts would be too much exposed to the vicissitudes of temperature - and by opening into the throat the air is warmed and moistened before entering the cavity of the ear - perforating the tympanum has been attended with no success - beyond the cavity of the tympanum lies the labyrinth which consists of the semicircular canals, the cochlea and the vestibule - the three semicircular canals begin and terminate in the vestibule there is no organ which is less demonstrated than the organ of hearing altho[ugh] much attention has been paid to this part and its parts all named and described - these parts are not explained in reference to the functions of

⁶³ Bats belong to the order: Chiroptera

⁶⁴ Graminivorous (of an animal) means feeding on grass.

⁶⁵ Domestic cat species: *Felis silvestris catus*

⁶⁶ Domestic horse species: *Equus caballus*

hearing - Scarpa⁶⁷ gives the best and most rational account of the organ of hearing - fishes have no meatus auditorius externus - we do not know what each part contributes to the function of hearing in animals - The organ of hearing is always the organ of sense the most immediately connected with the bones of the cranium and formed by the nerves coming directly from the substance of the brain - before proceeding to the eye we must describe the temporal fossa by which Cuvier has been able to distinguish the species of animal - this fossa forms a part of the orbit for the eye and many animals have no orbit but only this temporal fossa for the eye.

8th Lecture. [Thursday 17 May, 1821]

Temporal fossa of Cuvier - the cavity for the temporal muscle to play - the force of this muscle in shutting the jaw is almost inconceivable a man who once exhibited here carried three waggon wheels on his chin by the force of the temporal muscle - the zygomatic arch indicated the size of the temporal muscle and is very large in carnivorous animals, instanced in the polar bear, the royal tyger [sic] - some graminivorous animals have a large temporal fossa as in the elephant because this animal requires great force of the temporal muscle to grind the hard branches of trees, and the squirrel⁶⁸ which cracks nuts with ease with its front teeth the glires⁶⁹ or rongeurs do not require to use much force in grinding their food and therefore have small temporal fossae - birds which swallow worms, fishes &c have strong temporal muscles inserted a good way forward on the lower jaw to give them a longer lever - in the seal⁷⁰ there is scarcely any appearance of an orbit, the eye is merely placed at the anterior part of the temporal fossa - the orbit is more perfect in graminivorous animals as we see in the sheep, horse & when the bill of the snipe⁷¹ is compressed by the temporal muscles the extremity of the bill is opened so that it both swallows and receives at the extremity of the bill at the same time the nose becomes dry on that side where the fistula lachrymalis is placed and the pate loses the sense of smell, which shows the necessity of the tears to the sense of smell to lubricate the pituitary membrane - the foramen infra-orbitarium recedes far from the orbit in the sheep and some other animals, but it always belongs to the superior maxillary bone.

9th Lecture. [Friday 18 May, 1821]

On the cavity of the nose - this cavity is divided into two cavities by means of a septum. The cavity of the nose communicates with the frontal sinuses - the ethmoidal bone is so named from its cribriform

⁶⁷ Antonio Scarpa (1752-1832), was an Italian anatomist and Professor at the University of Pavia; Scarpa, A. (1789), *Disquisitiones anatomicae de audit et olfactu*. Ticini : In typographeo Petri Galeatii.
http://en.wikipedia.org/wiki/Antonio_Scarpa

⁶⁸ Eurasian red squirrel species: *Sciurus vulgaris*

⁶⁹ The glire is a dormouse species: *Muscardinus avellanarius*

⁷⁰ Harbour or Common seal species: *Phoca vitulina*

⁷¹ Common snipe species: *Gallinago gallinago*

plate, because εθμοος in Greek signifies the same as cribrum⁷² in Latin or sieve in English - the inferior spongy bone in quadrupeds is very much convoluted and quite separate from the other bones for the more extensive ramification of the olfactory nerves. The term turbinata, tho[ugh] applicable to these spongy bones in the lower animals where they are convoluted like a turban, is not applicable to them in the human species where they are more simple in their structure - the frontal sinuses have been seen by Portal⁷³ extending over the frontal bone almost to the coronal suture and in one of my preparations it extends backwards to the two tables of the orbital plate of the frontal bone - in most animals the nostrils terminate near the extremity of the upper jaw as in dogs - but in birds as in the parrot it terminates nearer the cranium at the proximal extremity of the long bills - in those animals which receive and throw out water by means of spiracula have no ethmoidal bone or cribriform plate which has caused Cuvier rather hastily to conclude that these animals are destitute of the sense of smell - but if we examine attentively the surface lining these spiracula we perceive very minute ramification of nerves which may have perception from the particles floating in the water similar to those of smell in other animals - Aristotle makes several curious queries concerning sneezing to which he gives his own solutions - statement of these queries from the works of Aristotle Greek x Latin folio - Why is sneezing considered as a thing sacred? Even in the Highlands of Scotland at this day this is still considered as something sacred and they say to each other when one sneezes God bless you.

10th Lecture. [Monday 21 May, 1821]

The two nasal bones in the human species always form a convex surface externally which is not always the case in the lower animals - in the dog &c this external surface is concave which I cannot quite explain - Galileo⁷⁴ was the first to show that this convexity outwards towards the resistance gives greater strength without adding to the weight or substance of the bones - the bones of the head of the foetus which are connected only by membrane would collapse in making a skeleton (notional skeleton) if they were not kept separate by being stuffed with cotton or hair.

Hydrocephalus internal can only take place to a very limited extent in the adult when all the all the bones of the cranium are ossified and united by sutures - the sutures allow the bones to be sooner formed, facilitate parturition, make fractures terminate sooner, and allow a free communication between the external and internal parts of the head, and prevent the accumulation of water in the

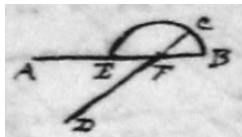
⁷² Cribrum - A horizontal lamina that fits into the ethmoidal notch of the frontal bone and supports the olfactory lobes of the cerebrum. Also called the *cribriform plate of the ethmoid bone*.

⁷³ Baron Antoine Portal (1742-1832) was a French anatomist, doctor and medical historian. Portal, A. (1770-1773), *Histoire de l'anatomie et de la chirurgie: contant l'origine et les progrès de ces sciences*. Paris: P. Fr. Didot le jeune. http://en.wikipedia.org/wiki/Antoine_Portal

⁷⁴ Galileo Galilei (1564-1642), often known as Galileo, was an Italian physicist, mathematician, astronomer, and philosopher who played a major role in the Scientific Revolution. http://en.wikipedia.org/wiki/Galileo_Galilei

ventricles of the brain in the adult - the breadth of the nasal bones - their concavity outwards allows a more extensive surface for the distribution of the olfactory nerves and hence these animals have an acute smell - Socrates⁷⁵ has observed in the Memorabilia of Xenophon that the nose is placed near the mouth of the lower animals that it may direct them to the choice of their food - the larva of insects are sometimes inhaled by those who sleep in hay or grass which become insects in the frontal sinuses where they gnaw [sic gnaw] the pituitary membrane and at last make their escape when they find their strength sufficient to do so - applying fumes of tobacco sulphur &c is just absurd for these fumes would kill the patient much sooner than they would the patient [sic]

Blumenbach pretends to be able to distinguish the skulls of different nations by their outward form, but I have already shown you that he is an inaccurate observer, and there is no general character which is common to any nation - I told the Craniologists that I could not distinguish the skulls of different nations and could not distinguish the character of individual skulls, but on examining the



outward form of my own skull they found that I wanted the organ of Discrimination (*a laugh*) - Compare facial angle - Dr Leach invented an instrument for measuring the facial angle called a craniometer

A B brass rod with a section fixed on it marked with degrees from B through towards E - C D is the moveable bar which rotates on the centre F - the centre F is placed on the meatus auditorius externus - principles and excellency of the Greek statuary - they gave a very small jaw to their gods and a small face with large frontal sinuses - their nose did project forwards but descended in a line with the forehead - altho[ugh] Esculapius⁷⁶ and some have large beards they have young faces.

11th Lecture. [Tuesday 22 May, 1821]

Objections to Campers⁷⁷ facial angle in some of the lower animals the meatus auditorius externus mounts as the ossification advances and the external orifice of the nostrils in very differently situated in different animals - this objection I state in my work on Nomenclature⁷⁸ and was glad to find afterwards that Cuvier had also made a similar objection to this angle of Camper - I propose that

⁷⁵ Socrates (c. 469 BC-399 BC) was classical Greek (Athenian) philosopher. Credited as one of the founders of Western philosophy, he is an enigmatic figure known chiefly through the accounts of later classical writers, especially the writings of his students Plato and Xenophon and the plays of his contemporary Aristophanes. <http://en.wikipedia.org/wiki/Socrates>

⁷⁶ Asclepius, a demi-god and best known for medicine and healing in ancient Greek religion. <http://en.wikipedia.org/wiki/Asclepius>

⁷⁷ Peter, Pieter, or usually Petrus Camper (1722-1789), was a Dutch physician, anatomist, physiologist and zoologist who invented the measure of the facial angle. http://en.wikipedia.org/wiki/Petrus_Camper

⁷⁸ BARCLAY, J, (1803), *A new anatomical nomenclature, relating to the terms which are expressive of position and aspect in the animal system*. Edinburgh: printed for Ross and Blackwood; and T.N. Longman and O. Rees, London.

the lines should rather be drawn down along the whole face, & the other to pass forwards below the lower jaw and my friend Dr Leech⁷⁹ has invented this instrument for measuring this facial angle - the ramus of the lower jaw rises from the body of the jaw bone in the young and in the very aged subject at a very obtuse angle, while in the adult jaw where the teeth are present the ramus rises nearly at a right angle - the extent of motion of the lower jaw in the lower animals depends on the mode of its articulation with the glenoid cavity - this articulation in the carnivorous animals is a hinge like structure and this hinge like articulation is most perfect in the badger⁸⁰ where the lower jaw is for a moment locked in so that it cannot be separated from the articulation without breaking off the condyloid process - the curve at the symphysis of the lower jaw is nearly the same in the young as in the advanced life - when the alveolar processes of the jaw bones are destroyed the teeth necessarily decay, and human dentists who used the tooth drawer with the broad fulcrum destroyed the alveolar processes of the two neighbouring teeth, and these two generally decaying soon after the extraction of the first were obliged to give up this instrument and have recourse to that which pressed only on the one tooth which has to be extracted - In the lower animals the incisores [sic] of the upper jaw are inserted into two bones distinct from the upper jaw bone - these bones are called ossa incisiva, and Galen described these as existing in the human species, and it is as customary long after his time to describe the ossa incisive of the human cranium - the dentes canine are very large in all carnivorous animals for the purpose of securing and tearing their prey - on the formation of the teeth and their growth - the first and second sets of teeth have no connection with each other and are placed in different cavities separated from each other by osseous septae

12th Lecture. [Wednesday 23 May, 1821]

On the growth of teeth - the artery and nerve run thro[ugh] the canal below the teeth and send up branches to each tooth - the teeth are first of a pulpy nature - the fangs are hollow both in man and the lower animals - the ossification commences from the corona and proceeds downwards - then proceeds from without inwards till the passage for the blood vessels and nerves through the fangs is almost obliterated - the corona of the tooth is at first merely a hollow shell - when the ossification is complete there is gradually a greater and greater pressure on the contents of the fangs, and by this process in the first set of teeth the vessels and nerves are at length excluded - and these teeth become dead substances their fangs are acted on by the absorbents, they drop out - and the blood and nerve energy are both directed to the second set of teeth - some have even doubted whether

⁷⁹ William Elford Leach (1790-1836) was an English naturalist who graduated MD at Edinburgh University; He invented an instrument termed the *Gonio-craniometer*. See 'Cranio-metry' in The Edinburgh Encyclopaedia, Volume 7 by Sir David Brewster, page 157 and Plate CCXVIII, Figure 7.

<http://books.google.co.uk/books?id=gY2lwu0vPNAC&pg=PA157&lpg#v=onepage&q&f=false>

⁸⁰ Species: European badger species: (*Meles meles*)

the second set of teeth when fully grown are nourished with vessels and nerves because they are of a very compact texture while the alveolar processes are very soft - and indeed in fossil remains the whole jaw is sometimes completely destroyed by the long action of the elements and only the teeth are left ossified - this is the reason too why so many teeth of animals are found in a fossil bone below the orbit when they occasion much pain and require to be extracted - sometimes also the last molars project from the ramus of the lower jaw among the muscles and occasion much pain so as to require extraction in the horse and many of the lower animals the new teeth push out the old set before state and these teeth quite along - sometimes the eye teeth project from the jaw them - sometimes the last molars grow horizontally forwards from the ramus of the jaw and occasion the most excruciating pain and are difficult to extract - Mr Naismith⁸¹ having seen several of these horizontal teeth invented an instrument for their extraction - some say that the shark has muscles for the erection of its teeth - the tooth of the Mastodon⁸² has very thick layer of enamel on the surface of the tooth - this tooth has points like the mammal and hence the name of this animal from $\mu\alpha\sigma\sigma$ mammae οδου dens - the enamel of the elephants tooth is placed in the inside of the tooth - the horse and the cow⁸³ have also the enamel intermingled with the substance of the tooth like the elephant the teeth of fishes are not confined to the jaw some have them on the tongue [sic tongue] or the gills - some have them in the stomach - birds take in small pebbles to serve for teeth having no teeth or jaws - the first set of cutting teeth are formed hollow in the horse by which the age of the horse is sometimes judged of - these hollow incisors of the young horse soon wear down and sometimes in the older horse they are burned down so as to deceive the purchaser and make the animal appear young the pain of the toothache sometimes removed the actual cautery as by a red hot wire sometimes by the potential cautery as by Muriatic⁸⁴ acid or other concentrated acid - the teeth of the human species appear still to be nourished like other parts even when their ossification is complete.

13th Lecture. [Thursday 24 May, 1821]

The arguments advanced by Mr. Hunter to show that the teeth are dead substances are by no means proofs - the injections do not enter them because the blood vessels are too small to admit the injection or even red blood - ligaments &c are insensible in their natural state as well as the teeth - by rubbing the hardest bodies in nature as diamonds for a series of years against each other their bodies are ultimately ground down and wasted away but the teeth which are rubbed against

⁸¹ Robert Nasmyth (1792-1870) a dentist in Edinburgh.

