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On the Anatomy and Development of the Placenta

The Process of generation as we rise in the Animal scale becomes more and more complex. Thus we observe that in the lowest forms of animal life there is no "differentiated generative system" at all. In them reproduction is effected by fission and gemmation; and all the parts of the animal contribute alike to the performance of the act. Ascending a little further we find distinct traces of a reproductive system of organs, which in the higher forms of invertebrate life become abundantly palpable. Still even among them the organs of reproduction, when contrasted with those of the mammalia, are simple. Testes and ovaries, the bare necessities of bisexual generation exist, but none of the permanent system of accessory organs which play such an important part among higher animals. All, or at all events nearly all these changes in the ovum, which result in the formation of the foetus, take place out of the parents body.

Comparative Anatomy and Physiology have also shown that there is a proportion between the Psychological manifestations, together with the complexity of organization in the adult animal, and the care with which it is elaborated in the maternal parent. In the invertebrata we either find no accessory generative organs at all, or, when traces of them do occur the part which they perform is almost of no importance whatever. This remark holds good with some of the lower invertebrata. But among the higher animals of the
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last division and more especially in the class mammalia we not only find a permanent system of accessory generative organisms, whose functions are essential to the development of the foetus, but also a number of temporary organs called into existence at each pregnancy and terminating their functions and existence together at parturition.

These like the other systems we have noticed are generally found more highly developed as we ascend in the animal scale; and it is in man that their anatomical structure is most highly organised and that their function assumes its greatest importance.

It is the placenta, - one of the most important of these organs, which forms the subject of this Essay.

The Placenta first called so by Gallapius is found in all the mammalia with the exception of the Marsupial and Monotreme Animals, and also in some cartilaginous fishes. It is variously modified in the different classes and species of animals, but is always constructed on the same plan.

The human Placenta is a bulky flattened mass. Even when healthy and at full time its size may vary a good deal; but in general its diameter is from six to eight inches; its thickness is about an inch and a half, and it is bevelled off slightly at its edges. The Umbilical cord connects it to the foetus while by the other surface it is attached to the mucous membrane of the Uterus. There is no part of this into which it is not liable to be inserted, but its site is generally in the neighbourhood of the Fallopian tubes.

The shape of the Placenta is subject to considerable

variation


variation. Though generally of a roundish form, it may be oval triangular or irregular; and sometimes there is a small process jutting out from the main part by itself.

The surface which is applied to the Uterus is convex when in situ. This is somewhat rough being marked by numerous furrows which divide it into masses variously called cotyledons or lobules. On this aspect until the Decidua serotina has been removed there is no appearance of bloodvessels.

The free surface of the placenta which in the natural state is covered by the Chorion, is concave. On it the ramifications of the Umbilical Veins are apparent. Its texture here is firmer and smoother than on the other side.

Hitherto we have been considering the Placenta as a single organ, but now we must look upon it as naturally divisible into a foetal and maternal part. We will now consider the foetal portion.

This is the part into which the Umbilical cord is inserted and it consists mainly of the ramifications of the Umbilical Vessels with possibly a minute quantity of connective tissue. It is covered internally by the Chorion and externally is in close relation with the maternal portion of the Placenta. The Umbilical Arteries immediately on entering it divide, and these divisions subdivide until they form a vast plexus of Vessels differing but little in structure from ordinary capillaries. These minute subdivisions terminate in the Umbilical Veins, and have no connection by tubular continuity with the Vascular system of the Mother. This is proved by the fact that

that when the Umbilical Artery is injected with care, the Umbilical Vein is also filled to some extent, while the Uterine Vessels are not so, unless some of the Vessels in the axis of the foetal Placenta have given way; and then traces of this have always been found when carefully sought for. It is only however fair to state that when water or some such fluid was used in experiments of this nature, not only were the Veins filled but also the Uterine Vessels. But then this only proved that the coats of the ultimate capillaries were so thin and in so close a connection with the Uterine Vessels as to permit the free absorption.

