The Prenatal Development Of The Brain In Goat

BY

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وَلِيَعْلَمَ الَّذِينَ أُوتُوا الْعِلْمَ أَنَّهُ الْحَقُّ مِن رَّبِّكَ فَيُؤْمِنُوا بِهِ فَتُخْبِتَ لَهُ قُلُوبُهُمْ وَإِنَّ اللهَ لَهَادِ الَّذِينَ آمَنُوا إِلَى صِرَاطٍ مُّسْتَقِيمٍ

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To . .. .
My Husband Dr. Khalid Saad
To My Lovely Suns
Ahmed & Osama
Who Suffered Too Much

CONTENTS

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Introduction

Introduction

Studies on the prenatal development of the brain in domestic animals in general and especially in goat are either insufficient or incomplete.

CHEAVAUX (1905) in domestic animals, BRADLEY and GRAHAM (1946,1948) in horse and dog respectively; SISSON and GROSSMAN (1969) in domestic animals, MAY (1970) in sheep, MEYER (1964) and JENKINS (1972) in dog, RAGHAVAN and KACHROO (1964) in ox, and GETTY (1975) in domestic animals, FRANDSON and WHITTEN (1981) in farm animals, MANSOUR (1983) in camel, AMIN (1984) in goat, and DYCE and SACK (1996), in domestic animals, gave a full gross anatomical description of the brain of the previously mentioned animals.

On the other hand PATTEN (1948) in pig, JENKINS (1972) in dog, EL.KHALIGI (1977) in camel and EL.NAHLA (1982) in water buffalo in Egypt deal with the prenatal development of brain in these animals, while, SHRIVASTAVA, MEHROTRA and MALIK, (1987 and 1988), performed a prenatal encephalometry and deal with the prenatal development of certain parts of the brain of goat.

Accordingly, the aim of this work is to give a basis for histogenesis and organogenesis to some parts of the brain of the goat which may help in future studies in the field of veterinary neuroanatomy.

Review of Literature

REVIEW OF LITERATURE

The studies on the prenatal development of the brain of the goat were rare. However, many authors delt with the brain of domestic animals and human either prenataly or postnataly.

NELSEN (1953), in vertebrates described the development of specialized areas and outgrowths of the brain including formation of the brain vesicles which included telencephalon, diencephalon, mesencephalon, metencephalon and rhombincephalon in addition to other outgrowths, he also described the cavities of these five parts and formation of flexures. The derivatives of each of the five parts of the brain in different vertebrates including dog, bird and human were illusterated in this study. SHRIVASTAVA, MEHROTRA and MALIK (1987), carried out a prenatal encephalometry on the brain of the goat. Fetuses were divided into 3 groups based on CR length, group I (up to 10 cm CR length), group II (10-20 cm CR length) and group III (over 20 cm CR length), in this study the width shows higher increase than the length in group 2 and 3 and vice versa in group 1 and 2, the consistence increases in width over length reveals the tendency of the brain for lateral expansion, and may have bearing on the relative degree of cephalization and possible evolutionary status of the mammalian brain, length and width of the cerebellum increases more in comparison to the corresponding parameters of the cerebrum. In early age group fetuses, the midbrain is proportionally larger and elongated and its size gradually declines in older groups due to the rapid growth of cerebrum and cerebellum. Moreover, SHRIVASTAVA et. al. (1988), in goat recorded that, fetuses are divided into 3 groups according to the CR length, group I (up to 10 cm CR length), group II (10-20 cm CR length) and group III (over 20 cm CR length)), where in early age group specimens, the midbrain is proportionally large and elongated and its size is gradually declines in later

groups. They added that, the cerebral aqueduct is nearly triangular in shape, broad dorsally and narrow ventrally and the differential growth of the midbrain is by lateral expansion rather than by dorsoventral expantion. FRANDSON and WHITTEN (1981), in farm animals described the neural tube as the premordium of the brain vesicles. On the other hand, DYCE and SACK (1996), in domestic animals stated that, in most parts of the brain the full complement of the neurons is established shortly after, if not before birth.