⁸² Mastodon species: *Mammot americanus*

⁸³ Domestic cow species: *Bos primigenius taurus*

⁸⁴ Hydrochloric acid historically called muriatic acid

each other for nearly a hundred years often are not much worn down because the waste is continually renewed by a vital process Linnaeus took the characters of animals from the teeth - the size of the skull diminishes as one descend in the scale of animals in proportion to the size of the face because the organs of sense are more developed and more necessary in the sheep and cows smell their young to be sure that their eyes do not deceive them - the mouth of the lower animals are larger in general than that of man, because this organ is often employed by them for organs of defence and is used for hands as we see in the cat which carried its young from place to place in its mouth - in birds and in fishes the lower jaw is never articulated with the temporal bone as in man - in birds it is articulated with the bone called by the French the os quadratus than an other little bones connected with the os quadratus which I propose to call the os quadrato-maxillare and the os quadrato-palatinum - I know not whether these have yet received any name and if any of you can suggest better names for these bones I shall be happy to adopt them - in many birds the upper mandible is moveable and this is allowed by means of these ossa quadrata - the lower jaw of birds and fishes is not articulated with any of the bones of the cranium directly but thro the medium of a complicated bone or series of bones - the teeth of fishes of the upper jaw belong properly to the ossa incisiva or what corresponds to those bones of animals (quadrupeds) - none of the teeth of fishes are fixed into the upper jaw bone itself - we have now seen the bones forming the different cavities of the cranium for the brain the eyes, the sense of smell, the sense of hearing and the sense of taste and we now proceed to examine the vertebral column - in most quadrupeds the cervical vertebrae are seven in number as in man - in these there are in general seven processes to each vertebra as in man. viz four articular, two transversus, and the spinous process - the last of the cervical approaches near in its character to the first of the dorsal, and the last of the dorsal approaches near to the first of the lumbar in its characters - the cervical vertebrae are distinguished chiefly by the perforation in the transverse processes for the passage of the vertebral artery - birds have numerous cervical vertebra but they have the vertebral arteries passing through them as in quadrupeds and man - the cervical vertebra of the horse have two additional articular surfaces

14th Lecture. [Friday 25 May, 1821]

Sometimes the vertebral arteries do not pass through the last or even the two last of the cervical vertebrae and in those cases these vertebrae will not have the perforation in the transverse processes - those transverse processes however have no depression marking the articulation of the ribs as we see in the dorsal vertebrae - in old horses which have been hardly wrought during their

lives the vertebrae are often united by anchelosis⁸⁵ marking that inflammation must have existed and that these animals must have suffered much pain even when their labour was not intermittent - the coxygeal or caudal vertebrae are distinguished from the lumbar vertebra by their transverse processes pointing distal while the lumbar point proximal they have also convex articulation surfaces presented to each other, they have in the lower animals a perforation for the continuation of the cauda equina which perforce are not found in the human coxygeal vertebra - in fishes we can easily distinguish three classes of vertebrae - by pouring a little hot water from a tea pot on the tail of a fish the whole flesh comes away simply by rubbing it off with the fingers, while by trying to dissect this tail without this preparation it is found to be one of the most difficult dissections possible - this I found out by mere accident - different curvatures of the vertebral column - this curvature of the spine are alternately backwards and forwards like atlantal and sacral extremities - these observations were first made by the illustrious Aristotle, a most correct observer and the knowledge as far as it depended on observation have scarcely been able to add any thing since - what we have since done has been discovered by means of experiment which Aristotle had not the opportunity of performing - some have pretended to account for these observations by supposing that they serve to support or give room for the viscera of the different cavities - but these curvatures are seen in the dog and many of the lower animals where they cannot seem to support the viscera the real purpose of these curvatures is to give the individual a greater power of balancing himself - the centre of motion of the vertebral column in the lower animals is generally near the middle of that column - the elephant has only three lumbar vertebrae and therefore I would naturally suppose that that animal would be tardy in turning itself - the young calf and young horse have such long legs that they find it difficult to bring their head down to the ground - hence the length of the neck should be and is regulated by the length of the anterior extremities - but the elephant has a short neck and long anterior extremities because these animals have a long proboscis which serves for a long neck, and this part serves also in these animals both for hands and for a nose, besides these animals eat the twigs and branches of trees which are situated on a level with their head.

15th Lecture. [Monday 28 May, 1821]

We turn to the right and left side chiefly by means of the lumbar vertebrae and tho[ugh] I have seen very few living elephants I should suppose that that animal would turn with difficulty from right to left or from left to right from having only three lumbar vertebra - the frog⁸⁶ wants lumbar vertebra

⁸⁵ Ankylosis or ankylosis (from Greek ἀγκύλος, bent, crooked) is a stiffness of a joint due to abnormal adhesion and rigidity of the bones of the joint. <http://en.wikipedia.org/wiki/Ankylosis>

⁸⁶ Common frog species: *Rana temporaria*

and caudal vertebra - the tendons of birds are osseous instead of being tendonous - the squirrel has many lumbar vertebrae and has the greatest power of turning its body from right to left - in some of the lower animals as the ring tailed monkey⁸⁷ the coxygeal or caudal vertebrae are more numerous than all the rest of the vertebrae of the column - in man there are only three coxygeal vertebrae which serve to diminish the apperture [sic] of the pelvis while they enable that apperture to be enlarged during parturition - in the cow and horse these caudal vertebrae serve for organs of defence in warding off insects by the tail - in the war with Germany the English horses suffered most from the effects of insects because they had thin tails cut short, while the tails of the enemies were allowed to remain long - the rat uses the caudal vertebrae in climbing - and some say that this animal uses its tail as a hand which he dips into a fluid then tastes the fluid from his tail, or seizes articles with it - the fox⁸⁸ uses its tail according to some to decoy bees which gather round upon it and then the fox plunges his tail into the water and drowns the bees after which he preys the honey off the hive - the fox also uses his tail to enable him to turn more rapidly in running - in the kangaroos⁸⁹ [sic Kangaroo] the tail serves as an organ of progression for by the spring of his tail he can spring forward to the distance of 16 feet - the pea hen⁹⁰ [male presumably] expands his tail to the sun and solely from vanity can increase and regulate their motions through the air by their tails as well as by their wings - fishes also direct and increase their course thro[ugh] the water by their tails as by their fins - in whales the pectoral fins have through them bones arranged like the atlantal extremities of the birds and quadrupeds - in most animals whether birds fishes, quadrupeds, &c we must always seek for the organs of generation and of urine towards the farthest extremity of the intestinal canal whatever be the form of the intestines - the inter-vertebral articulations of fishes are the best calculated for lateral motion, having a ball and socket joint and that ball having a fluid nature to prevent friction - in old men the intervertebral substances are practically worn away and the person becomes shorter while at the same time the vertebral column gradually inclines forward - the ball and socket joint is very distinct in the vertebral column of serpents⁹¹. - in the horse the balls point towards the head and in the serpents they have a contrary direction - pointing towards the distal extremity of the column In the sea wolf⁹² and the whales we see the spinal marrow distinctly without dissection passing from one spinous process to another the vertebrae of fishes being at some distance from each other - in some birds too we can also see the spinal marrow passing from one spinous process to another - whereas in man and quadrupeds it is concealed by

⁸⁷ Ring-tailed lemur species: *Lemur catta*

⁸⁸ European red fox species: *Vulpes vulpes crucigera*

⁸⁹ Red Kangaroo species: *Macropus rufus*

⁹⁰ Indian peafowl species: *Pavo cristatus*

⁹¹ Suborder: Serpentes

⁹² Sea wolf is a species of fish: *Anarhichas lupus*

these process and cannot be seen in the vertebral canal without dissecting and breaking some part of that canal.

16th Lecture. [Tuesday 29 May, 1821]

I meant to have proceeded today to the thorax, the bones of the thorax but as I came down to the class I happened to meet a human brain⁹³ which I shall therefore demonstrate lest an opportunity should not occur when we come to treat of that part - the upper surface of the brain - the lower surface, where we can see the separation of the lobes - the convolutions like the turnings of the intestinal canal - the sinuses lying in the interstices of the convolutions and going to empty themselves into the sinuses the veins enter the sinuses in a direction opposite or the reverse of that of the current of the blood - I shall now lay open these sinuses - the air you see thrown backwards into the sinuses fills the veins, so that their oblique entrance does not serve as a complete valve as has sometimes been suggested - this obliquity in other parts does serve as a valve as we see in the case of the ureters in the bladder, and the entrance of the pancreatic duct into the duodenum - I separate the falx from the anterior part and fold it backwards - this which I tear off is the pia mater a membrane much more extensive than the dura mater because it dips into all the convolutions while the dura mater mostly covers the surface - if this brain were not a little too far gone by commencing putrefaction I could not so easily tear off the pia mater as you can see here I have thrown in air into cellular membrane lying between the dura and pia mater the cellular membrane connecting the two membranes of the brain is called tunica arachnoidea the corpus callosum - I shall now cut off one of these hemispheres on a level with the corpus callosum - here I have cast off both hemispheres - the corpus callosum called the great commissure - the raphe or suture of the corpus callosum - the cortical or cineritious part - the white medullary or central part of the brain - the centrum ovale of Vieussenius⁹⁴ would be better called ovoid than oval because ovoid as used by Botanists as a more indefinite term and the part so called is not actually oval but somewhat of ovoid but this term was not in use in the time of the French anatomist of Montpellier Vieussenius - the convolutions are all double as you see by my blowing separate the part more easily in the middle of the brain can be separated into a continuous membrain what becomes of the distinction of organs the Drs Gall & Spurzheim⁹⁵ seem not to have been aware how this bore upon

⁹³ Dr Barclay walked past the University's Anatomy Department and the Royal Infirmary on his walk from his house downhill to 10 Surgeons' Square.

⁹⁴ Raymond Vieussens (c. 1635-1715) was a French anatomist. He is remembered for his anatomical studies of the brain and spinal cord. http://en.wikipedia.org/wiki/Raymond_Vieussens

⁹⁵ Franz Joseph Gall (1758-1828) was a German anatomist and physiologist, and a pioneer in ascribing cerebral functions to various areas of the brain. http://en.wikipedia.org/wiki/Franz_Joseph_Gall
Johann Gaspar Spurzheim (1776-1832) was a German physician who became one of the chief proponents of phrenology. http://en.wikipedia.org/wiki/Johann_Spurzheim

their own doctrine there may be external indications of character without the brain being a group of distinct and independent organs like a bunch of keys all hanging on the same string - but more of this when I come to the Physiology of the brain when we have seen a variety of brains - My friend Sir George McKenzie⁹⁶ makes the organ of Music, an organ which I very much want, and the others possessed of memory, imagination, taste &c in short so many distinct intellects - the corpus striatum - thalamis nervorum optitorum - the centrum geniinum semicircular of Viensserius or teni semicircular of Haller - the septum lucidum here are some small vesicles containing water these are a morbid appearance here called hydatids - here gentlemen not to defame you I shall only cut this body to show you why it is called the corpus striatum - you have made different sections different in depth and they have very different appearances but are striated - here you see the pineal gland arbor vitae very imperfect here because brain is quite putrid - corpus denticulate corpus zig-zag - is it dark or is it not ?

17th Lecture. [Wednesday 30 May, 1821]

Exhibition of the Lopes [sic, Lophius] - very large mouth - stomach of a small one - skeleton small one - canary⁹⁷ bird newly killed some be laying eggs - I know that my friend Dr Grant⁹⁸ will have no objection to allow any gentleman to examine the interior of this fish when he opened it, I have not asked him but I know from his generosity that he will readily do so - the oviduct of the canary bird very narrow, and I defie [sic] all the artists of Europe to make so large an egg enter or pass through so narrow a tube - the ribs of man and quadrupeds are connected to the bodies of the vertebrae - in the cetaceans animals the ribs are only connected with the transverse processes of the vertebra - the cavity of the thorax becomes wider from above and downwards of a conical form in man, quadrupeds, and birds - motions of the ribs - the ribs are attached between the vertebra, and not to the body of a single vertebra in order that they may not be obliged to move allong [sic] with these vertebra - Cuvier is one case mistaken with regard to the articulation of the elephant, and Blumenbach we have seen is much mistaken - the reason why Cuvier is so accurate in his distinguishing the bones of animals whether natural or in the fossil state is because he has a more complete set of the skeletons of the lower animals, and if we had a complete set we would be also more quick and accurate in these cases - the ribs articulate by the opposite pulling of the ribs - The sternum varies in form in different animals - in man it consists of three portions - the first portion is articulated with the two clavicles and with the two first ribs, and with half of the second pair if ribs -

⁹⁶ Sir George Steuart Mackenzie of Coul, Baronet (1780-1848) was the President of the Edinburgh Phrenological Society. http://en.wikipedia.org/wiki/Sir_George_Steuart_Mackenzie

⁹⁷ Domestic canary species: *Serinus canaria domestica*

⁹⁸ The writer of these notes, Dr Robert E. Grant.

of all anatomical plates those of the bones are the most useful because the bones are the more permanent and the least variable parts - the sternum is compressed in the dog and other quadrupeds by the scapula as they have no clavicles the sternum of birds consists of one piece - in some birds which are perpetually on the wing the pectoral muscles weigh more than all the rest of their body, as we see in the albatross⁹⁹ and some other birds - have their sternum very large for the attachment of these large muscles

18th Lecture. [Thursday 31 May, 1821]

Liver of the angler fish examined yesterday - in this fish there are three ducts leading from the liver to the cystic duct and the hepatic duct formed a large sac before entering the duodenum - we found the kidneys lying on the axillary plexus - the pancreas has some resemblance to that part in other animals more than in other fishes - the sklerotic [sic] coat was quite transparent and had a quantity of aqueous humour interposed between that coat and the opaque choroid coat - On the ribs - There are processes which I may call intercostal processes projecting sacral in birds from the posterior margin of the ribs - the lungs of birds are fixed - they are more fixed in their vertebral column than quadrupeds and because they require to keep exactly their ballance [sic] whether on their feet or on the wing - the ribs of birds are united to the sternum not by cartilage but by sternal bones - This is also the case in some of the whale tribe - the eye in the mole and some other animals is not in an osseous orbit - in some birds the trachea enters into the substance of the sternum and there allows the air to pervade all the osseous system - in the cassowary¹⁰⁰ the sternum has no spine as in other birds, it has small pectoral muscles and consequently its wings are not well calculated for flying, they have however large sacral extremities for walking, and their fork bone¹⁰¹ connected with the sternum is moving two small processes of the sternum itself on the atlantal extremities - in the dog there are not clavicles, but in the hare¹⁰² we some times see an embryo clavicle - the monkey has large clavicles, all animals which have clavicles have a great extent of motion in their atlantal extremities - but bears /the polar/ have no clavicles but have a great mobility of their atlantal extremities - the clavicles of birds are very large because they have to support the whole weight of the body - On the varieties in the form of the scapula in the human species - the scapula of the monkey more resembles that of a dog than that of man - the spine of the scapula remains pretty steady in the lower animals, but we generally lose sight of the acromion and coroid processes.

⁹⁹ Southern Royal Albatross species: *Diomedea epomophora*.

¹⁰⁰ Double-wattled Cassowary species: *Casuarius casuarius*

The cassowaries are ratites (flightless birds without a keel on their sternum bone) in the genus *Casuarius* native to the tropical forests of New Guinea, nearby islands, and north eastern Australia <http://en.wikipedia.org/wiki/Cassowary>

¹⁰¹ The Furcula, or wishbone, is almost absent in the Cassowary.

¹⁰² European hare species: *Lepus europaeus*

19th Lecture. [Friday 1 June, 1821]

Forms of the scapula - In many of the fish tribe we see distinct digital divisions of the fins corresponding with the articulations of the fingers and toes of quadrupeds - these minute articulations of the radii of the fins is distinctly seen in the whale and in the salmon fish - the whale has six divisions of each finger corresponding to the three phalanges of man - On the Humerus - we see the bicipital groove in quadrupeds as in man this groove is bounded by the larger and smaller tuberosity of the humerus - exhibition of a dislocated humerus where all the processes and tuberosities forming the shoulder joint have been formed anew around the head of the humerus in its new situation below the glenoid cavity - the ulnar condyle of the humerus is always the larger and the radial condyle the smaller of the two - observation on the terms radial and ulnar as preferable to the terms outer and inner side from their being applicable to the arms in every position in which they can be placed - in those animals which climb the distal extremity of the humerus is perforated for the transmission of a blood vessel which would otherwise be compressed and the arm in climbing might become benumbed - in this perforation we see in the case of the monkey and some other animals - the varieties in the structure of the parts of animals become greater as we recede from the trunk towards the extremities - in the whale there are humerus, radius, ulna, carpal, metacarpal and digital bones on the pectoral fins - the radius is that bone which rolls while the ulna admits of no rotatory motion - the radius is always the steady bone of the forearm, while the ulna is sometimes merely a process of the radius - in some animals however we find the ulna is larger than the radius as we see in birds - the tibia of the sacral extremities corresponds with the radius and is the steady bone. the radius in the dog and the lower animals crosses over the ulna - where we find an ulna we always see the olecranon process, but often we see the coronoid process wanting.