This is further confirmed by the circumstance that there is a considerable difference between the size of the red blood corpuscles of the foetus and Mother. The comparatively greater number of white corpuscles in the blood of the foetus also supports this view. For, if there were any direct communication between the two systems of blood vessels, it would be reasonable to conclude that as the blood sent to both was elaborated in the same place it would be identical in every respect; but if not so, then on physiological considerations alone we are shut up to the conclusion that the blood of the foetus has no direct channel of communication with that of the Mother.

By far the most complete refutation of this erroneous theory however is that furnished by Reid and Goodair. It consists in following the ramifications of the Umbilical Arteries to their termination in the Umbilical Veins & so demonstrating that they are continuous, and that neither are continuous with the Vessels of the Uterus. —

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It has been stated above that the Umbilical Arteries divide and subdivide forming complicated convoluted masses, which at last send in Vessels resembling capillaries. These are arranged in tufts or "barguets" and are again subdivided by the Chorion which lines the external as well as the internal surface of this organ into villi. The Chorion passes for some distance between each Villus, separating it from the adjoining ones, being reflected from tuft to tuft, and completely severing both from the Decidua Serotina. The minute vessels which form the tufts and villi are like ordinary capillaries in as much as they are interposed between the Umbilical Arteries & Veins and also in having only one coat proper to themselves, although several others are interposed between them and the parts of the Mother. But they differ from true capillaries in being of a much larger diameter, permitting according to Mr Goodwin from four to six blood corpuscles to pass abreast. They further differ in being of unequal calibre in different parts of their course.

In the foetal part of the Placenta there are none of these Cells which Hunter described as being filled with blood from the vascular system of the Mother and from which he imagined the tufts absorbed nutrient materials for the growth of the foetus. There is also very little if any cellular or connective tissue.

A tuft when examined under the microscope in low power has an appearance not unlike "a tree". According to Mr. Goodwin the main Vessel gives off others, and these in their turn subdivide into branches still more minute, which form villi. These villi which are given off near the termination of the Main Vessel have
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generally a "digitate" or palmate arrangement. Those which are given off later and in the early part of its course are usually "solitary". Both sets of villi are somewhat flat but the palmate series are more so than the "solitary" ones, and in them it may be carried to such an extent as to give them a "heartshaped" appearance.

In the centre of the villi the placental capillaries ramify. Their arrangement differs considerably in different villi. A capillary may enter a villus, leave by making an abrupt convolution and pass on to another. This may be repeated several times before it enters a vein. Other unimportant variations have been described by Mr Goodair, the main point of difference consisting in the number of vessels entering the villus, their mode of ramifying, subdividing and anastomosing in it, and the number of vessels by which they return. When a vessel divides within a villus the diameter of each of the branches is equal to that of the trunk from which they spring. According to Mr Dalrymple each capillary just before emerging from the villus undergoes a slight enlargement of its calibre, but this is denied by Mr Goodair who asserts that it retains "throughout the same mean diameter". On purely theoretical considerations Mr Dalrymple's view appears the more probable one, and it is strengthened by the fact that it is founded on observations made on injected Placentae, while in those of Mr Goodair those examined were uninjected. And as the outline and calibre of a vessel are much more distinctly revealed when it is injected than when in a collapsed state, it is extremely probable that Mr Dalrymple's view is the correct one.

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In the villi the capillaries are found to exhibit considerable variation in their more minute arrangements. The vessel may form what Mr. Goodeir has called "the simple loop," that is "it turns" sharply "on itself" not leaving any space between the two parts. Or it may be like the preceding in everything except the turn, which is wider so as to enclose a space. The third and fourth varieties described by Mr. Goodeir differ respectively from the first & second only in having an undulating course. The characteristic of the fifth variety lies in its being contorted at what may be called the fundus of the villus. The vessels may assume other forms, which however are unimportant. They also influence the shape of the villi to a considerable extent.