SHRIVASTAVA et al (1987, 1988), in goat stated that, fetuses of group 1 (up to 10 cm CR length) possessed agyric cerebrum and did not present fissures or sulci of cerebral cortex, in group 2, (10-20 cm CR length) it shows convolutions separated by sulci of varying depths and extents, fetuses of group 3, (over 20 cm CR length) show definitive pattern and formation of distinct gyri and sulci identical to adult, they added that the rhinal sulcus appears first. Moreover, EL KHALIGI (1977), in one humped camel mentioned that, fetuses were divided into 4 groups according to CVR length group I (19-30 cm CVR length), group II (30-50 cm CVR length), group III (from 50-70 cm CVR length), group IV (from 70 cm CVR length to full term fetuses), the cerebral hemispheres are smooth in fetuses up to 19 cm CVR length, while in fetuses from 19-30 cm deep lateral fossa appears at the middle of the ventrolateral aspect of the cerebral hemispheres which later on form the lateral sylvian fissure, the other sulci and gyri of the cerebral hemispheres appear at group 2, (30-50 CVR length) and attain full properties and arrangement In group 3, (50-70 cm CVR length) and 4, (above 70 cm CVR length), EL.NAHLA (1982) in water buffalo stated that, fetuses were divided into five groups according to the CVR length, group I (from 5-15.5 cm CVR length), group II (from 15.5-34 cm CVR length), group III (from 34-56 cm CVR length), group IV (from 56-79 cm CVR length), group V(from 79 cm to over 100 cm CVR length), the cerebral hemispheres of group I fetuses are smooth with neither sulci nor gyri and by the

end of this group the surface of the cerebral hemispheres presented a faint lateral rhinal sulcus separating the neocortex from the olfactory cortex, the second group showed the appearance of the suprasylvian, marginal , coronary and caudal ectosylvian sulci, while the other sulci and gyri appeared in the third group and the cerebral hemispheres have adult form and sulcal and gyral arrangement at the fourth group, BRADLEY and GRAHAM(1946), stated that, in horse the external surface of the cerebral hemispheres remains smooth in the early stages of prenatal development, in addition, PATTEN (1948), reported that the telencephalic lobes in pig are smooth in contour without showing striking local differentiation up to 100 mm embryos, and at later stages, they become much convoluted and certain regional divisions appear clearly marked, FOX (1963), JENKINS (1972) stated that the dog posses a lissen cephalic brain where the sulci and gyri are not completely developed until the first few monthes after birth.

AREY (1974), recorded that the olfactory bulb appears in human fetuses during the 6th week, while EL.KHALIGI (1977) stated that the olfactory bulb appears in camel fetuses of more than 19 cm CVR length as an elongated oval to rectangular projection, while, EL.NAHLA (1982) in water buffalo recorded that this bulb appears at 5cm CVR length fetuses (51 days) as a pin head in shape and size ventral to the rostral end of each cerebral hemisphere.

CLABOUGH (1973), reported that, the pineal development in foetal rats occurs during the last eight days of gestation and in foetal hamster during the last five days of gestation, a comparative study was performed here between the histogenesis of the gland in both species. AREY (1974) in human, reported that the pineal body evaginates during the 7th week (49 days) of pregnancy. Moreover, EL.HKALIGI (1977) stated that in camel fetuses of 30-50 cm CVR length, the pineal body is well developed In

addition, REITER (1981), stated that, in mammals, the anlage of the pineal diverticulum lies in the dorsal median area of the neural tube at the level of the neuroaxis, which will become the diencephalons between posterior and habenular commissures, but in opossum it obtains a subcommissural location. On the other hand EL.NAHLA (1982), reported that, the pineal body of the buffalo fetuses can be recognized as a very small spherical body at the age of 34-56 cm CVR length While, GABR et. al. (1992), recorded that, the pineal gland in bouscat rabbit appears firstly in 14-day old embryo. On the other hand, REGODON et. al. (1998) stated that, the ovin pineal outline begins to differentiate into a dorsal evagination of the diencephalic median line at around 30 days of prenatal life it lies close to the anterior and posterior commissures.