20th Lecture. [Monday 4 June, 1821]

The humerus or what corresponds to it in the wing of birds admits of much more varied motion than the human humerus - the bones of the carpus are always articulated with the radius - the radius is the steady bone of the arm and the fibula of the leg - it is impossible that the ulna can have a rotatory motion from the mode of its articulation with the humerus - the greatest care should be used in cases of reduced dislocations or other diseases of the joints to preserve the motions of the joint by continual and gentle exercise of it lest it should anhelose which it is very apt to do after inflammation - bones of the Carpus and the fanciform names they have received from very slight analyses - these names are not properly either names or descriptions or definitions - they [are] too long for names. They are not at all descriptions - and they do not distinguish them from every other which definitely should - quadrupeds and even birds have a patella on the knee joint altho[ugh] a

bear was lately exhibited here showed and standing upright and was said from the patella having them very distinctly seen to be a monster between man and the lower animals - what is generally called the knee of the fore leg of the horse is in fact the carpus of that animal and consists like our carpus of a cluster of small bones - diffusion of concussions by the bones of the carpus and by the other articulations of the body - the carpal bones are seen at the distal extremity of the radius and ulna uniformly in quadrupeds - but birds have no necessity for differing any force applied to its wings in the liquid element of the air and therefore birds have very few carpal bones - whales which strike the water with great violence require and have many carpal bones to diffuse the concussions given to their fins - man is plantigrade he walks on his whole foot - the horse, sheep, cow &c walk on tiptoe - this lecture more on surgery than on any thing relative to Comparative Anatomy

21st Lecture. [Tuesday 5 June, 1821]

Recapitulation of the very important matter of yesterdays lecture on the bones of the carpus - the horse has one large metacarpal bone - the deer¹⁰³ has two long metacarpal bones as long as the radii and ulnae - birds have the radius and ulna in their wing as distinctly as many quadrupeds - in the fins of most fishes we see divisions of each fibre corresponding to the digital phalanges of man and quadrupeds On the bones of the sacral extremities - the pelvis is the only part of the skeleton by which we can distinguish the male from the female - the pelvis of the elephant below very large it is the skeleton of a female pelvis - different bones forming the cavity of the pelvis - difference between the male and the female pelvis depends on the uterus which swells out the female pelvis as also the additional determination of blood to the female pelvis after the period of puberty and which constitutes the menstrual discharge - the atlantal parts of the foetus in utero grow quicker than the sacral because the foetus being suspended with the head downmost the gravity of the blood assists its flow to these parts, and hence we find the sacral extremities are proportionally smaller - the ossa pubis in birds are not united before, they have no symphysis pubis, in order that they may more easily lay their eggs which they can do almost every day and from the hen's¹⁰⁴ kackling after laying its eggs it seems to enjoy some pleasure from that function - whereas in the mammiferous animals the parturition is always accompanied with pain because their ossa pubis are united before by a symphysis - the pelvis of the mole is so small that the rectum when it reaches to the pelvis passes over the symphysis and does not enter [the] pelvis - we can trace in fishes a sort of pelvis the processes of the vertebra uniting from each side to form a sort of symphysis pubis.

¹⁰³ Red deer species: *Cervus elaphus*

¹⁰⁴ Female of domestic chicken species: *Gallus gallus domesticus*

22nd Lecture. [Wednesday 6 June, 1821]

On the importance of the suture in the foetus in easing parturition and allowing the brain to develop and prevent hydrocephalus internus, and preventing extension of fractures in the adult - in the foetus the humerus is as large as the feet but after birth when the child assumes the erect posture the blood gravitates downward and the femur becomes longer than the humerus - the cavity of the acetabulum accommodates itself better to growth of the femur from being formed of several bones, as we see in the foetal cranium the same accommodation to the growth of the brain - specimens of human femora ill united after fractures - specimens of the bones of birds fractured and united very awkwardly by a process of nature - the tibial condyle of the human femur is always the larger of the two and hence the knees are brought near each other - in the monkey the condyles are more nearly equal and its legs are therefore more straight - in birds we can scarcely distinguish in the condyles - or perceive any difference in their length - the patella and sesamoid bones are merely ossified parts of tendons, and tendons always become ossified opposite to articulations where they are subject to great force or great pressure - we find the patella in the knee joint of all quadrupeds and birds - those animals called waders such that the crane¹⁰⁵ has a process projecting upwards from the tibia which serves in them the same purpose as the patella in other animals - the knee joint has a much more complicated apparatus than the hip joint and is on that account much more subject to disease but is less liable to luxation - On the bones of the leg the fibula in the lower animals is very trifling and neither enters into the formation of the knee joint nor of the ankle joint.

23rd Lecture. [Thursday 7 June, 1821]

On the bones of the Tarsus and Foot - those whose foot is flat are easily fatigued by walking because the whole of the soft parts are compressed in the sole of the foot - while those who have the arch way complete in the foot are less easily fatigued because these soft parts are better protected from pressure by the arch - birds have no tarsal bones and only one metatarsal bone. Those birds which climb such as the parrot have two toes before and two projecting backwards- the eagle¹⁰⁶ has large claws and powerful muscles attached to them in order to seize its prey - On the bones of those animals which have their skeleton on the outside of the soft parts - the turtle carries its skeleton on its back for its protection - the toes of the crab¹⁰⁷ tribe more resemble the phalanges of the toes than the bones of the extremities of animals - the scarf skin of man and animals are continually renewed during life - birds moult or throw off their feathers as well as their cuticle - we see the human scarf skin continually renewing and the old falling off in the form of dry scales - serpents

¹⁰⁵ Common crane species: *Grus grus*

¹⁰⁶ Golden eagle species: *Aquila chrysaetos*

¹⁰⁷ Crabs belong to the infraorder Brachyura

throw off the whole of the scarf skin and the cornea of the eye at once the serpent slips out at a small hole of the old skin leaving that skin almost intact some talk of Organization as if they meant the organized structure itself - organization is a vital process - in the impregnated ovum there is something totally different from any form of matter which arranges and organizes the transparent fluid - parent has nothing to do with the organization of the foetus - this is done a vital principle - the parent only supplies the foetus with nourishment no matter how whether by the mouth or the blood vessels or by the intestines - the uterus has no advantage above the fallopian tubes or any other part of the maternal system for the nourishment of the embryo, as see[n] by extra uterine gestations - only the uterus is a convenient place for allowing the foetus to be expelled when it arrives at the full period - in the foetus before the full period the thorax is small in proportion to the size of the body it is smaller than the cavity of the cranium - the thorax is small in these cases because the foetus has not yet expanded its lungs - the abdomen is larger in proportion to the rest of the body because the liver is large and performs a very important function in the foetal system - Sir Everard Home¹⁰⁸ in the Philosophical Transactions has lately asserted that the ovum first descends into the uterus before sexual intercourse and that if there happens to be one ovum in the uterus during sexual intercourse that ovum becomes impregnated in the uterus - but if this was the case extra-uterine gestations would be impossible for the ovum would never return again through the Fallopian tubes after being already in the uterus.

24th Lecture. [Friday 8 June, 1821]

Exhibition of the Plates of Kerckring¹⁰⁹ showing the foetal skeleton at the different periods after conception - the plates are a good deal applicable to the progress of ossification also in the lower animals progress of ossification in each bone of the human skeleton and the number of parts of which each bone is originally composed - by macerating the long bones in muriatic acid [HCl] we can easily separate them into long fibres extending from one end of the bone to the other the flat bones ossify from different points - the long bones ossify from their middle towards their extremities - the clavicle however both in man and the lower animals ossifies from one extremity to the other and not by epiphyses exhibition of the Plates of the osteogeny of the celebrated Albinus¹¹⁰ - the separation of

¹⁰⁸ Sir Everard Home, 1st Baronet (1756-1832) was a British surgeon. http://en.wikipedia.org/wiki/Everard_Home

¹⁰⁹ Theodor Kerckring or Dirk Kerckring (1638-1693) was a Dutch anatomist and chemical physician; Kerckringii, T. (1672), *Doctoris Medici anthropogeniae ichnographia, sive, Conformatio foetus ab ovo, usque ad ossificationis principia, in supplementum osteogeniae foetuum*. Lugduni Batavorum. <http://www.byassrarebooks.co.uk/bookdescription.aspx?id=5951&paintmode=full&searchmode=archive&categorymode=yes&category=History%20of%20Science&categorycount=14&categorylist=5332!5230!5214!5549!5129!5347!5346!5266!5951!5229!5236!5235!5175!5251!>

¹¹⁰ Bernhard Siegfried Albinus (originally *Weiss*) (1697-1770) was a German born Dutch anatomist: Albinus, B.S. (1747), *Tabulae sceleti et musculorum corporis humani* Lugduni Batavorum : Apud Joannem & Hermannum Verbeek http://en.wikipedia.org/wiki/Bernhard_Siegfried_Albinus

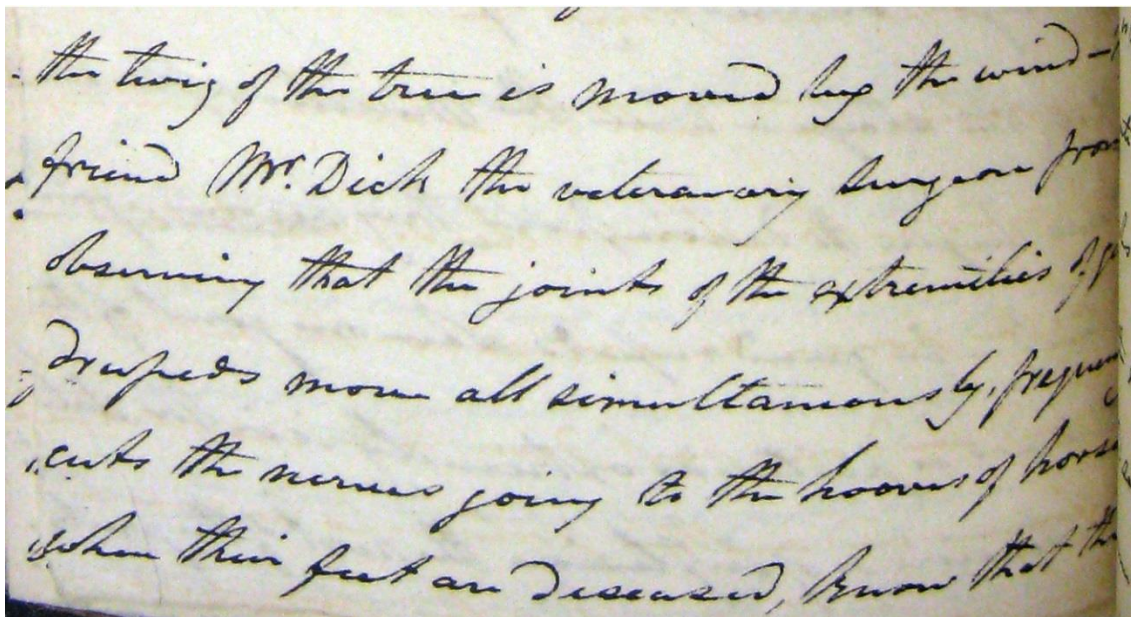
the epiphyses of bone before complete ossification more serious than even a fracture, as the cartilage less easily unites than bone when broken - Differences between the female and the male skeleton - this plate of the female skeleton by Soemerring¹¹¹ is, you easily perceive gigantic - most of the characters which Soemerring has ascribed to the female skeleton are found likewise in the foetus - the thorax is small in the female because she is less exercised in the open air which enlarges the male thorax, we find the foetal thorax likewise proportionately smaller the bodies of the vertebrae are deeper because she is more sedentary and less exercised in the correct posture than the male &c - therefore all these characters which Soemerring has given to the female skeleton are much more remarkable in the foetal than in the female skeleton - the only peculiarity of the female skeleton mentioned in the whole work is the large diameters of the pelvis - and while the female skeleton differs in this respect from the male it differs still more from the foetal skeleton - some of the Tartars who are almost continually on horseback have very small thighs from the pressure and interruption to the circulation - the largeness of the female pelvis is only conspicuous after the period of puberty - the female has likewise more sensibility than the male and has more of the foetal characters in her conduct thro[ugh] life.

25th Lecture. Monday 11 June, 1821

On the Muscles - The Panniculus carnosus under the skin of quadrupeds to shake off insects from the surface of their body - the same muscle which pulls upwards and backwards the angle of the mouth in the dog also pulls the ear backwards - by tying the ears of a bull together it was found to be disabled from leaping the fences, because when it leaps the fences it always erects the ears, but when the ears were tied it could not erect them and it thought that some one pulled it backwards whenever it attempted to leap - the muscles of this dog are so rigid that I cannot without considerable effort open its mouth - the muscles become this rigid when the animal cools but not till then - and the actors are quite ignorant of nature who pretend to become quite rigid immediately after being stabbed upon the stage - when the muscles after some hours begin to decompose they become again relaxed - in quadrupeds when one joint of the anterior or posterior extremity is in the state of extension or of inflexion the rest of the joints of that extremity assume the same state is not the case in man who can inflect one joint of his arm while at the same time extends another - we observe however the same thing in the legs of birds whose joints are all in a state of flexion when any one joint is so - and hence when the bird sits on a branch of a tree the weight of its body causes one joint of the legs to bend and the consequence is that the claws are bent round the twig are so fixed till the bird chooses to let go by raising the weight of its body off the legs - it thus sleeps with a

¹¹¹ Soemerring, S.T. (1797), *Tabula sceleti feminini: iuncta descriptione*. Traiecti ad Moenum: Apud Varrentrapp et Wenner.

secure hold of the branch even when the twig of the tree is moved by the wind - my friend Mr Dick the veterinary surgeon from observing that the joints of the extremities of quadrupeds move all simultaneously, frequently cuts the nerves going to the hooves of horses when their feet are diseased, know that the same muscles which move the leg will still continue to move the foot as before - the same operation however upon our hands would deprive us of the sensibility of the hand and of the power of moving it - parotid gland duct of Steno¹¹² - Plates of Steno showing vessels attached to the parotid and pancreatic ducts in order to ascertain the quantity secreted in a given time and the influence of substances on the secretion.



Five lines from lecture 25, showing a reference to 'My friend Mr. Dick'

26th Lecture. [Tuesday 12 June, 1821]

Pectoralis major of the dog - the serratus magnus very large and strong in the dog - rises the ribs towards the scapula when the scapula is the fixed point and is thus an organ of respiration - and pull the scapula towards the same ribs - the sternocleido-mastoideus in the dog, the horse &c arises [sic] in the back of the neck and send one part down to be inserted into the sternum and another portion to be inserted to the proximal extremity of the humerus - by hanging down its head the horse rests this muscle and is more apt to stumble because the base upon which the animal stands is diminished in these cases - the latissimus pectoralis major et minor, trapezius, rhomboidei, tracheo

¹¹² Nicolas Steno (1638-1686) was a Danish Catholic bishop and scientist and a pioneer in both anatomy and geology; Steensen, Niels / Sténon, Nicolas. Nicolai Stenonis (1662), *Observationes anatomicae quibus varia oris, oculorum et narium vasa describuntur, novique salivae, lacrymarum et mucii fontes deteguntur, et novum nobilissimi Bilsii de lymphae motu et usu commentum examinatur et rejicitur*. Lugduni Batavorum : apud J. Chouët.
http://en.wikipedia.org/wiki/Nicolas_Steno

brachialis &c connect the atlantal extremities of quadrupeds which want clavicles to the trunk - combinations of movement given numbers of muscles - demonstration by a machine of the action of two muscles the movable point in the diagonal of the forces - the muscles which produce the tones of the voice must act with a precision to the 100,000th part of an inch in order to produce all the sensible modifications of sound in singing - Lucretius¹¹³ says 'how can a thing [that] is incorporeal act upon a thing [that] is corporeal" we know not how it does but we know well that it actually does - these are above discussions into which physiologists are fond of entering - they enquire how it is that a muscle can contract itself and such like absurdities when they ought rather to examine what is within their reach.