Within the villus and between the capillaries & chorion an internal membrane of Goodeir is a layer of nucleated cells. He has called them "the internal layer of cells" to distinguish them from the external, which will be described in connection with the maternal portion of the Placenta. They differ in no respect from ordinary cells, consisting of an external wall, an internal nucleus and a fluid mass placed between. Their form is oval and the substance contained in their interior is transparent and refracts light strongly. The most striking peculiarity which is exhibited in this layer is the presence of what Goodeir has called germinal centres. From these centres, cells are developed which supply the loss occasioned by the dissolution of those which have performed their functions. This interesting fact shows that they have some important purpose to serve,

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since nature makes such a provident provision for their permanent supply. We must also bear in mind another circumstance which moreover leads to the same conclusion, that the importance and activity of cell function generally depends upon their evanescence, not on their stability. The secreting Cells of the Salivary have but a short existence, yet they perform a constant and most active duty in the animal economy; and many other examples might be cited to prove the truth of this remark.

Exterior to these Cells and confining them in the interior of the Uterus is a membrane, which has been noticed briefly before. It is the most external of the foetal structures which constitute the Uterus. As has already been stated it is a layer of Chorion derived from the outer part of that membrane. By its internal surface it adheres firmly to the layer of cells internal to it. The external surface though generally in contact with a cellular layer belonging to the maternal structures, does not stick to it, and in some places spaces intervene between them.

The maternal portion of the Placenta will next be described. As the foetal part was seen to consist of the Chorion, so this may perhaps somewhat loosely, be said to consist of the decidua serotina. It may be divided into three layers; first, an external which is cellular in its structure, and lies on the Wall of the Uterus; secondly, an internal layer in contact with the Chorion of the foetal part of the Placenta; and thirdly, of an intermediate vascular layer.

Before proceeding to speak of each of these in detail; it would be advisable briefly to examine the Account given by the

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Hunter's of this part. They shewed first, that the Placenta consisted of a maternal and a foetal portion which were distinct from one another having no channel of intercommunication; secondly, they described with their usual accuracy the course of the ~~course of the~~ curling Arteries of the Uterus which they represented as opening into a series of cells which from the account they have given closely resembled the lacunary vascular system of some of the lower animals; after having acted while thus extravasated on the blood in the foetal part of the placenta it was returned to the circulatory system of the Mother by the Uterine placental Veins; and thirdly, some processes of these Veins which were continuous with the Uterine sinuses, were found to be in close relation with the foetal part of the placenta.

Modern research, while confirming some of these observations, has disproved others, a more minute description of this part will suffice to shew this

The external parietal or Uterine layer of the maternal decidua, is a structure which consists mainly of cells. Internally to it is the great vascular "Sac" or chamber of the placenta. It is perforated by two sets of Vessels, one of which goes to act upon the foetal part of the placenta, the other to nourish the decidua itself. The vessels pass through it very obliquely.

The vascular part of this organ, has very important physiological functions to perform, and its anatomical structure is beautifully adapted to the due discharge of them. By Dr. Reid it is called "a large Sac". Its walls have only one Coat. Blood is poured into it by the curling arteries and is restored to the circulatory system of the Mother by

by the Utero-placental Veins which are continuous with the Uterine sinuses. How it happens to have only one Coat will be explained when the development of the organ is considered.

The remaining portion of the maternal placenta is the innermost layer of all. It is in contact as mentioned before with the chorion of the foetal part of this organ. Like the parietal layer it consists of cells, but it has no vessels in it. The cells of which it is composed have important functions to serve, and as germinal centres exist, from which new cells are developed it is probable that they are very evanescent, rapidly passing away to give place to new ones. —

Having thus described the anatomy of the two parts of the placenta, the mode in which they are connected will now be considered. We have seen that there is no vascular continuity between the two elements of the placenta; yet it is necessary to the discharge ^{of their respective} functions that they should be in close connection with one another. This is effected by a very beautiful arrangement between the two parts. The delicate tufts of the foetal placenta are prolonged into the "sac" of the maternal part. Its thin Wall has receded before them, so that it, along with the layer of cells interior to it may be considered as the external coat of the foetal villi. We must not forget however that it is a maternal structure.