EL.KHALIGI (1977) reported that, the corpora quadrugemina are the second in size to the cerebral hemispheres in camel fetuses of 19 cm CVR length,, the same result was stated by EL.NAHLA (1982) in buffalo fetuses of 5-15 cm CVR length, the latter added that by the beginning of the first group (5 cm CVR length) the corpora quadrigemina present a very faint mid-dorsal groove which deepens at 7-9.5 cm CVR length and becomes clear separating two rostral colliculi at 15.5 cm CVR length, in addition a very faint transverse groove appears thus the caudal colliculi are connected, the complete differentiation of the corpora quadrigemina occurs in buffalo fetuses by the end of the second group (15.5-34cm CVR length). In addition, WENISCH, JOST and HUMMEL (1997), in cattle reported that, macroscopically, the mesencephalon can be recognized for the first time at 0.8 cm CR length, whears the superior colliclus can be clearly differentiated in embryos of 4.5 cm CR length. The macroscopic features of this brain reachs adult condition at 80 cm CR length.

TEWARI and RAO (1977), stated that, the corpus geniculaum lateralis in indian buffalo (Bulbus bubalis), is convex, swing in a semicircle around the thalamus and covered with the fibers of the optic tract.

EL KHALIGI (1977) in camel mentioned that, the rhombic flexure, the premordia of the cerebellum and the medulla oblongata firstly seen in fetuses from 19-30 cm CVR length, while in fetuses of 30-50 cm CVR length, the cerebellum maintains approximately the same size as the corpora quadrigemina, and posses numerous sulci and gyri. In fetuses of 50-70 cm CVR length, the cerebellum enlarges, and its lobules and fissures become an evident. Moreover, EL.NAHLA (1982) stated that, the premordia of the cerebellum is represented by a smooth transverse band in fetuses of 5-15 cm CVR length, complete development occurs at 52-56 cm CVR length. On the other hand, PATTEN (1948) mentioned that in pig, the early smooth outline of the cerebellum is broken after the 35 mm stage by the development of a complex series of folds. Three main lobes are formed, each of which is subdivided into a great number of minor folds, which give the cerebellum a very characterestic appearance. BERUJON (1970) in bovines, recorded that, the vermis develops faster than the cerebeller hemispheres and added that the cerebellum is marked by fissures at 60 days. In addition, LOESER (1972), stated that the cerebellar vermis in man begins to develop folia by the 13-14 weeks estimated gestational age and that the nine lobules of the vermis can be identified by the development of the major fissures at approximately 15 weeks of gestation, he added that the development of the folia is not completed until about two months after term. On the other hand AREY (1974) in human stated that, during the 2nd month a paired swelling at the midline indicates the future vermis and during the 3rd month the cerebeler mass everts and formed the cerebeller hemispheres, the human cerebellm attains its adult form at the seventh month..

EL.KHALIGI (1977) in camel recorded that, in camel fetuses of more than 19 cm CVR length the pons is represented by two elevations located in between the fibers of the pyramids and the trigeminal nerve appears at 32-33 cm CVR length, while EL.NAHLA (1982) observed that the pons appears as a narrow transverse band at 15.5 cm CVR length buffalo fetuses and the trigeminal nerve originates at 34-56 cm CVR length.

EL.KHALIGI (1977) reported that, the pyramids are well developed in camel fetuses of 30-50 cm CVR length, while in the buffalo fetuses the pyramids are well defined at 70 cm CVR length and its decussation is recognized at 73.5 cm CVR length (EL.NAHLA, 1982).

The corpus trapizodium can be recognized by EL.KHALIGI (1977) in camel fetuses of 30-50 cm CVR length as two rounded elevations. On the other hand, it was observed by EL.NAHLA (1982) in buffalo fetuses of 38.5 cm CVR length.