27th Lecture. [Wednesday 13 June, 1821]

The temporal fascia - the temporal muscle - the masseter muscle the sterno-thyroidei - sterno-hyoidei - the cricothyroidei - mylo-hyoideus - all these correspond pretty much with what we can see in the human species - genio-hyoidei immediately below which lie the ninth pair of nerves going to supply the tongue - the appearance of these parts in the human species can be very well learned from the dissection of them in the dog - the eighth pair or par vagum the most important pair of the whole body - here we now take the atlantal extremity separate from the trunk - enumeration of the muscles which connect to the trunk - the subscapular muscle is a rotatory muscle as in the human species, and is little affected by flexion and extension - the Deltoid muscle - the infraspinatus and teres minor are the same in the dog as in man, they are inserted into opposite sides of the centre of motion of the humerus so that one is an extensor while the other is a flexor tho[ugh] they are inserted very near to each other - since there is no coracoid process of the scapula in the dog, there is no short head of the biceps flexor or cubit nor coracobrachialis muscle, because these in man arise from the coracoid process - in the dog the flexors of one joint are extensors of the next joint, and the extensors of one joint are flexors of the next so that we can account for the simultaneous movement of the joints of the extremities - the anconeus is very powerful in the dog is called likewise the triceps extensor cubitor in the human The anconeus and the pectoralis are very large in the dog for the support of the humerus and they keep that bone tied close to the thorax - the extensor carpi radialis is inserted into the carpus exactly as in man.

28th Lecture. [Thursday 14 June, 1821]

¹¹³ Titus Lucretius Carus (c. 99 BC-c. 55 BC) was a Roman poet and philosopher. His only known work is the epic philosophical poem *De rerum natura* about the beliefs of Epicureanism, which is translated into English as *On the Nature of Things* or "On the Nature of the Universe". <http://en.wikipedia.org/wiki/Lucretius>

On the muscles of birds - Dissection [of] a young goose¹¹⁴ - the latissimus dorsi exactly as in the dog the largest muscle of the back - the atlantal extremities of this animal admit of more rotatory motion than in the dog - the rhomboideus as in man - the scapula here is fixed by means of the clavicle - the clavicle in this animal is always a strong bone the pectoralis major - the scapula and clavicle are often ossified to each other in birds - the pectoralis major is very large for supporting the whole weight of the body, as is tinged with reddish colour by the blood being forced through the minute vessels from its great exertion - the pectoralis minor on the other hand is very small and is of a paler colour from its being less exerted - the air in birds enters the lungs where there are numerous perforations giving oxygen to air vessels which enter the bones and fill these with air instead of marrow - the bones are thus rendered lighter and the respiratory organ is increased in extent - there is a large perforation at the head of the humerus where the air vessel entered - Mr John Hunter when he wanted to kill an animal of this kind amputated the humerus and the bird could no longer breath - this muscle going from the scapula to the humerus I have ventured to call the scapulo humerals as it hadn't hitherto received any name - this other I have sterno-humeralis, and this the claviculo-muscularis the bird has a flexor cubiti and biceps extensor cubiti - the humerus in most birds is marked by the insertion of large feathers.

29th Lecture. [Friday 15 June, 1821]

Dissection of the hedgehog¹¹⁵ - these muscular fibres passing from the neck to the integuments which surround the body of the hedge hog and seem to compress the animal - by its strong cutaneous muscles this animal contracts its body forcibly into a globular form so as to conceal its head completely - the generation organs of the hedge hog [are] very large - the testicles lie within the cavity of the abdomen besides these are the vesicula seminales - the clavicle is present in this animal - the pectoral muscles prevent the extension outwards of the atlantal extremities of this animal the subclavian muscle here as in man, as this muscle does not exist in the dog which has no clavicle - the pectoral muscle [is] very large and also the sternum in birds to support their whole weight and strike the air with great force - wherever the birds have occasion to remain long on the wing we find a fourchette bone placed at a considerable distance from the sternum to admit of free motion the glutei of birds are rotators and extensors of the hip joint as the same muscles are in the human species - the trochanter minor is wanting in birds - the rectus femoris is present in birds but is not a penniform muscle as in man and quadrupeds - the rectus cruris has a distinct band coming from the superior margin of the acetabulum in the human species which is not generally described - the obturator externus is very conspicuous in birds - the muscles in birds which correspond with the

¹¹⁴ Domestic goose species: *Anser anser domesticus*

¹¹⁵ European hedgehog species: *Erinaceus europaeus*

biceps flexor cruri in man I have called the ilio-tibialis from their attachments - the knee joint of birds is never in a state of complete extension as there are two fleshy bellies which unite in the same tendon as the gemelli muscles in man - the tibialis gracilis or plantaris in birds i[is] as in man, this muscle seems intended to excite the secretion of sinovia in the knee joint and in the heel joint - as it is too small to give any assistance to the tendon of Achilles, and passes thro[ugh] the cellular substance.

30th Lecture. [Monday 18 June, 1821]

The scapula of the horse has no coracoid process, and therefore there can be no coraco brachialis - the viscera of the horse were dissected in the back court on Saturday by my friend Mr Dick the veterinary surgeon of this place - I have a duck¹¹⁶ which lays black eggs - here is one of these, you see there are some white spots upon it - the cicatricula of eggs is always at the upper part of the egg whatever may be the position of the egg - like a globe of air in a vessel containing water - so that this cicatricula being at all times uppermost in the egg is also at all times the part nearest to the breast of the mother when it hatches out the heat is generally in birds at 103 degrees - so that Paracelsus¹¹⁷ is false when he says that an egg can be hatched under the arm pit of man, for the human temperature is only 96 degrees - but something more is necessary than more heat as the state of the atmosphere being moist, if there is no change on the cicatricula when the egg has not been impregnated - at the thick end of the egg there is always a globule of air for the chick to respire - the head is always next the thick end of the egg - the day of incubation the chick you see is distinctly formed and the vessels going to its umbilicus - the eye extremely large at this period, and the head larger than the rest of the body - the vitellus or yolk of the egg does not afford the least nourishment to the chick which in ovo, and is seen perfectly entire in the egg till the last day of incubation and then is all swallowed into the abdomen of the chick and the chick escapes and lives for some time with this yolk distending its belly, it there affords nourishment when the chick is born or hatched but did not afford a particle of it while in ovo - something exists which organizes the structure of the chick before that structure is formed, and as it exists before that organised structure it may also for ought we know exist after the destruction of that organized structure.

31st Lecture. [Tuesday 19 June, 1821]

¹¹⁶ Perhaps a domestic duck (*Anas platyrhynchos*). A duck was found in North America about four decades later that laid black eggs, and this was commercialised as the Cayuga breed.

¹¹⁷ Paracelsus (born Philippus Aureolus Theophrastus Bombastus von Hohenheim, 1493-1541) was a Swiss German Renaissance physician, botanist, alchemist, astrologer, and general occultist. He founded the discipline of toxicology. <http://en.wikipedia.org/wiki/Paracelsus>

Muscles of the foot of the horse the horse has only one large carpal bone, and two small imperfect ones - the muscles corresponding with the interossius in man - has nothing corresponding with the Lumbricales muscles - has a flexor of the fore leg corresponding with flexor primum intermedium policis of man and the dog - the horse has only one digit and if we compare the muscles of one human finger with those of the digit of the horse a very close analogy will be observed - the flexor tendons in the foot of the horse become ossified in passing over the joints so as to form sesamoid bones in the haddock¹¹⁸ and such like fishes have four rows of muscles from head to tail running in opposite directions - these muscles bind the whole body to the side on which they are placed, and backwards and forwards.

32nd Lecture. [Wednesday 20 June, 1821]

On the brain of the sheep - the $\mu\epsilon\nu\nu\xi$ of the Greeks was the Pia mater of the [S]akians¹¹⁹ - in the two hemispheres the convolutions in most animals are similar or somewhat analogous - in this specimen the convolutions are not analogous - all the organs according to Drs Gall and Spurzheim must be double even those lying on the mesial plain - pushing back the cerebellum from the posterior lobes we look down upon the four corpora quadrigemina and anterior to these we see the pineal gland a black body here lying - the Pineal gland sends two pedunculae to the thalamic nervorum optitorum and it was only by following these small peduncula that I discovered any pineal gland in the dog where it is remarkably small - in the sheep the sheep on the contrary the pineal gland is very large - which is strong proof that it is not the seat of the Animating Principle because in these cases the sheep would be more sagacious than the dog - the corpus callosum - the white part of the brain is called the medullary part from its situation resembling that of the medulla or pith of plants and not from any relation to the medulla or marrow of bones - the two lateral cavities or ventricles may rather be considered as Potential cavities than as real cavities - in dissecting the brain to examine whether there be any water contained in the lateral ventricles we should not cut horizontally outwards from the level of the corpus callosum as we would then enter the ventricles we should raise the incision a little in passing outwards - the septum lucidum completely separates the two lateral ventricles from each other - in order to fold back the corpus callosum we must tear the septum lucidum - the septum lucidum consists of two distinct layers - the septum lucidum sometimes in hydrocephalus contains water between its folds and this cavity so formed is called the sinus Sylvii or the fifth ventricle - the two lateral ventricles communicate freely under the anterior crura of the fornix where the two plexus choroides meet - there is no medullary partition between

¹¹⁸ Haddock species: *Melanogrammus aeglefinus*

¹¹⁹ Possibly used as a collective name for Arabs. SAKIAN: the Iranian language of the Saka people <http://www.merriam-webster.com/dictionary/sakian>

the two lateral ventricles at the bottom - by putting back the fornix we see that these two ventricles form but one cavity - the posterior crura of the fornix terminate in the corpora fimbriata - by raising the posterior lobes of the brain we cut into the lateral ventricles without tearing any medullary matter - simply a membrane prevents the water from escaping backwards - the fissure between the thalami is the third ventricle - here is an egg, gentlemen, said to be at the eleventh day of incubation we shall see at what pitch the organization has arrived - it is a rotten one (a laugh) - the valve of Vieussens¹²⁰ is composed of medullary matter but remarkably thin - it lies on the iter a tertio and gerartium ventriculorum.

33rd Lecture. [Thursday 21 June, 1821]

Another sheep's brain - here I lay open the lateral ventricles in another way by making a vertical [sic] section - here you see the cornu ammonis of an ashen¹²¹ colour within and white without - the pineal gland remarkably large in this animal - in the dog where the pineal gland is very small we first see the two peduncula and then we discover the small pineal gland behind them.

the cornu ammonis follows the course of the ventricles - each of the lateral ventricles has three cornua - the termination of the cornu ammonis is called the pes hippocampus - there is more variety in the posterior cornu of the lateral ventricle of man than in any other part of the brain - the third ventricle is always found lying between the two thalami - we have only to separate these thalami from each other in order to see the space called the third ventricle - in the human species there is a thin medullary expansion passing from one thalamus to the other which is called the commissura mollis - you see distinctly here a white fibrous medullary substance (which is the commencement of the optic nerve) coming from the superior of the corpus quadrigemina and lying upon and connected with the thalami. this origin of the optic nerves is considered as a discovery of Drs Gall and Springhaus [sic, Spurzheim] - these anatomists assert that when the optic nerves are diseased these corpora quadrigemina superiora are found more diseased than the thalami - in birds we see the optic nerve arising from two white eminences which Drs Gall and Springhaus [sic, Spurzheim] say cannot be the thalami as they want the character of them, they have no third ventricle between them, and therefore they are or correspond with the corpora quadrigemina superiora of man and quadrupeds - I have seen Dr Springhaus [sic, Spurzheim] tryingly dissect the brain, and I must say I have never seen anyone dissect it with more care and accuracy than him - but I do not go along with

¹²⁰ The Vieussens valve of the coronary sinus is an anatomic landmark between the coronary sinus and the great cardiac vein http://en.wikipedia.org/wiki/Vieussens_valve_of_the_Coronary_Sinus

¹²¹ Ashen, ash-like.

him in his physiology of the brain - the anterior commissure passes obliquely forward to the corpora striata as was first observed by these two anatomists.

34th Lecture. [Friday 22 June, 1821]

Dissection of an egg at the 13th day of incubation - the membrane lining the shell has nothing to do with the other membranes which is more dense covering the albumen and chick - the chick and its membrane do not nearly fill the cavity of the egg - the umbilical cord very distinct - the yolk of the egg now divided into two distinct halves with blood vessels passing thro[ugh it] - the whole structure of the chick is formed from the albumin - the bird still surrounded with a clear watery fluid enclosed within a distinct membrane between the yolk and it - the blood vessels of the cord seem tortuous but not filled with blood - the chick swallows the whole of the yolk immediately before being hatched which causes the largeness of its belly when the bird is newly hatched - by passing the electric spark thro[ugh] the impregnated ovum before its being hatched the bird has been blinded sometimes in one eye and in others in both eyes - those which have not recovered from the shock have lived in a weakly state - On the brain of the sheep and of the dog - the convolutions [are] pretty analogous in the two hemispheres of both these animals - the vermiform process of the cerebellum very distinctive in the dog and tolerably distinct in the sheep - here I lay open the lateral ventricles without any dissection whatever simply by lifting up the posterior lobes - the pineal gland here a little diseased of a bluish colour - the hemispheres of the brain in the dog as in man easily separated down through the corpus callosum having no sort of adhesion as they have in the sheep which causes some cutting to be necessary in order to see them in it. the pineal gland in the dog remarkably small but easily found by tracing back its two pedunculae which are conspicuous - the pineal gland very large in the sheep - the corpora quadrigemini superiora in the sheep larger than the inferiora - in the dog the reverse - the inferiora being larger than the superior Dr Willis¹²² has observed that those animals which arrive slowly at the full use of their faculties have the corpora quadrigemini small as in the dog and man - the Drs Gall and Springhaus [sic, Spurzheim] have satisfactorily shown that the size of the tuber annulare bears always a proportion to the size of the cerebellum, because the two crura cerebelli form the greater part of this tuber annulare. here I have inflated the olfactory nerves by blowing air from the lateral ventricles - and the ancients you see had really some grounds to go upon when they assented to certain exudations passed from the brain thro[ugh] the nose - the horses I showed you already communicate likewise with the nose - Drs G&S did not say that the whole of the optic nerve did terminate in the substance of the corpora quadrigemini - but only a part of it, and partly from the thalamic nerve often - here in the dog you see that the

¹²² Thomas Willis (1621-1675) was an English doctor who played an important part in the history of anatomy, neurology and psychiatry. http://en.wikipedia.org/wiki/Thomas_Willis

greater part of the optic nerve comes from the thalamus and a part only from the superior of the corpora quadrigemmini.

35th Lecture. [Monday 25 June, 1821]

On the brain - by raising of the cerebellum from the medulla oblongata we see the triangular cavity called the fourth ventricle - the fourth ventricle terminates in the calamus scriptorius - a process of the cerebellum is seen in this ventricle running into the inferior of the corpora quadrigemmini - another process from each side of the cerebellum is seen proceeding downwards in the 4th ventricle towards the medulla oblongata - the corpora olivaria and pyramidalia not very well seen in this animal [the sheep] - the brain of the cock,¹²³ we see the optic nerves coming from white eminences which you may therefore either consider as the thalami nerv. optic. or the superior of the corpora quadrigemmina the brains of these birds are in such a state of softness and so minute as to require the microscope we shall therefore throw them aside and proceed to a human brain which we have got here in good condition - by tearing up the posterior lobes thus we can see the inferior of the corpus quadrigemmina - but not so distinctly as in the quadruped - you see here on the lower surface of the middle lobes the white striae from which the celebrated Vic D'Azyr¹²⁴ and the olfactory nerves took their origin the third pair take their origin from the crura of the cerebrum where they enter the tuber annulare - the crura of the cerebrum evidently exhibit - fibrous appearance - by tearing up the hemisphere from the corpus callosum to one side we see a distinct fibrous appearance running outwards to the sides of the brain - this fibrous appearance of the corpus callosum is not produced by scraping because we cannot produce the same effect by scraping other parts and we can duly produce this fibrous appearance in that direction from the medial plane outwards - by scraping in a contrary direction we entirely destroy the fibrous appearance of the corpus callosum - the optic nerves not so distinctly traced to the superior of the corpora quadrigemmina in man as in quadrupeds - in separating the two corpora pyramidalia we see cross medullary filaments towards the tuber annulare they run directly across, but at the lower extremity of the corpora pyramidalia they run very obliquely downwards and these latter are the decussating fibres mentioned by Petit¹²⁵ [altho[ugh] Vic D'Azyr in his plates has represented those near the tuber Annulare - The fifth quiver of nerves you see I have this the side of the tectum annulare distinctly to the medulla oblongata, as in quadrupeds, where we see them easily arising from the

¹²³ Male of domestic chicken species: *Gallus gallus domesticus*

¹²⁴ Félix Vicq d'Azyr (1746-1794) was a French physician and anatomist.
http://en.wikipedia.org/wiki/F%C3%A9lix_Vicq-d'Azyr

¹²⁵ François Pourfour du Petit (1664-1741) was a French anatomist, ophthalmologist and surgeon.
http://en.wikipedia.org/wiki/Fran%C3%A7ois_Pourfour_du_Petit

medulla oblongata - the fourth ventricle when fully laid open has somewhat of a rhomboid as form sending angles forward and backward.