This Wall and the maternal layer of cells follow the contours of the tufts, being reflected from villus to villus. The tufts of the foetal part of the placenta thus hang down in the arterial blood of the mother, and the two currents of blood are separated by the following structures. Beginning at the foetal part

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of the streams we have first the structureless Wall of the capillary itself; more externally we have the foetal layer of cells, which intervene between the Wall of the capillary and the Chorion; next in order we have the Chorion which is the last of the foetal structures; still more exteriorly to this and forming part of the maternal placenta, we come upon the maternal layer of cells; and lastly we have the thin Wall of the maternal "Sac". Thus the two streams of blood are separated by three membranes, and two layers of cells all of which are extremely delicate. —

The tufts of the foetal part, held down in their situation by the reflections of the Wall of the "Sac". In fact the relation of the tufts to this Wall may be compared to a hand in a glove, the glove representing the Wall and the fingers the villi.

An interesting observation was made by Dr. Reid regarding the manner in which some of the foetal tufts were arranged in the maternal part. He found that some of them could be traced into the "open mouths of the Uterine sinuses". It was only in those which were next the inner surface of the Uterus that they were discovered. Professor Goodsir believes it to be merely accidental, the result of the mode in which the foetal Placenta is formed and to be of no importance physiologically. —

There still remain some structures in the maternal placenta, which perhaps ought to have been described before this. It seems better however to consider them now, when their function will be more apparent, and when consequently their description will be easier and more intelligible.

The tissues alluded to are certain "thread like" substances which

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run from the Decidual layer of cells that line the foetal villi, through the "sac" of the Placenta to the parietal Decidua and the outer Coats of the Uterine sinuses. Those of the foetal tufts which pass into the Uterine sinuses, are connected to interspaces between these sinuses by "thread like" structures. Near these interspaces they have the appearance of "flattened narrow bands". They consist of fibrous tissue which Mr Goodwin thinks is continuous with the outer coats of the Uterine sinuses. As they proceed in the direction of the foetal tufts they become enveloped in the Walls of the sinuses which are reflected over them. Before attaching themselves to the layer of the Decidua which is interior to the Vascular "sac" of the Placenta they become cellular. —

Another set of threads exist which pass from the parietal layer of the Decidua, enveloped in the same manner as the preceding in the Wall of the "sac" to the same layer of the Decidua, but are connected to it, where it lines those of the Villi which do not enter the Uterine sinuses. These threads, and this remark applies equally to the former set, are sometimes stretched between the summits of two Villi of different tufts; sometimes between villus and villus of the same tuft; sometimes two villi are joined by their sides and in short they are connected together in almost every conceivable Way.

These threads when subjected to microscopic examination, are found to be hollow and many have numbers of cells in their interior. At each extremity they expand so as to become somewhat bell shaped. The cells in their interior are continuous on the one hand with those of the parietal Decidua, on the other with those lining the internal surface of the "sac" of the Placenta.

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These threads are thus the connecting link between the two parts of the cellular Decidua.

The function of these threads seems to be to prevent the foetal villi from collapsing and it is hardly possible to imagine a more beautiful or more perfect arrangement for accomplishing this.

Development of Placenta

After impregnation and while the ovum is still in the Fallopian Tube, the mucous membrane of the Uterus begins to undergo a variety of changes which end in the development of the Decidua. The object evidently contemplated in these, is the preparation of that organ for the reception of the ovum - as it were to make it more comfortable especially during the early part of its sojourn there. The Process indeed may not inaptly be compared to the furnishing of a House.

The mucous membrane of the Uterus becomes more highly vascular, and tubular glands which are compound, having in their structure smaller tubes opening into them and radiating out from them in all directions, make their appearance. They pour out a fluid matter containing cells floating in it, which eventually fills the Cavity of the Uterus. In addition to this fluid matter there is developed in the interior a large quantity of epithelial cells, and the same thing also takes place in the interfollicular spaces. From these various elements, the Decidua which lines the whole of the Uterine Wall is developed. In the early part of pregnancy its texture is exceedingly delicate, but latterly its consistency becomes firmer & denser.