The facial nerve arises in the camel fetuses of 50-70 cm CVR length as stated by EL.KHALIGI (1977), while it appears at 15.5 cm CVR length buffalo fetuses (EL.NAHLA, 1982), the vestibulocochlear nerve arises at the age of 56-79 cm CVR length buffalo fetuses (EL.NAHLA, 1982), and at 50-70 cm CVR length camel fetuses (EL.KHALIGI, 1977), the glossopharyngeal and vagus nerves are clearly differentiated at 79 cm CVR length buffalo fetuses (EL.NAHLA, 1982), but in the camel fetuses it appears at 50-70 cm CVR length (EL.KHALIGI, 1977), while the hypoglossal nerve can be see at 56 cm CVR length in buffalo fetuses (EL.NAHLA, 1982) and at 50-70 cm CVR length camel fetuses (EL.KHALIGI, 1977). In addition, Moreover, ORAHILLY and MULLER (1990), stated that, the arrangement of the tracts and nuclei of the human rhombencephalon at 8 weeks is shown to be closely similar to that present in the newborn. The opinion of the author was that rapid growth of the rhombencephalon during the embryonic period proper is associated with

corresponding early functional activity. Moreover, RUHRING, HUMMEL and GOLLER (1994), in cattle reported that, nuclei of the cranial nerve VII correspond at 53 cm CR length topographically and cytologically the adult animals. In addition, RUHRING et. al. (1995), in cows recorded that, at 53 cm CR length the hypoglossal nerve nucleus correspond to the pattern as described in adult animals.

MALIK et. al. (1992), in goat recorded that, fetuses were divided based on CR length into 3 groups, group I (up to 10 cm CR length), group II (10-20 cm CR length) and group III (over 20 cm CR length), the premordium of the telencephalic choroid plexus develops from the medial ventricular wall in fetuses of 5 cm CR length and followed by diencephalic and rhombicephalic choroids plexuses respectively. It become convoluted and branched with the advancement of the age of the fetuses. The lining of the telencephalic premordium is the thickest, followed by the diencephalic and then the mylencephalic lining. While the height of the choroid epithelium variably decrease in different ages in comparison to the epithelial height of the respective premordium, the decrease is maximum in the lateral ventricle. Moreover, EL.KHALIGI (1977) in camel stated that the lateral ventricle attained its adult pattern at 50-70 cm CVR length, while in buffalo fetuses this occurs at 67 cm CVR length (EL.NAHLA, 1982), the latter added that, the caudate nucleus and hippocampus are observed in buffalo fetuses of 32 cm CVR length, this occures at 30-50 cm CVR length camel fetuses as recorded by EL.KHALIGI (1977). On the other hand, ORAHILLY and MULLER (1990), in human stated that, closure of the caudal neuropore heralds the onset of the ventricular system.

LISBRE (1903), reported that the encephalon of camel is larger than that of the bull, its weight ranges from 508-520 gm. He also compared between the general external features and configuration of the brain of camel and those of ox with a special attention to the piriform or mastoid lobe and sylvian groove in

camel. On the other hand FOX (1963) in dog recorded a data about weight, length, volume and gyrus patterns, the author stated that, body-brain weigh relationships indicates some breed differences, where no gross differences in gyrus patterns can be detected. In addition, structural maturation proceeds rapidly up to 6 weeks and then more gradually, the sylvian sulcus is poorly developed at birth and then become deep with increasing of width of the brain, this structural changes are associated with changes in behavior and reflexes of neonatal dogs. Moreover, HARPER and MASTER (1975), in the brain of the American plain buffalo described its characteristic large size, fissural pattern of the cerebral hemispheres and well developed insular cortex, the midbrain particularly the tectum is outstanding. They added that the cerebellum is small in relation to the total brain volume. Comparison between the brain of bison and that of domistecated and wild ungulate species as well as other mammalian forms were induced in this study. Moreover, AMIN (1984) in goat recorded that, the sulci which are demonstrated on the convex surface of the cerebral hemisphere are fissura sylvius, sulcus ectosylvius, sulcus presylvius, sulcus proreus, sulcus suprasylvius, sulcus marginalis, sulcus ansatus and sulcus cruciatus. The sulci which can be observed on the medial surface of the cerebral hemisphere are the calcarin, splenial, genual, endogenual and rostral internal sulci. The gyri cerebri includes, gyrus sylvius, gyrus ectosylvius, gyrus ectomarginalis, gyrus marginalis, gyrus occipitalis, gyrus precruciatus, gyrus postcruciatus, gyrus prorius, gyrus cinguli and gyri insuli, the study includes the course, position and relation of each sulcus and gyrus. On the other hand, MANSOUR (1983) in one humped camel stated that, the sulci which are located on the convex surface of the cerebral hemisphere are, fissure Sylvia, sulcus ectosylvius, sulcus presylvius, sulcus prorius, sulcus suprasylvius, sulcus marginalis, sulcus ectomarginalis, sulcus endomarginalis, sulcus ansatus, sulcus coronalis and sulcus cruciatus, while the sulci of the medial surface of the brain