36th Lecture. [Tuesday 26 June]

On the brain of birds and fish the two large white bulbs lying behind and below the brain and before the cerebellum in birds is what corresponds to the two corpora quadrigemina superiora from which the optic nerves take their origin cock's, hen's and cod's¹²⁶ brain - we can separate the hemispheres of the birds brain to the very bottom and we see no corpus callosum, no septum lucidum, no fornix, no corpora striatum - here we see as it were the third ventricle and the posterior commissure - we do not see any thing corresponding with the tuber annulare in birds - no convolutions - the arbor vita distinctly seen in the cerebellum - the optic nerves seen coincidentally to run across and enter the eye opposite I cannot find any thing corresponding the corpora quadrigemina inferior in birds - Brains of fishes - these do not fill the cavity of the cranium but lye in a glassy fluid - the concave surface of the bone of the ear in fishes is outward and the convex surface next to the brain - the skin passes over the eye and is nearly transparent when it passes over the cornea - the optic nerves evidently cross each other without being there at all connected - there is however a slight connection between the optic nerves immediately after their origin.

37th Lecture. [Wednesday 27 June, 1821]

On the changes on the egg during incubation - Harvey wrote a work on insects the manuscript of which was burnt as well as his house by the fury of the populous Fabricius wrote much on the progress of incubation and has given many plates - the 11th day the yolk exhibiting a red circle on its surface, the cicatricula always uppermost - the air which the chick respire is always at the thick or round end of the egg - the albumin of the egg melts down into a clear fluid which Harvey calls the colligumentum crystallinum which the chick is supposed to sip with its bill - by boiling the eggs at the different periods of incubation we see more distinctly the progress of the different parts being then rendered more firm and more manageable - the air at the thick end of the egg is never very great in the fresh egg till the foetus is formed the colligumentum crystallinum is clear and thinner than the albumen from which it is formed and which has a yellowish tinge - the chick at first is seen at the thick end of the egg where the air is - but afterwards when the air increases in quantity we see the chick approaching to the thin or narrow end of the egg - the vitellus or yolk is at best departed into two distinct halves like what we see in the bean and pea when they begin to shoot out tendrils - towards and the end of incubation we see the excrement of the chick floating in greater quantity of

¹²⁶ Atlantic cod species: *Gadus morhua*

a whitish colour and soft consistence - the blood vessels drop from the umbilicus to be spread upon a membrane covering the albumin - on the last day of incubation the egg is nearly half filled with air and the albumin is mostly absorbed, but the vitellus is still nearly of its original size and divided into two portions - the abdomen of the chick at the full period is quite open at the membranes and thro[ugh] this opening it swallows the whole yolk in the space of a few hours before making its escape from the egg.

38th Lecture. [Thursday 28 June, 1821]

On the brain of the skate¹²⁷ You see here when I touch with the scalpel the nerves coming from the brain and spinal marrow I throw the skate in different parts into convulsions - the heart of the ray fish¹²⁸ pulsates in my Museum for two days after being taken out of the body - Cicero¹²⁹ saw the human heart beating out of the body as he mentions in his [De] Natura Deorum - Bacon likewise saw the heart of man beating and leaping out of the body - all these facts show that the blood is not the only cause of the pulsation of the heart - the corpora olivaria and pyramidalia are as distinct in the skate as they are even in quadrupeds - the eye lid of the skate is a beautiful curtain which hangs in fringes over the pupil - here is an egg at the full period and you see the fluid is almost wholly absorbed the yolk is nearer to the umbilicus - the chick is still alive - a great part of the yolk is already lodged in the cavity of the abdomen - here you see the vitellarium of the hen with a number of young ova - a membrane covers half of each of these ova like the husk of the acorn covering the acorn on one half - there is only the vitellus of the egg in the vitellarium, the shell and the albumin are got as it passes through the oviduct - this egg in the oviduct has you see organised a soft shell and contains a quantity of pure air in the upper part of the egg - the oviduct changes in organization at the part at which the egg rest as it passes along towards the cloaca - the racemus is that bunch of small ova, compared to a bunch of grapes, lying close to the spine.

39th Lecture. [Friday 29 June, 1821]

Progress of the chick during incubation - recapitulation of the former statements respecting the formation of the chick - extrauterine gestation - in the English language laying - we have no word to express the phenomena of life different from the word which expresses the principle of life - but the Greek language has a word ψυχῆ which expresses the living principle- γουσ the intellect - the animal temperature was to the ancients the most perplexing subject and that which excited most

¹²⁷ Common or thornback skate species: *raja clavata*

¹²⁸ Ray fish belong to the Superorder Batoidea

¹²⁹ Marcus Tullius Cicero (106 BC-43 BC) was a Roman philosopher, orator, political theorist and consul. He came from a wealthy municipal family of the Roman equestrian order, and is widely considered one of Rome's greatest orators and prose stylists. <http://en.wikipedia.org/wiki/Cicero>

speculation among them - sensation is felt by animals before the brain is formed and the blood circulates or moves before the heart is formed, therefore these organs cannot be necessary to these functions – Harvey makes the blood the residence of the soul, he ascribes too much to the blood - Mr John Hunter cannot conceive how the soul can reside in a fluid - but we always see the fluids necessary to the manifestation of the phenomena of life - ghosts are always supposed to reside in aerial fluids - we found the brain of quadrupeds differing very little in structure from the human brain, and yet how is it that the brain does not exhibit the same phenomena - of intellect as man - the reason is that the principle which employs the brain is not the same in man and quadrupeds - the brain is merely the instrument employed by the animating principle - the ancients placed in the heart the seat of the animating principle and we see in scriptures frequently the expression of “the thoughts of the heart” - when we ascribe too much to the influence of the brain as governing the whole economy we plunge in the grossest materialism, and therefore the Chemists Chaptal¹³⁰ and Dr Thompson¹³¹ have combated the false opinion which ascribes the phenomena of matter to the properties of the matter and not to a principle distinct from the manner - Physiognomy¹³² began with Heiromancy¹³³ or the act of telling the fortune from the lines of the hand - Dr Saunders¹³⁴ a physician and astrologer of England pretends to tell the fortune from the moles of the body - then they thought of looking to the brain for some more certain index of fortune telling - but physiognomy is always considered as an imposition - Lord Bacon makes a great many very sensible remarks on this subject - the Drs G&S judge from the form and bulk of the organs - but the size of an organ is not always an index of the intensity or acuteness of its action - they pretend that there are 33 organs on each hemisphere or 66 in the whole brain - and they are all placed on the surface of the brain in order the better to pass among the vulgar - according to my friend Sir George McKenzie¹³⁵ there are 66 Tastes, 66 Imaginations, 66 Memories, - I have no objection to the external forms of the head corresponding with a difference of intellectual faculties this may really be established by future observation, and our theories will not be placed in comparison with facts established by actual observation - when the brain is expanded into a medullary neck as we see in Hydrocephalus internus

¹³⁰ Jean-Antoine Claude, comte Chaptal de Chanteloup (1756-1832) was a French chemist and statesman. He coined a new word for the gas then known as 'azote' or 'mephitic air' which quickly passed into English as nitrogen.

http://en.wikipedia.org/wiki/Jean-Antoine_Chaptal

¹³¹ Thomas Thomson (1773-1852) was a Scottish chemist and mineralogist whose writings contributed to the early spread of Dalton's atomic theory. He gave silicon its current name. [http://en.wikipedia.org/wiki/Thomas_Thomson_\(chemist\)](http://en.wikipedia.org/wiki/Thomas_Thomson_(chemist))

¹³² Physiognomy is the assessment of a person's character or personality from his/her outer appearance.

<http://en.wikipedia.org/wiki/Physiognomy>

¹³³ Palmistry or chiromancy (also spelled cheiromancy), is the art of characterization and foretelling the future through the study of the palm, also known as palm reading, or chirology. <http://en.wikipedia.org/wiki/Palmistry>

¹³⁴ Richard Saunders was an English physician and astrologer, born in 1613, and who died either in 1675, 1687, or 1692.

The National Archives in London hold a book by Saunders on palmistry, with horoscopes; also attributed to him is *The Astrological Judgment and Practice of Physick*, published in 1677, although the fact that it includes charts from as early as 1616 to 1618 has led doubts to be cast on the actual authorship. http://en.wikipedia.org/wiki/Rider%27s_British_Merlin

¹³⁵ Mackenzie, G.S. (1817), *An Essay on some Subjects connected with Taste*, Edinburgh: Caledonian Mercury Press.

http://en.wikipedia.org/wiki/Sir_George_Steuart_Mackenzie

the organ must be all destroyed no distinction of organs is observed - the difference of faculties depends not on the brain, but on the difference of the principle which employs the brain as its instrument -

40th Lecture. [Monday 2 July, 1821]

On the eye - the bullock's eye the terms tunica adnata and tunica albuginea ought not to be applied to any coats of the eye, because these terms are already used in the anatomy for other parts - Dr Porterfield¹³⁶ tried[sic] to introduce the distinction of the tunica adnata from the tunica conjunctiva, parts of the same membrane - in cases of violent hypotalamia red blood vessels advance as far as the centre of the transparent cornea and in these cases surgeons raise a portion of the tunica conjunctiva and cut the blood vessels across - the optic nerve in quadrupeds is surrounded by the musculus suspensorius which wanting in the human species - the eye has a rotatory motion not very perceptible on an axis passing through the eye from before backwards (*this is a gross absurdity which the Dr has resolved to cherish tho[ugh] I have repeatedly shown its absurdity*) - the cornea becomes of a bluish opaque colour when we press hard upon the eye - when I first observed this I imagined I had made a discovery, I imagined I had injected the mercury into the vessels of the transparent cornea which had not hitherto been done - Dr Porterfield pretends that the tunica conjunctiva is continued over the transparent cornea, but this is a mistake as it terminates at the commencement of the transparent cornea - it does not adhere to the eye at any other part than just close around the cornea, behind that the tendons of the muscles lye between it and the sclerotic coat - the iris is composed of two membranes the external layer is properly called iris from the variety of its colours the internal layer is called the musa - the Iris divides the aqueous humour into the anterior and posterior chambers - the ciliary processes are the loose terminations of the choroid coat in the posterior chamber of the aqueous humour.

41st Lecture. [Tuesday 3 July, 1821]

On the eye. A blood vessel seen in the bullock's eye running round the anterior termination of the retina near the ciliary process - the retina distinctly terminates at the commencement of the ciliary plicae - Dr Monro first imagined that the retina terminated at the commencement of the ciliary plicae, but he afterwards changed his opinion and asserted that the retina went forward under the plicae and terminated at the lens. Hallen adopted this last opinion but he again changed to Dr Monro's first opinion - by dividing the bullocks eye through the middle at right angles to the

¹³⁶ William Porterfield (ca. 1696-1771) was a prominent Scottish physician and an authority on vision; he devised the first optometer and examined accommodation after cataract operations. <http://www.byassrarebooks.co.uk>

visual plane, and looking down through the humours to the anterior termination of the retina we distinctly see it terminate at the outer termination of the ciliary plicae - example of the veins and arteries seen ramifying on the retina in the recent eye of the sheep - example of the retina seen terminating at the commencement of the ciliary plicae by a well defined smooth margin in the sheep's eye - the circle of Petit does not communicate with the cavity of the capsule of the lens - by simply puncturing the capsule of the lens the lens starts out of its cavity, but the air does not escape from the circle of Petit - Dr Porterfield imagined that the ciliary processes were of a muscular nature and that they and the ciliary ligament lay before the lens and that they pulled the lens backwards so as to accommodate the eye to near and distant objects - but this whole theory was founded on a false supposition of the situation of the ciliary ligament and processes, which in reality lie behind the lens and pass forward to it whereas he and some others have represented these lying before and passing backwards and to the lens.

42nd Lecture. [Wednesday 4 July, 1821]

On the eye of the cod fish - the skin is continued over the fore part of the eye of fishes and is transparent when it passes over the cornea - fishes have no eye lids - the lens of the cod and of most fishes is perfectly spherical - in the ray fish it is not quite the same - Lieuenhoek¹³⁷ supposed that the lens was formed of a fiber rolled up like a clue¹³⁸ of thread - the dried lens breaks into concentric layers, which again are composed of fibres - Dr Brewster¹³⁹ has lately been making some researches on the lenses of different animals the kind of animal may be ascertained from the manner in which the fibres of it run in the formation of the lens - demonstration of the structure of the Duck's egg at the last day of incubation - *nothing new* - the eye brows are peculiar to the human species - the cassowary has some brisly hairs in the place of our eye brows - those who have dark hair on the eye brows and lids have more distinct vision than those who have the hair of those parts of a fair colour - eastern nations darken the hair of the eye brows and eye lids and the Europeans have adopted their practice having found their vision improved by so doing discussion of the extent to which the electric fluid is diffused thro[ugh] nature - the electric fluid is the cause of the evaporation of water because that takes place below the temperature of 32 degrees Fahrenheit - the eye lids may serve some important purpose of an electric nature of which we can at present give no explanation - the study of electricity has too much neglect by the chemists and left generally to the province of the Natural Philosophers - the hair the pubes and arm pits promotes the evaporation of the fluids secreted in

¹³⁷ Antonie Philips van Leeuwenhoek (1632-1723) was a Dutch tradesman and scientist. He is considered to be the first microbiologists. http://en.wikipedia.org/wiki/Antony_van_Leeuwenhoek

¹³⁸ Variant of clew ("a ball of *thread* or yarn"), from Middle English clewe

¹³⁹ Sir David Brewster 1781-1868) was a Scottish physicist and mathematician. He was most noted for his contributions to the field of optics. http://en.wikipedia.org/wiki/David_Brewster

these parts, and old wives aware of this circumstance then dust on these parts in young persons whom these hairs are not yet formed, in order to promote the absorption of secreted fluids the eye lids serve to diminish the quantity of light admitted to the retina - the eye lids fall of themselves when we are about to fall asleep - in man the upper eye lid is the most moveable, but in the lower animals the lower eye lid is the most moveable - the membrane nictitame is in birds the same as the eye lids in other animals, and throwing this thin membrane over the transparent cornea they can moderate the quantity of light in the higher regions of the atmosphere - and in birds¹⁴⁰ which dive from a height into water use this membrane to preserve the eye from the violence of the impulse of the water - Drs Gall and Spurzheim pretend to judge of the intellect from the distance of eyes from each other or in other words from the thickness of the nose.