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When at a later period the Ovum has reached the Uterus it embeds itself in this membrane. The Decidua retreats before it, being detached from the adjacent part of the Wall of the Uterus, and partially envelopes it. This reflection is called the Decidua reflexa to distinguish it from the layer above described which is named the Decidua vera. As the embryo increases in size, the amount detached from the Uterine Wall, and consequently the extent of the Decidua reflexa ^{itself} increases also. Ultimately the Decidua reflexa and vera come into contact, so that it is impossible to distinguish the one from the other.

This part of the membrane consists almost entirely of cells, only a few glands being found in it and these near the point of junction between it and the Decidua vera.

There is still a third part of the Decidua which has received a separate name. It occupies that part of the Uterine Wall which has been left bare by the detachment of the Decidua reflexa, and the maternal part of the Placenta is developed from it. By its circumference it is in connection with the Decidua vera, with which it is identical in structure.

The embryo at the time when it enters the Uterus is surrounded by two membranes, the outer of which is the Chorion. Its outer surface which is villous is at first in contact with the Decidua reflexa and at a more mature period also with the Decidua serotina. Its villi which are cellular in their structure, are lined by a basement membrane of scaly cells, united by their edges. The free extremity of these are bulbous, and have
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germinal Centres by which their size seems to be increased. They seem even at the earliest period to be the means of absorbing nutrient materials for the foetus, and in some inferior animals they have been traced into the mouths of some of the large compound glands before spoken of, for the evident purpose of obtaining a steady supply of nourishment. In the early part of pregnancy there are no bloodvessels in it. It may be divided into two layers, an external called the Exochorion and an internal called the Endochorion.

By means of these cellular villi the embryo is supplied with nourishment for a considerable time, but nature does not leave it always so precarious a commiseration. The Allantois carrying with it the Umbilical Vessels applies itself to that part of the inner surface of the chorion which is opposite the decidua serotina, and bloodvessels communicating with those brought by it begin to appear in it. The villi on this part of the surface at the same time are stimulated to renewed growth while those on the remaining portion become shrivelled up and die away. After this the development of the foetal part of the Placenta consists in the extension of the Umbilical Vessels through the above mentioned part of the Chorion, and in their arranging themselves in very large plexuses of vessels which subdivide into the tufts and villi. These again, lined exteriorly by structures before mentioned meet with the maternal "lac" and become embedded in it. The development of the maternal portion has been partially described already in connection with the decidua serotina. This is identical in structure with the Decidua vera, consisting

consisting mainly of vessels and cells. Some of these Vessels enlarge and encroach upon the space occupied by the Cells. A thin layer (the maternal layer before described) is pushed so as to be internal to them. As the Vessels enlarge they come into contact with one another, and at last unite so as to form the "sac" of the Placenta. Goodwin thinks that the capillaries have the largest share in the formation of this "sac" but Virchow^{offering} that the Arteries, capillaries and Veins all contribute to this end, but especially the Veins.

Although the enlarging Vessels encroach much on the cell portion and split it into two layers they leave the threads before spoken of, which connect the two layers of the cellular Decidua. These threads are lined by reflexions of their Wall.

The foetal and maternal portions of the Placenta having come in contact, proceed to arrange themselves in the manner before described. The tufts of the foetal Placenta grow into the "sac" pushing its wall and the layer of cells before them, and the Wall envelopes the tufts. The formation of the Placenta is completed about the third month of pregnancy, but even after this it continues to enlarge and the connection of the two elements composing it becomes more intimate. Towards the end of pregnancy the Placenta is in consequence of the obliteration of some of the foetal Vessels less vascular. —

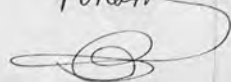
In ordinary Placentae there is a generally a free anastomosis between the two Umbilical Arteries, and it is not an unfrequent occurrence to meet with the same thing between the Placentae of dual and plural births. Indeed there is a very remarkable case

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on record, which bears on this point, and moreover goes to show that there is no vascular connection between the mother and child. The case is as follows - A woman was delivered of a child and the Cord cut near the Umbilicus but tied only on the side of the child. Shortly afterwards she was seized with what the medical man in attendance supposed to be flooding & Dr. Hamilton was summoned to see the case. A good deal of blood had been lost, but the patient showed none of the symptoms of hemorrhage. On examining her more attentively Dr. Hamilton discovered that there was still another child in the Uterus, and it when born was found to have died from loss of blood, without the mother having suffered at all from hemorrhage. There was scarcely any blood in the child's body at all, and there was found an extensive anastomosis between the Placentae of the two children.