are sulcus splenialis, calcarinus, sulcus suprasplenialis, sulcus endoinguinalis, and sulcus rostralis internus. The gyri of the cerebral hemisphere are arranged in the following pattern, gyrus sylvius, gyrus compositus rosteralis caudalis, gyrus ectosylvius, gyrus ectomarginalis, gyrus occipitalis, gyrus marginalis, gyrus postcruciatus, gyrus precruciatus, gyrus prorius, gyrus cinguli and gyri inslae.

Materials and Methods

MATERIAL AND METHODES

This work was carried out on sixty seven goat fetuses procured from cairo small animals slaughter houses.

Fetuses were fixed in 10% buffered formaldehyde after removal of a part of the skulls opposite to the cerebral hemispheres to allow penetration of the fixative to the brain tissue.

Each foetus, was subjected to the following measurements:

1-CVR (crown vertebral rump) length.

2-CR (crown rump) length.

The foetuses were classified into three groups according the CVR length:

Group 1 of CVR length less than 10 cm.

Group 2, of CVR length 10-20 cm.

Group 3, of CVR length over 20 cm.

This three groups represents the early, mid and late stages of gestation.

Brain extraction:

Brains were extracted from the cranium by using a small scissor with a pointed tip, and a small untoothed forceps, a median longitudinal incision was done extending from frontal suture anteriorly to the dorsomedian line of the vertebral column posteriorly at the level of emergence of the first cervical spinal nerve, another incision formed transversely perpendicular on the longitudinal one and median in position.

Cartilage (in the early stage) or bones (in the late stage) of the skull were removed as flaps by using the untoothed forceps and carefully detached from the underlying meningeal layer.

After removal of the whole dorsal cartilaginous covering of the brain, the lateral surfaces of the brain were loosen by the scissor, the spinal cord was then

cut at the level of the first cervical spinal nerve, and the ventral aspect of the brain was then loosen by using the scissor in a caudo-rostral direction.

The extracted brains were immediately dehyderated in ascending grades of alcohol started by 70% (for 48 hrs), 80% (for 24 hrs), and 90% (for 12 hrs) before examination.

The brains were subjected to the following investigations:

I-Gross developmental features:

Photo graphic pictures were taken for each specimen dorsaly, venterally and laterally in addition to mid sagital section of certain specimens.

The development of each part of the brain in the obtained ages was traced by naked eye or by aid of magnifying lens or stereomicroscope (in group I), then the brain was photographed either by camera or by research stereomicroscope.

II-Histogenic study:

Specimens were fixed immediately then, subjected to an ascending grade of alcohol (ethyl alcohol) beginning with 50% (for 5 hrs), 70% (for 7 hrs), 95 % (for 5 hrs) and three changes of absolute each for 2 hrs. The dehyderated specimens were then cleared three changes of xylen each for 2 hrs. The specimens were impregnated into paraffin wax at 58-60 c, then embedded in paraffin wax , blocks of paraffin were cutted into sections 5-6 micrometers thick .

Sections were stained with haematoxylin and eosin (H&E), mounted with DPX , examined and photographed by using research microscope. This was carried out according to BANCROFT and STEVENS (1996).

III-Morphometric study:

A-Measurements concerning the whole brain:

1-Length : from frontal pole to the end of the medulla oblongata.