43rd Lecture. [Thursday 5 July, 1821]

On the eye - every species of animal which has eyes at all has at least two eyes - from the position of the human eyes we can take in the whole horizon in the twinkling of an eye - the horse, the cow &c see the objects placed latterly to them only with one eye till they turn their whole body - the spider¹⁴¹ has eight eyes, so that it does not require to turn his head, and it has these eyes of a dim colour so as not to be perceived to be eyes by the unwary fly - the spider also perfectly counterfeits death by its stillness and sees the movement of the smallest thread of its web - the crab fish has its eye placed at the extremities of two firm pedicles which project beyond the surface and which it can move with the greatest rapidity - the great drone fly¹⁴² microscopically examined by the Hook¹⁴³ and found to have nearly 14,000 eyes - the Dragonfly¹⁴⁴ has still more eyes and these eyes adapt to see objects at different distances these animals have that number of eyes because they cannot turn their eyes to different objects from wanting muscles, and because they cannot accommodate them to different distances they are constructed originally only to see objects at fixed distances - they have no lachrymal gland - and from wanting eye lids they employ their arms which are covered with a fine hair to brush their eyes as we see the flies on our windows every day - the human eye accommodates itself to different distances by the accumulation of the aqueous humour which is occasioned by the compression of the muscles on the veins which carry the blood from the eye back into the cranium - and it would appear that the venous [sic] blood is returned from the eye back into the cranium solely for the purpose of being exposed to the compression of these muscles,

¹⁴⁰ Barclay is probably referring to the Gannet: *Morus bassanus*

¹⁴¹ Spiders belong to the order Araneae

¹⁴² The great drone fly is the European hoverfly species: *Eristalis tenax*

¹⁴³ 'The Hook' seems to be how Barclay refers to his microscope. Probably after Robert Hooke (1635-1703) the English natural philosopher, architect and polymath. Robert Hooke wrote *Micrographia*, the first book describing observations made through a microscope. http://en.wikipedia.org/wiki/Robert_Hooke

¹⁴⁴ Dragonflies belong to the infraorder Anisoptera

otherwise the blood would naturally have passed over the face the most direct course towards the heart - I know that this theory of mine has been objected to and I think it very natural for those who do not know the structure of the eye and cannot conceive how the blood is retarded in its course back wards, to say that this can be the means by which the eye accommodates itself (*this is a contemptible sneer at my opinion of the muscles of the eye compressing the eye and lengthening the axis, which I have often explained and demonstrated to the Doctor*) the owls¹⁴⁵ eye is contracted or compressed by the muscles of the eye when a light is suddenly presented to that bird, and we hear the crackling noise of the osseous plates of its eye from the compression of the muscles those animals which see in the strongest light have the darkest pigment for the purpose of absorbing the wandering rays of light and then rendering the image more distinct - those animals which see in the dark have a brilliant metallic-like surface of the choroid coat near the optic nerve for the purpose of reflecting and accumulating those wandering rays of light.

44th Lecture. [Friday 6 July, 1821]

On vision. The Retina, and not the choroid coat, is the part of the eye which perceives the impressions of light - the image according to Bercley¹⁴⁶ is formed inverted on the retina - but no one has yet proved this to be the case in the living eye - and even tho[ugh] the image were properly formed on the retina (which no one has proved), this does not at all explain the theory of vision. what perceives that image on the retina? Is there an eye behind the retina to perceive or in the brain? - there are pontes asinorum¹⁴⁷ such as those which only asses would passes[sic] over - (*the Doctor's usual excuse for ignorance, or laziness to examine*). the image of one object falls upon parts of the retina which do not correspond and we see the object single - for while one image falls on the temporal side of one eye that image falls on the nasal side of the other eye - indeed we cannot give any explanation how we see objects singly when we have two images of them form on the eyes - when we keep the eye steadily fixed on a wafer of a certain colour we come at least to see that wafer of a different colour, that accessory colour being exactly the reverse of the true colour of the wafer and in the circular spectrum the accessory colour is exactly opposite to the original colour - in the northern nations the Esquamaux¹⁴⁸ are apt to become blind from gazing perpetually on the snow, and the Esquamaux use a kind of wooden spectacles to moderate the quantity of light transmitted from the snow to the eye - these spectacles of the Esquamaux are merely pieces of

¹⁴⁵ Owls belong to the order Strigiformes

¹⁴⁶ George Berkeley (1685-1753), also known as Bishop Berkeley (Bishop of Cloyne), was an Irish philosopher. Berkeley, G. (1709), *An essay towards a new theory of vision*. Dublin: printed by Aaron Rhames, for Jeremy Pepyat.

http://en.wikipedia.org/wiki/George_Berkeley

¹⁴⁷ 'pontes asinorum' is the plural form of 'pons asinorum': a problem that severely tests the ability of an inexperienced person.

¹⁴⁸ Eskimo or Inuit: Northern peoples

wood perforated with small slits, and Professor Jamison¹⁴⁹ has some specimens of these spectles [sic]- we now proceed to contents of the thorax and abdomen Cicero approached nearer than any of the ancients to the true theory of animal temperature, and said that heat was the cause of fluidity in bodies and existed in all bodies in a latent state, thus approaching to the discovery of latent heat made by Dr Black¹⁵⁰ - Hippocrates supposed that the left auricle served as a pair of bellows to keep alive the fire contained in the left ventricle - but Cicero objected to this that the fire contained there was not like the culinary fire but a vital fire which did not require the presence of fire

45th Lecture. [Monday 9 July, 1821]

The ψυχον or intellectual principle of the ancients was situated in the pit of the stomach and hence the nerves seen spreading on the Diaphragm are now called the Phrenic nerves - these nerves are affected in inflammation of the liver when the disease extends to the diaphragm and in the cases we feel a pain extending to the right shoulder, because these nerves come down from that quarter - Those animals which have a great extent of motion (of flexion and extension) have a proportionally great number of lobes of the lungs and of the liver - the parietes¹⁵¹ of the thorax both expand and collapse more rapidly than the lungs themselves the triangularis sterni muscle on the inside of the sternum more distinctly seen in the dog than in the human species - the thymus gland large in the dog - larger in in the foetus than in the adult where it seems to have been partly absorbed - this gland is larger in hybernating animals - the functions of the thyroid, the thymus, the suprarenal glands, and of the spleen, are unknown - the vena cava superior and inferior should be in the lower animals called the anterior and posterior - you see here blood oozing from the trachea which comes from the lungs - this shows that the carbonaceous matter may also easily pass into the cavity of the lungs from the branch of the blood vessels spread there - discourse on the opinion of the ancients about the source of animal temperature - Hierophilus and Erysnstratus¹⁵² first showed that the brain and nerves were the source of motion and of sensation - from the time of Galen it was supposed that the black blood and the red blood met in the head and there formed the animal spirits, and it returned to the lungs and met there where they formed the vital spirit then met in the abdomen and formed the natural spirits - the discovery that arteries contain blood was a great discovery in those days - they had been called ἀγγεῖα or air-vessels from being supposed to contain part of the spirits

¹⁴⁹ Professor Robert Jameson (1774-1854) was a Scottish mineralogist and naturalist. He was Regius Professor of Natural History at Edinburgh University for fifty years. http://en.wikipedia.org/wiki/Robert_Jameson

¹⁵⁰ Joseph Black (1728-1799) was a Scottish physician and chemist, known for his discoveries of latent heat, specific heat, and carbon dioxide. http://en.wikipedia.org/wiki/Joseph_Black

¹⁵¹ A wall, as of a hollow organ.

¹⁵² Erasistratus (304 BC-250 BC) was a Greek anatomist and royal physician under Seleucus I Nicator of Syria. <http://en.wikipedia.org/wiki/Erasistratus>

of fire of the left side of the heart - the ancients had taken up this notion from finding the arteries always empty after death and the blood accumulated on the right side of the heart in the veins.

46th Lecture. [Tuesday 10 July, 1821]

The heart of the quadruped is placed nearer the mesial plain than in man - Galen first demonstrated that the arteries contained blood - the three kinds of spirits of the head the heart and the abdomen were under the direction of three kinds of faculties the animal the vital and the natural faculties - the lesser circulation through the lungs was ascribed to Columbus¹⁵³ and also to Servetus¹⁵⁴ - Andrew Cesalpinus¹⁵⁵ knew almost the whole course of the circulation from the right ventricle through the lungs to the right ventricle again, but then he imagined that the blood returned by the same course backwards like the tide between Attica¹⁵⁶ and Euboea¹⁵⁷ - the tide of Euripus¹⁵⁸ Galen supposed that the blood passed thro[ugh] the septum of the heart from one side to the other - the blood to which Homer¹⁵⁹ alludes as issuing from some of his wounded heroes is the black coagulated blood we have here in the right side of the heart, αιμα μελαινα the valve of Eustachius¹⁶⁰ seems like a continuation of the coat of the inferior cava and acts as a valve to the coronary vein - we see this valve much more distinct and more complete in the dog than in the human species the valve of Eustachius serves to direct the blood of the inferior cava as high as the foramen ovale without mixing with that of the superior cava - those whose foramen ovale remains open generally die at an early period of life of convulsions and their muscles are found prematurely relaxed - they have always a difficulty of breathing and are of a livid colour - Lower¹⁶¹ in the year 1660 [sic, 1669] discovered the art of transfusion of blood from one animal into another and immediately after this was published in the Philosophical Transactions of the Royal Society of London¹⁶² this practice of

¹⁵³ Realdo Colombo (c. 1516-1559) was an Italian professor of anatomy and a surgeon at the University of Padua between 1544 and 1559. http://en.wikipedia.org/wiki/Realdo_Colombo

¹⁵⁴ Michael Servetus (1509 or 1511-1553) was a Spanish theologian, physician, cartographer, and Renaissance humanist. He was the first European to correctly describe the function of pulmonary circulation. <http://en.wikipedia.org/wiki/Servetus>

¹⁵⁵ Andrea Cesalpino (1524 or 1525-1603) was an Italian physician, philosopher and botanist. He theorized a circulation of the blood. http://en.wikipedia.org/wiki/Andrea_Cesalpino

¹⁵⁶ Attica is an historical region that encompasses the city of Athens, the capital of Greece <http://en.wikipedia.org/wiki/Attica>

¹⁵⁷ Euboea is the second largest Greek island in area and population, after Crete. <http://en.wikipedia.org/wiki/Euboea>

¹⁵⁸ The Euripus Strait is a narrow channel of water separating the Greek island of Euboea in the Aegean Sea from Boeotia in mainland Greece http://en.wikipedia.org/wiki/Euripus_Strait

¹⁵⁹ In the Western classical tradition, Homer is the author of the Iliad and the Odyssey, and is revered as the greatest of ancient Greek epic poets. These epics have had an enormous influence on the history of literature. <http://en.wikipedia.org/wiki/Homer>

¹⁶⁰ Bartolomeo Eustachi (1500 or 1514-1574), also known by his Latin name of Eustachius, was one of the founders of the science of human anatomy. http://en.wikipedia.org/wiki/Bartolomeo_Eustachi

¹⁶¹ Richard Lower (1631-1691) was an English physician who is most remembered for his works on transfusion and the function of the cardiopulmonary system. Lower, R. (1669), *Tractus de corde*. Londini: Jacobi Allestry; Amstelodami: Apud Danielelem Elzevirium. [http://en.wikipedia.org/wiki/Richard_Lower_\(physician\)](http://en.wikipedia.org/wiki/Richard_Lower_(physician))

¹⁶² Lower, R. (1669), *Tractus de corde; item de motu & colore sanguinis &c. Philosophical Transactions*, 4, 909-912.

transfusion was practiced by all ranks of society in France - Haller called the Tricuspid valve the anulus voloulant - the only valves of the arterial system are those at the orifices of the pulmonary and systemic arteries -

47th Lecture. [Wednesday 11 July, 1821]

The blood of the inferior vena cava must necessarily pass through the foramen ovale in the foetus and not that of the superior cava - the blood of the superior cava can contain no nourishment and therefore the whole nourishment of the foetus must be contained in that of the inferior cava - the blood of the foetus is mostly dark venous blood - there is air secreted into the lungs of the foetus (*absurd*¹⁶³) and the blood of the foetus may undergo some change from this air of the foetal lungs - Thebesius¹⁶⁴ found certain orifices of secreting vessels opening on the surface of the ventricles and supposed this blood passed thro[ugh] this septum to continue the circulation - From the experiment of Sabatier¹⁶⁵ I am inclined to think that the cause of the large size of the right ventricle of the heart is owing to the accumulation of the blood on that side of the heart in articulo mortis and there not in reality much original difference between the two ventricles - all discoveries are made gradually, and many approximations to the discovery of the circulation were made before the time of Harvey - the art of printing made in Germany by Dr Faustus¹⁶⁶ had been approximated by the Chinese and the ancients on their medals and ingravings[sic] - the steam engine was the discovery of mere accident - and the steam boat was approximated by the ships of the ancients, where we see wheels on the sides of these ships in figures of them printed more than 350 years ago - and the Americans first thought of turning these wheels of the ships by the force of steam - Stepheus¹⁶⁷ [sic, Stephanus] had discovered some of the valves even before the time of Fabricius ab Aquapendente - Realtus Columbus was a professor of Padua - Asselius was a native of Brussels and also a professor of Padua - and Harvey was a graduate of Padua - so that the school of Padua has some of the merit of the discovery of the circulation - all the valves of the heart, of the arteries, and of the veins were known before the time of Harvey, but Harvey drew first the conclusion that these must cause the blood to

¹⁶³ A comment from the note-taker Robert E. Grant

¹⁶⁴ Adam Christian Thebesius (1686-1732) was a German anatomist best known for his studies of the coronary circulation. He described the tiny cardiac venous tributaries that drain directly into the cardiac chambers; Thebesius, A.C. (1708), *Disputatio medica inauguralis de circulo sanguinis in corde*. Doctoral dissertation, Leiden.

http://en.wikipedia.org/wiki/Adam_Christian_Thebesius

¹⁶⁵ Raphaël Bienvenu Sabatier (1732-1811) was a French anatomist and surgeon born in Paris; Sabatier, R.B. (1798), *Traité complet d'anatomie, ou, Description de toutes les parties du corps humain*, Théophile Barrois le Jeune.

http://en.wikipedia.org/wiki/Rapha%C3%ABl_Bienvenu_Sabatier

¹⁶⁶ Fausto Veranzio or Faust Vrančić (c. 1551-1617) was a polymath and bishop from the Venetian Republic. It was his idea to use the rotary printing press to alleviate printing difficulty and improve results.

http://en.wikipedia.org/wiki/Fausto_Veranzio

¹⁶⁷ Charles Estienne 1504-1564) was a French anatomist. The family name was Latinized as *Stephanus*. He was the first to detect valves in veins, in the liver. Estienne, C. (1545), *De dissectione partium corporis humani libri tres*. Parid: Apud Simonem Colineum. http://en.wikipedia.org/wiki/Charles_Estienne

pass in a circular manner thro[ugh] the body - *usual eulogiums, comparisons similes and bombast about Harvey*¹ - of the lungs and respiration - Dr Mayo¹⁶⁸ was the first who discovered the oxygen gas. He ascertained many of its qualities - but he accounted for animal heat by the friction of angular particles because this was the hobby of his day - David Ellis¹⁶⁹ has shown that the dark colour of the venous blood owing to the presence of carbonaceous matter and that this carbonaceous matter is excreted into the cells of the lungs where it combines with the oxygen of the atmosphere and passes out again as carbonic acid - but that the oxygen does not enter into blood vessels and there combine with the oxygen - by pushing water thro[ugh] the pulmonary arteries we see it opening from the branches of the trachea -

48th Lecture. [Thursday 12 July, 1821]

Exhibition of the Plates of Dr Mayo - he correctly represents the pneumatic trough with a candle burning under it - in another plate he represents a mouse under this trough - he found that both these destroyed the same part of the air, and the same part of the air which is destroyed by the combustion of nitre - chemical affinities are not sufficient to account for the phenomena of animals life, or to account for the generation of animal heat. - the ancients called the innate heat the *calidum adnatum*, the εμψυτοτ κυφ - Cicero *De Natura Deorum*¹⁷⁰ mentions the cause of animal temperature, and in that passage he has almost anticipated the discovery of latent heat made by Dr Black - the passage from Cicero read and translated - he mentions that even the air, which he considers as the coldest of all bodies, contains heat in a latent state to which it owes its tenacity - mentions that the food is propelled through the intestines by their contractions that the blood circulates in the veins, and the spirits circulate in the arteries (*he having written before the discovery of Galen that the arteries contained also the blood*) - these passages are contained in the second book of *De Nat. Deorum* where he anticipates many discoveries of Nat[ural] Hist[ory] Dr Hook mentions that the air is a universal solvent and thus shares in the discovery of Dr Mayo - Dr Mayo ascertained that there was a principle in the air which supports combustion, and animal temperature, and that this same principle gave the colour to the blood - he found that a little nitre added to black blood gave it the red colour - this principle of the air he called the *Nitrum Aerium* - plants and most insects from the want of external heat fall to the torpid state during the winter - every plant and animal is confined to a certain and fixed range of temperatures within which show it can carry [sic] on its functions - all the animals which live in cold countries have a thick covering of

¹⁶⁸ Mayow [Mayer, Mayo], John (1641-1679) was a physiologist and chemist, who is remembered today for conducting early research into respiration and the nature of air. http://en.wikipedia.org/wiki/John_Mayow

¹⁶⁹ Ellis, D. (1807), *An inquiry into the changes induced on atmospheric air by the germination of seeds, the vegetation of plants, and the respiration of animals*. Edinburgh: J. Murray.