After all, the main point regarding the Anatomy of the Placenta, rounds which all the minor points crystallize as it were, is that there is no vascular continuity between the maternal and foetal circulation; and after the amount of evidence that has been brought to establish this point, the adding of anything further ^{may} seem like the conduct of the judge spoken of in Lord Cockburn's Memorials of his times, who, in addressing the jury, used to say; "And so gentlemen having shown you that the pannel's argument is utterly impassible, I shall not proceed far ~~to~~ to show you that it is extremely improbable." Still it is both instructive and interesting to observe the numerous points from which arguments converge to favor this view.

By it the comparatively large size of the Spleen and ductless glands in the foetus can be satisfactorily explained. We

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Know that the foetus in utero digests nothing, for even if it do swallow the Liquor amnii (which however there is good reason to disbelieve) it would be absorbed into the venous system at once like other diluted aqueous solutions. We know also that the yellow blood corpuscles in the adult animal are formed principally from digested matters absorbed into the lymphatic system. This channel of supply being cut off whence come the blood corpuscles of the foetus?

Physiologists for some time back have regarded (and on grounds which cannot easily be gainsayed) the spleen as the organ which forms the white corpuscles of the blood. This opinion has recently been strengthened by some important observations made by a gentleman in London. The white corpuscles contain a number of nuclei and when the cells burst there is every reason to believe that these are developed into the yellow corpuscles. Since therefore the ordinary means for elaborating the yellow corpuscles are absent, there is a satisfactory reason why the system of ductless glands should be enlarged. This receives confirmation from the fact that the white corpuscles are more numerous in foetal than in adult blood.

Again the very experiments by injection which were believed to prove the existence of a channel of communication between the foetal and maternal blood may not be adduced in favour of the opposite view; for they show that the Vessels of the Placenta are as delicate as a microscopic examination would lead us to believe. In other words they confirm the microscopic discoveries of modern investigation.

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The extreme liability of kicks on the abdomen &c. to bring on miscarriage by inducing hæmorrhage, also shows the extreme delicacy of the vessels in this part, when compared with those of internal viscera. The Writer of this paper does not know a single case where pulmonary apoplexy was brought on by a kick, but there are many cases recorded in which Placental hæmorrhage has been induced by even assuming the erect position.

It was shown on a former part of this paper that bleeding from the Umbilical Cord did not affect the Mother. The converse of this is also true. Even when fatal hæmorrhage from the maternal part of the Placenta ensues the surface of the child is not blanched, and there is every evidence that it has lost no blood. —

The functions of the Placenta are, first, to absorb matters from the maternal blood for the development of the foetus; and secondly, to excrete effete matters from the blood of the latter. The interchanges cannot, the Writer thinks be satisfactorily accounted for by osmose alone. They are more likely to be effected by a species of vital attraction, and this view is strengthened by the fact of two layers of cells intervening between the foetal and maternal blood. If osmose were the sole means of effecting it then the two layers of cells with their germinal centres, so far from being of any use would be a drag to the process; for the strength of the osmotic current depends among other things on the delicacy of the membrane through which it takes place.

The most probable view is that the cells are the

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main instruments of performing these functions, and that they are assisted by the amniotic current. Possibly the one layer of cells may separate the necessary matters from the maternal, the other from the foetal blood. —

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List

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10. Dr. John Hunter on the Placenta
11. Quain's Anatomy
12. Kirk's Physiology
13. Notes taken at the class
14. Private conversation with Mr. Goodwin -