¹⁷⁰ *De Natura Deorum (On the Nature of the Gods)* is a philosophical dialogue by the Roman orator Cicero, written in 45 BC. http://en.wikipedia.org/wiki/De_Natura_Deorum

fur - the human species have a greater range of temperature than many other animals - animals and man too accommodate their bodies to changes of climate and of external temperature -

49th Lecture. [Friday 13 July, 1821]

On the ramifications of the Pulmonic arteries - by injecting water with a syringe thro[ugh] the pulmonic arteries it was shown to issue from the trachea pleurius it does not enter into the pulmonary veins so that the openings of the arteries into the cells of the lungs are larger than their orifices into the veins Cicero maintained that not only the air which is the coldest of all the bodies but that an other body in nature contained a quantity of the calor or element of fire - and the sun and stars were considered as Deities in those days, this fire was supposed to be of divine origin - Lower had observed before Mayo that nitre gave a red colour to dark blood - if oxygen entered at all the blood in the lung it must have passed thro[ugh] the absorbents as nothing enters into the circulation excepting thro[ugh] that medium - it is very absurd to call red blood as we still do arterial blood - it is a relict of the old idea that there were two kinds of blood one circulating in the veins and another kind circulating or moving to and fro in the arteries - and therefore I propose to call all that blood which flows towards the lungs pulmonic blood, and all that which flows from the lungs towards the system systemic blood - all pulmonic blood is thus of a dark colour and all the systemic blood is thus of a red colour - the terms oxygenation, decarbonisation &c are objectionable as implying some hypothesis while the term aerized is less objectionable as implying no theory whatever Cavity of the Abdomen - the omentum - the Greeks call this membrane εκικλοον υχο χονδον under the liver - the omentum of this dog you see is double forming a sac but each of these folds is again double and the blood vessels (which are here transparent carrying no red blood) pass between the folds - the liver has a different number of lobes in different animals - those animals which have a great extent of motion have a great number of lobes both of the liver and of the lungs - χολη bile and δεχομαι to receive for the term choledoeus - no person has yet observed in man or most quadrupeds any cystohepatic ducts or ducts leading directly from the liver into the gall bladder - those ducts however exist in birds - in the Lofius [sic, Lophius]¹⁷¹ we saw the gall bladder at a great distance from the liver lying on the abdominal viscera - the viscera of the abdomen are not only lubricated by the serous secretion of the peritoneum but are also supported by the omentum which is likewise - Serous membrane - all the viscera of the abdomen lye on the outside of the peritoneum and some individuals have been born when the whole viscera were seen lying completely behind the peritoneum - μηδος and ευτεγον in the middle of the viscera - give the name of Mesentery to the membrane connecting these viscera to the spine - parts of intestinal

¹⁷¹ A reference to the angler fish demonstrated first 10th May and again on 30th and 31st May.

canal thro[ugh] which the food passes between the mouth and rectum - the Oesophagus from φερω, οιδω to carry and φαγοσ the food - it would be better to omit the term jejunum as applied to any part of the human intestines and Winslow¹⁷² had actually abandoned this improper term as we know not what part or how much of the intestine may be empty at any time in the living body - Haller asserts that the spleen is present in all animals which have red blood - but there is red blood formed before there is spleen or any other organ.

50th Lecture. [Monday 16 July, 1821]

Specimen of a young seal newly calved with the umbilical cord still remaining this seal is nearly two feet long and 14 inches in circumference round the abdomen and notwithstanding the large size of this newly calved seal the cavity of the pelvis of the largest seal in the museum below is far from being of a size large enough to contain to transmit an animal of this size - and yet the intestines and internal contents must pass through the pelvis - this is to me inexplicable - perhaps the cartilages of the pelvis yield very much as the largest pelvis below stairs has not a cavity large enough to contain my fist - the Thymus gland consisting of two lobes very large in this animal - the arteries coming from the heart in this young seal are quite red with the beautiful plexus of the vasa vasorum - Hewson has remarked that the coagulability of the blood is much affected by the mental emotions - this I think is owing to the vasa vasorum pouring out a greater quantity of serum at one time than at another and thereby rendering the blood more or less thick - there are here three lobes on the left side of the lungs and only two lobes on the right side - the lungs absorb very rapidly [sic] air effused into the cavity of the thorax - Dr Sanderson & I opened the sides of dogs and allowed the air to rush in, the lungs to collapse the respiration and circulation to cease - but on stopping up the perforation the air was very soon absorbed by the lungs, the respiration recommenced and after that the circulation recommenced, but the respiration always began before the circulation - the great sympathetic nerve is called great not from its size (being very small) but from its very extensive communication with the nerves of the body - the omentum here very small - the omentum in old animals contains more fat than in the young of the same species - this membrane is four-fold though it appears as a single membrane - the liver of this animal consists of many lobules as this animal inflects the body much at this part - the urinary bladder in this young quadruped (the seal) has a more lengthened appearance than in the adult, it here resemble a long narrow tube - the small intestines of this animal remarkably long, as though this is a carnivorous animal, living upon fish - the small intestine measures 11 times the length of the animal - in the skate however which is

¹⁷² Jacob B. Winsløw, also known as Jacques-Bénigne Winslow (1669-1760) was a Danish-born French anatomist. Winslow, J.B. (1732), *Exposition anatomique de la structure du corps humain*, Amsterdam: Aux Depens de la Compagnie. http://en.wikipedia.org/wiki/Jacob_B._Winslow

carnivorous the intestine is very short agreeing with the general rule of the intestines being short in carnivorous animals.

51st Lecture. [Tuesday 17 July, 1821]

On the Nerves - Before proceeding with the cavity of the Abdomen I shall merely give you a cursory view of the nerves - the Axillary plexus - these nerves all communicate more or less directly with each other - Scarpa¹⁷³ has ascertained that the nerves of this plexus exhibit varieties in every individual, tho[ugh] their manner of distribution is not the same in any two, tho[ugh] all have the same specific characters - the eighth pair from its extensive communications is called the great sympathetic - issues from the base of the cranium (from the foramen magnum) communicates with almost all the vertebral nerves - *the old story about the poor man wounded in the neck on the Pyrenees* - the nerves are in general distributed on the part adjacent to their course - but the recurrent branch is an exception to this rule, which first enters the thorax then remembers that it should have given another branch to the larynx which it therefore returns to give but it returns after making a turn round the aorta, as if it was intended to be affected by the changes of the circulation, and thus to betray the affections and emotions of the kind which always affect the circulation - so that however a person may try to conceal the outward signs of mental emotions, this nerve will always betray the emotions of the mind by the changes it produces in these cases or the tones of the voice - this I give you merely as an hypothesis, and I am not aware of any other means by which the organs or tones of the voice can be affected by mental emotions - and Bacon has justly remarked that if you wish to know whether a person is in a state of emotion or not, you have only to attend to the voice which can certainly betray the person so affected - involuntary organs are supplied with comparatively few or small nerves, and the voluntary organs have large nerves - the arms have large plexuses of strong nerves while the thorax and abdomen have very small nerves - and so small are the nerves of the heart that they have not yet been traced into that organ - and a Thesis written with the title "*Cor nervis carere*"¹⁷⁴ the nerves of the senses can be traced almost to their ultimate terminations, as in the retina, tongue, &c - we can trace very distinctly large nerves to the very extremities of the fingers - the sense of touch is rendered exquisite by habitual attention to the impressions made upon the fingers, as we see in the blind who have been taught in Paris to read books of very small print simply by carrying their fingers over the letters - Of the viscera of the abdomen - the fat is in greater quantity in the omentum of animals which inhabit cold climates - It

¹⁷³ Antonio Scarpa (1752-1832) was an Italian anatomist and professor. His finest work is considered to be his *Tabulae neurologicae* which was published in 1794, and gave an accurate depiction of the Heart's nerves.

http://en.wikipedia.org/wiki/Antonio_Scarpa

¹⁷⁴ Johann Bernhard Jakob Behrends (1769-1823) was a surgeon at the Anatomical Institute of the Dr. Senckenbergischen Stiftung; Behrends, J.B.J. (1792), *Dissertatio qua demonstratur cor nervis carere addita disquisitione de ve nervorum arterias cingentium*. Mainz.

was the opinion of Harvey and of all before the discovery of the lacteals that the nutritious part of the food was taken [into] the veins spread on the mesentery - this discovery was made on the intestine of a dog - Dogs have suffered very much from physiologists since the discovery of the circulation - and no other animals have suffered more unless we except perhaps the Frogs after the discovery of the Galvanic fluid which became the victims in these cases - (laugh) - opinions of the ancients about the manner in which the nourishment is coming into the blood - Harvey refused to admit the discovery of the Lacteals because he was old and had not the assistance of Highmore¹⁷⁵ to make experiments to convince himself of its truth - discovery of the Lymphatics, which together with the lacteals called generally the Absorbent system.

52nd Lecture. [Wednesday 18 July, 1821]

On the nerves - the great sympathetic the pars vagum, or the Eighth pair sends its recurrent branch round the Aorta which returns to the larynx, and thus affects the voice when the circulation in the Aorta is affected, betraying in this manner the emotions of the mind however much we may try to conceal them - the great intercostal nerve enters a ganglion at the transverse process of the atlas on its sternal aspect - the great intercostal nerve communicates with all the intercostal nerves as it descends, and is smaller than any of these intercostal nerves and therefore is only called Great intercostal on account of these extensive communications - we see several small white lines along the surface of the heart here (in the dog) which are nerves, but these cannot be traced whither here or in man into the substance of the heart - *usual long story about the want of the definite article in the Latin language, and the consequent embarrassment of Haller's translators to know whether ramus transversus was the transversus branch* - story about the high division of the humeral artery as established in the notes to the Doctors book on the arteries¹⁷⁶, *and as frequently repeated in his course of Anatomy every winter*. Stomach - cardiac orifice next the oesophagus, the pyloric orifice next the small intestines - manner of showing the peritoneal coat of the intestines by inflating a portion and scraping its surface with the scalpel - the muscular coat - the nervous coat improperly so called - anciently however νευρον was applied not only to nerves but to membranes, and even to ligaments Dr Thomson found that by tying ligatures round the intestines of living dogs, the ligature gradually passed from the outer to the inner surface of the intestines, and was discharged with the feces[sic] - abscesses of the liver sometimes make their way through the external parietes¹⁷⁷ of the abdomen and are then discharged - abscesses on the colon take a contrary course passing from the

¹⁷⁵ Nathaniel Highmore (1613-1685) was a British surgeon remembered for his well-written treatise on human anatomy and its accurate account of blood circulation. [http://en.wikipedia.org/wiki/Nathaniel_Highmore_\(surgeon\)](http://en.wikipedia.org/wiki/Nathaniel_Highmore_(surgeon))

¹⁷⁶ BARCLAY, J. (1812), *A description of the arteries of the human body*. Edinburgh: printed for Thomas Bryce & Co.; and Longman, Hurst, Rees, Orme, & Brown; J. Murray, J. Callow; S. Highley; and T. Underwood, London; and W. Duncan, Glasgow.

¹⁷⁷ Parietes - a wall

outer surface to the inner surface of that gut the reason of this difference of the course of these abscesses is because inflammation always follows the course of the arteries, and in the one case they proceed from within outward, which in the colon their vessels proceed from without inward - the inner surface of the intestine is seen to be of a glandular structure, but this requires the part to be prepared or in a state of disease to see properly this appearance - the stomach of the dog lying forward under the action of the abdominal muscles is easily emptied of its contents by vomiting - while in the horse the stomach lies far back and is not easily acted on by the abdominal muscles and horses are seldom seen to vomit - tomorrow being the day of the coronation of his Majesty George the 4th we shall meet here again on Friday.

53rd Lecture. [Friday 20 July, 1821]

You see here the peristaltic motion of the viscera in this young dog killed and still quite warm - the vermicular¹⁷⁸ motion is here remarkably conspicuous and seems to be much more rapid than the descent of the contained matter - the small intestine removed wholly from the animal and laid on the table still retains a little of this peristaltic motion - that is they move as long as they retain any of what Haller has called the Calidum adnatum or innate temperature - the use of the spleen is still unknown and remains an opprobrium. Physiology - the spleen has nearly the same colour as the liver and is abundantly supplied with blood - on this account it was supposed to assist the liver in removing something from the blood - was supposed to afford a supply of blood to the stomach when that organ was distended with food and pressed upon the spleen - thus squeezing the blood out of the spleen as out of a sponge - but it was ascertained that the stomach actually received less blood when distended than when in a relaxed state - because when [we] inject the vessels of the stomach in a relaxed state, and then inflate the stomach we force back our injection from the vessels - Mr Hewson¹⁷⁹ found the red globules of the blood in the lymphatics of the spleen and therefore this was made the organ which formed the red part of the blood - but did not remember that the blood is in motion and of a red colour in the chick before the spleen or any other organ is yet formed - I am however inclined to trust that the spleen may be somehow connected with the formation of red globules, not from Mr Hewson's argument, but from an observation of Haller that the spleen is seen in all animals which have red blood, and in none which have not red blood - more then supposed to be the organ of melancholy - was supposed to assist the organ of germination - the Pancreas is a conglomerate gland or compound gland has small ducts leading from all its component glands to its large central duct which enters the duodenum or first portion of the intestine - the

¹⁷⁸ Having the shape or motion of a worm.

¹⁷⁹ William Hewson (1739-1774) was an English surgeon, anatomist and physiologist. He showed the existence of lymph vessels in animals and explained their function by hypothesizing the existence of a human lymphatic system.
[http://en.wikipedia.org/wiki/William_Hewson_\(surgeon\)](http://en.wikipedia.org/wiki/William_Hewson_(surgeon))

gastric juice accommodates itself to the forms of circumstances and food of the duodenal - carnivorous animals can be taught to live on vegetables which they can't at first digest - we could not at first nor for some time then reconciled to live on the whale blubber or which the Esquimaux has to - and every individual relishes particular sorts of food while he dislikes others emetics taken to relieve bile of the stomach only give a temporary relief and encourage still more the regurgitation of the bile into the stomach - we propel the bile along the intestines but purgative in its natural course in order to prevent the removal of the complaint - the best way to show the fibrous structure of the kidneys is to cut only the outer margins then to tear the halves separate the kidney of the dog is white in the middle and red on the outer parts, while in the man those two parts are much of the same colour.

54th Lecture. [Monday 23 July, 1812]

Birds have no masticating organs are found in the mouth - are said to have no stomach, but only an oesophagus and alimentary canal - but there is a part at the termination of the oesophagus having a great many small glands which I am inclined to consider as the stomach of birds - birds have two air cells under their abdominal muscles which communicate with the lungs, these two cells are separated from each other by a thin septum - the muscles covering these air cells are remarkably thin fine expansions of muscular fibres the liver is also placed in two other air cells which do not communicate with the two abdominal air - cells- there are also two large air-cells in the thorax which extend to the top of the sternum and appear above that bone - the air also enters the humerus by a large perforation at its atlantal extremity - the sternum is not only filled with air but contains many convolutions of the trachea - the intestines - in this bird you see (the sea-duck or Auk¹⁸⁰ from the Bass rock) are coiled round each other in a circular manner like a rope, and these convolutions vary in different animals tho[ugh] they are the same in the same species so that we might ascertain the species of the animal from the manner in which the intestines are convoluted - there are here vessels passing directly from the liver into the gall bladder which do not exist in man and quadrupeds - no stone however large can stop up the gall ducts, because the duct is elastic and can enlarge and does enlarge and allow the bile to pass - besides these stones are almost always of an angular form while the duct is cylindrical the best method of seeing the structure of the lung is to dry them and then examine them.

55th Lecture. [Tuesday 24 July, 1821]

¹⁸⁰ Perhaps the Common Guillemot species: *Uria aalge*

The air cells of the pigeon¹⁸¹ lie behind the viscera in the abdomen - in most birds the air cells of the lungs communicate with the cavity of the sternum - the duck with which we were occupied yesterday uses its wings to force its way down under water, they are specifically lighter than water from their numerous air cells - birds have all small heads in proportion to the size of their bodies, and their organs of mastication when they have any, are therefore placed nearer the centre of gravity - they [sic] thin long neck for the purpose of balancing themselves on their centre of gravity - the red colour is not a character of a muscle because this depends on their blood, nor is their power of contracting on the application of a stimulus a character because involuntary muscles can scarcely be made to contract by any artificial stimulus, nor is the fatigue consequent on their motion a character because the heart continues during life to contract without undergoing any fatigue - the pancreas of the common domestic fowl is of a whitish colour lying between two folds of the intestine - the stomach of the common domestic fowl is a pouch off the course of the intestine like an aneurismal sac lying to one side of the gut - in the pigeon however the stomach or crop lies above the thorax extending on both sides of the oesophagus & when inflated causes that swelling of the breast which we see in most pigeons - after passing thro[ugh] the first stomach in birds the gut becomes very narrow and descends to the second stomach or gizzard - birds might almost be said to have three stomachs because they have the ventriculus succuternatus¹⁸² between the first and second which is a widened part of the intestines with numerous small glandular bodies surrounding it - the gizzard has a dense inextensible lining to prevent its being affected by the sharp spiculae of stones contained in it - in the lower animals when a leg is broken [sic, broken] the animal being then impregnated the leg heals sooner than in another unimpregnated - the reverse is[sic, of] this is the case in the human body - so that in man nature seems to care more about the young than about the mother while in animals she cares more about the mother - and a hen will not lay eggs when its leg is mending or if it lays them those eggs have no shells - no mechanic or chemist in Europe could make that egg in the oviduct either pass up or down that narrow oviduct without rupturing the duct.

56th Lecture. [Wednesday 25 July, 1821]

The stomach of the horse has a corroded appearance on the inside at the cardiac extremity as if it were in a state of disease, which is apt to deceive. In gramminiferous animals the inner surface of the first stomach has a vile appearance - the second stomach [of the ruminant] has a honey-comb appearance on the inside there is a separate groove in the coats of oesophagus for conveying fluids from the first into the second stomach, because the fluids do not require to be detained in the first

¹⁸¹ Domestic pigeon species: *Columba livia domestica*

¹⁸² Proventriculus

stomach for undergoing any change the many-plies¹⁸³ leads from the second [sic third] into the rugous¹⁸⁴ or third [sic fourth] stomach - the gastric juice is secreted in great abundance in this rugous or last stomach, and a small portion of this stomach put among milk very soon causes that milk to coagulate - there is a valvular orifice from the small intestine in man opening into the caput duodenum coli¹⁸⁵ and preventing the return even of water into the small intestine when the peristaltic motion of the intestines is inverted however, as in stercoraceous vomiting¹⁸⁶, the caput caecum no longer acts as a valve, and the hardened faeces are thrown upwards from the distal extremity of the colon to the mouth, but this is a very rare occurrence the peristaltic motion of the small intestine is quicker than that of the large, so that the faeces enter the large intestine still retaining a portion of oliaginous nutritious matter, which however is absorbed during the passage thro[ugh] the colon - and Sir Edward Home has therefore supposed that the adepose matter is formed by the colon - but we see a great quantity of oliaginous matter in whales, porpoises¹⁸⁷ and several other animals which have no colon or large intestines, which militates against Sir E. Homes theory - Demonstration of the skate - the skate has gills like other fishes which receive each a branch from the large artery coming from the ventricle - these arteries after passing thro[ugh] the lungs or gills reunite and form the large systemic artery - the liver here as in fishes of a pale colour -

57th Lecture. [Thursday 26 July, 1821]

The alimentary canal of the lamper eel¹⁸⁸ long straight and twisted in a spiral form with a very wide oesophagus the wool which the sheep swallows gathers into knots - specimens of balls of hair taken from the stomachs of horses, and knots of hair taken from sheep - Dissection of the cod - has four gills - the arteries run along a groove in the proximal surface of each gill intestine of the skate runs in a spiral manner like the turnings or windings of a turnpike stair - heart of the cod with three sides somewhat of a prismatic form, not the same as the skates heart - no epiploon¹⁸⁹. the greater part of the liver here is on the left side, being the reverse of the human - a quantity of effused coagulated blood over the viscera from the rupture of veins which in fishes are very delicate - the liver of fish of a very light colour and if the ancients had attended to this circumstance they would not have imagined the liver to be the organ of sanguification¹⁹⁰ - no pancreas in the cod, but numerous

¹⁸³ Omasum

¹⁸⁴ Abomasum

¹⁸⁵ The start of the large intestine.

¹⁸⁶ Faecal or stercoraceous vomiting is a kind of emesis, in which partially or fully digested matter is expelled from the intestines into the stomach, and then forcefully expelled from the stomach up the oesophagus and out through the mouth. <http://en.wikipedia.org/wiki/Vomiting>

¹⁸⁷ Harbour porpoise species: *Phocoena phocoena*

¹⁸⁸ River lamprey species: *Lamprey fluviatilis* and sea lamprey species: *Petromyzon marinus*

¹⁸⁹ The greater omentum

¹⁹⁰ The production of blood; haematopoiesis.

radiated glands surround the oesophagus which correspond with the pancreas in other animals - the intestine here has only three folds, one going down to the lower part of the abdomen, another fold mounts upwards and the last fold goes down to the rectum - many living worms lying over the intestines the cod is a very voracious animal, I have seen a dozen herrings¹⁹¹ (young herrings) in the stomach of a cod, and some of these not at all digested - there is little blood but much oliaginous matter in the cods liver this cods oil has been recommended by old wives as cure for rheumatism and vermin lice, millipedes & spread on bread and butter has been recommended by them as a cure for jaundice (a laugh) - a large air bag or swimming bladder in the cod communicating by two long white tubes with the gills - within this swimming bladder of the cod are two red glandular-like bodies which perhaps secrete the air of the swimming bladders - the cod has a power over the bladder and lives generally at the depth of twenty fathoms¹⁹² - and when raised out of that great depth it is often choaked[sic] by the expansion of this bladder from the want of the usual pressure.

58th Lecture. [Friday 27 July, 1821]

There is a black spot on the back of the haddock¹⁹³ which is seen in every specimen of this fish. The makrel¹⁹⁴ one of the most beautiful fishes in the market having a shining metallic lustre over its whole surface - the anus of the haddock is nearer its anterior than its posterior extremity, while the anus of the makrel is nearer the tail extremity - the part below or backward from the anus is the principal organ of motion of these fishes and the part of their body most flexible - the makrel has an oesophagus, a large stomach, and a straight intestinal canal leading from the stomach to the anus - this is a very voracious fish and runs very quickly into putrifaction so that in London they are not allowed to be sold on Sunday because they will not keep about a dozen unidentified young fish taken from the stomach of the makrel - a thin and transparent membrane running down to the abdomen along the back bone marks the situation of the swimming bladder in the herring - this swimming bladder can be taken entire from the body of the herring and preserved inflated, which cannot so well be done in the cod fish. The crab and the lobster¹⁹⁵ have teeth in their stomach for the mastication of shells and other hard parts which are often found in their stomachs - Having examined the contents of the different cavities of the body of animals we shall now employ a lecture or two on the circulation of the blood - Harvey ultimately ascribed too much to the blood making it to be something divine, and was led thus into a mistake supposing that the organization of the animal only common with the appearance of the red blood - Andrew Cesalpino knew nothing about

¹⁹¹ North sea herring species: *Clupea harengus*

¹⁹² A unit of length equal to 6 feet (1.83 meters), used principally in the measurement and specification of marine depths.

¹⁹³ Haddock species: *Melanogrammus aeglefinus*

¹⁹⁴ Atlantic mackerel species: *Scomber scombrus*

¹⁹⁵ European lobster species: *Homarus gammarus*

the true circulation of the blood as discovered by Harvey altho[ugh] he used a language which was applicable to that circulation - he supposed that it returned by the same course during the night that it had taken during the day, like the tide of Euripus between Attica and Euboae - short enumeration of the principal arteries and veins of the human body which are the same in quadrupeds - Haller's figure for showing the arteries is entirely imaginary but is filled up by the most commonly observed distributions - and my book on the Arteries was principally intended to show what was common and what varieties are met with in the arteries of individuals - Haller was much puzzled with the irregularities out with in the arteries of the hands, and has represented first what he saw in one hand then what he met with in another - we always see the greatest number of varieties in the distribution of arteries, and the greatest number of valves in the veins in parts which are most under the influence of voluntary motion.

59th Lecture. [Monday 30 July, 1821]

Description of the Arteries of the human body and Demonstration of several human vascular preparations - In the lower animals the two carotid arteries after entering the cranium without passing thro[ugh] any convoluted canal as they do in man, in these cases as in the sheep &c the arteries exhibit immediately within the cranium a plexus called *rete mirabile*¹⁹⁶, which is merely the artery winding on itself - this *rete mirabile* is not seen in the horse because the carotid passes thro[ugh] a winding canal in the cranium. Columbus could not find this *rete mirabile* of Galen in the human brain because it only exists in certain animals, and therefore he thought it was that placed near the pituitary gland - the pituitary gland was supposed to be the common cloaca by wh[ich] the excrement of the brain passed down into the nose - the blood is determined to particular parts according as necessity requires an additional sensibility in the part at the moment the blood is determined to the eyes, to the tips of the fingers &c as we pay particular attention to the impressions received from these organs the arteries are minutely divided on the arms of the sloath¹⁹⁷ which accounts for the slowness of its motions - in the cat the tyger, and other animals of that feline genus often arteries are minutely divided on the surface of the kidney exhibiting a beautiful arborescent appearance - Haller has demonstrated that the difference of the angle at which the intercostal arteries come off from the aorta, causes the blood in all these arteries to flow with the same momentum - there is a very few anastomoses between all the branches of the mesenteric arteries in order to prevent any interruption to the circulation during the long course of

¹⁹⁶ In some fish, a *rete mirabile* fills the swim bladder with oxygen, increasing the fish's buoyancy
http://en.wikipedia.org/wiki/Rete_mirabile

¹⁹⁷ The two-toed sloth species: *Choloepus didactylus*

the intestinal canal - the sacro-median artery is larger in those quadrupeds which have long tails, it is small in the human species because there are few coxygeal vertebra - the frontal branch of the ophthalmic artery is largest in the foetus because the cranium at that period bears a large proportion to the size of the bones of the face - the nasal branch of the frontal artery is however the larger branch in the adult because there the face bears a larger proportion to the size of the cranium - we can never demonstrate the millionth part of the blood vessels ramified on a part by means of artificial injections, because the minor branches which are by far the most minute do not admit the injecting matter nor even the red globules of the blood.

60th Last or concluding Lecture. 31st July 1821

We cannot inject the veins to the tips of the fingers as we do the arteries, because we inject the veins from the branches towards the trunks and we could not employ pipes so small as to enter these minute veins - whereas the wax thrown into the arterial trunks penetrates very minute branches on the tips of the fingers - in toothache we feel the arterial pulsations in the teeth from the exquisite sensibility of the parts at that time - most of the arteries have two venae satellites accompanying them - the surgeon generally causes the patient when his vein is bleeding to squeeze something in his hand in order to compress the deep seated vein and direct the blood towards the surface and old people have larger subcutaneous veins because their integuments are more lax and press less upon these veins - the blood of the left side of the body in the veins must all cross the mesial plain before arriving at the heart - so that the venous blood has not so from a circulation on the left side of the body as on the right side - and hence all animals are instinctively led to employ the right side more than the left - and it would appear from Morgagni's¹⁹⁸ cases that diseases are more frequent on the left side of the body where the venous circulation is a little more retarded than on the right - venous congestions sometimes take place on the spinal marrow, because the blood in the venous canals is there out of the influence of any muscular motions - in Fishes the brachial arteries send branches to the extremities of all the small feathery parts of the gills, where they again unite and form the continuation of the aorta - Previous to the time of Harvey the arteries were considered as the only absorbents, and he was entirely ignorant of the Lymphatic circulation - Mr Kerr of Aberdeen¹⁹⁹ has published with a view to refute the existence of such a circulation as discovered by Harvey - demonstration of the Lymphatic exhibition of the drawing of the full size

¹⁹⁸ Giovanni Battista Morgagni (1682-1771) was an Italian anatomist, who set the fashion towards exact anatomical observation and reasoning. http://en.wikipedia.org/wiki/Giovanni_Battista_Morgagni

¹⁹⁹ George Kerr (1786-1826) was a Scottish surgeon; Kerr, G. (1816), *Observations on the Harveian Doctrine of the Circulation of the Blood*. London: printed for Longman, Hurst, Rees, Orme, and Brown; Edinburgh: T. and G. Underwood; Aberdeen: Brown and Co. <https://archive.org/details/observationsonha00kerr>

lymphatic preparation by Mr Fyfe²⁰⁰ - *usual encomium*²⁰¹ on that preparation, as the greatest undertaking ever attempted in Anatomy - exhibition of the Plates of Cruikshank²⁰² giving a better view of the lymphatics - exhibition of the plates²⁰³ of the celebrated Mascagni²⁰⁴ - he exhibits Lymphatics on the brain which no other anatomist has been able to find - but this is only because none have had his opportunities of finding them - he had the command of an Hospital and selected dropsical patients - he had exquisitely fine instruments and knew perfectly how to use them - Mascagni destroyed his preparations immediately after causing correct copies of this to be taken because the mercury very soon ran out of them - thus we have viewed in a superficial way the contents of the different cavities of quadrupeds birds and fishes I have avoided dwelling on my favourite hobbies the muscles and blood vessels because they require a long time to learn and because our time was very limited we have examined more attentively what was most interesting in a comparative view, the skeleton, the Brain, the Eye, the contents of the thorax and abdomen - I must now thank you for the very gentlemanly manner in wh[ich] you have always conducted yourselves here and for the regularity of your attendance - and I hope that tho[ugh] we now part as pupils and master we shall still see each other as friends - so Farewell gentlemen, and God bless you all.

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²⁰⁰ Andrew Fyfe the elder (1754-1824) was a Scottish anatomist appointed 'dissector' to Monro secundus in 1777. For about forty years he superintended the dissections and gave demonstrations in the anatomical school under Munro primus, secundus and tertius. http://en.wikipedia.org/wiki/Andrew_Fyfe_the_Elder

²⁰¹ Encomium - a speech or piece of writing that praises someone or something highly.

²⁰² William Cumberland Cruikshank (1745-1800) was a British chemist and anatomist. Cruikshank, W.C. (1786), *The Anatomy of the Absorbing Vessels of the Human Body*. London : Printed for G. Nicol. http://en.wikipedia.org/wiki/William_Cumberland_Cruikshank

²⁰³ Paolo Mascagni's *Anatomicae universae iconae* consists of 88 plates. Forty-four are hand-coloured lithographs of anatomical preparations and 44 are outline plates containing nomenclature for identifying the anatomical parts in an accompanying volume of text. <http://sdr.lib.uiowa.edu/exhibits/imaging/mascagni/imaging/imaging.html>

²⁰⁴ Paolo Mascagni (1755-1815) was an Italian physician. When he became a prosector at Siena he studied mainly the lymphatic vessels of the body; Mascagni, P. (1787), *Vasorum lymphaticorum corporis humani historia et Iconographia*. Senis: Carli. http://en.wikipedia.org/wiki/Paolo_Mascagni