2-Width : the widest part (interparietal).

B- Measurments concerning the cerebrum:

1-Length of the right and left cerebral hemispheres from frontal to occipital poles as well as the intermediate length.

2-Width of each cerebral hemisphere at anterior, posterior and middle levels .

C-Measurments concerning the cerebellum:

1-Length: rostro-caudal distance of the vermis .

2-Width : transeverse distance at the region of the brachium pontis .

D-Measurments concerning the pons:

1-Length : rostro-caudal distance from foramen caecum to the origin of the cerebral crura .

2-Width : transverse distance measured venterally between attatchements of the middle cerebellar peduncles .

E- Measurments concerning the medulla oblongata :

1-Length : from the caudal border of the pons to the caudal limit of the medulla .

2-Width : maximum transeverse distance of the medulla caudal to the pons.

The terminology used in this work was adopted to the N.A.V. (1994).

Table (1): The available materials in the present study

Group Number	CVR length (cm)	CR (CM)	Age (days	No. of embryos and foeti
GROUP (I)	1.79	1.5	23*	1
	1.99	1.69	24*	2
	3.3	3	29*	1
	3.8	3.1	32*	3
	4.3	3.3	34*	3
	5.7	4.8	36*	3
	8	7.1	44+	3
	8.3	7.5	45+	2
	9.5	8.5	50+	3
GROUP (II)	11	10.2	52+	2
	12	10.8	56+	3
	12.6	11.5	59+	3
	12.9	11.7	61+	2
	14	12.8	63+	3
	16.5	14.5	68+	2
	17	15	70+	3
	17.5	16.5	71+	2
	18.3	17.1	73+	3
	19.3	17.5	74+	3
	19.5	18.6	75+	2
GROUP (III)	20.5	19.5	76+	3
	21	19.5	77+	3
	22	19.5	78+	2
	23	20.5	82+	2
	24	21	82+	3
	26	24	91+	2
	32.5	30	100+	2
	35	32	124+	2
	37	33.5	136+	1
	38	34.5	138	1
	Total			67

* Actual determined age obtained either by cesearian sections from pregnant goats or natural parturition.

+ Estimated age according to the developmental horizons of goat by Molinari and Goicoiechea (1993) and Sivachelvan et. al. (1996).

Results

RESULTS

The results of the present investigation were divided into two parts:

A- Prenatal Macroscopic and Microscopic developmental studies.

B- Prenatal Morphometric Developmental Studies.

A- PRENATAL MACROSCOPIC AND MICROSCOPIC DEVELOPMENTAL STUDIES.

The obtained results were categorized into three groups according to the CVR length

1-Group I, (goat embryos of less than 10 cm C.V.R length):

The fetuses of this group were characterized by an elongated brain where the length was larger than the width in all specimens (tables 2 and 3).

At 1.79 CVR length (23 days) and 1.99 cm CVR length (24 days) (Fig. 1 and 2)

Microscopic studies at this age revealed that, the neural tube, the primordium of the brain and the spinal cord, was firstly observed, it was formed of three concentric layers; outer marginal layer, middle mantle layer and inner epindymal layer (Fig. 1/1,2,3), at 1.99 cm the neural crest was clearly separated from the neural tube and surface ectoderm (Fig. 2).

At 3.3 cm CVR length (29 days): (Tables 2 and 3, Fig. 3)

The brain measured 4 mm length and 1mm width.

The brain was developmentally primitive. The prosencephalon was poorly differentiated that it was difficult to differentiate between the telencephalon and diencephalon, at this region, there was a slight thickening at

the rostrodorsal region of the neural tube just rostral to the mesencephalon, the latter was the largest of the brain vesicles, it was elongated and bulged dorsally.

A very shallow pontine flexure could be observed at the ventral surface of the brain and separated between the metencephalon and mylencephalon (Fig. 3/5).

At 3.8 cm C.V.R length (32 days) : (Tables 2 and 3, Fig. 4)

The length of the brain was 4 mm and the width was 1 mm.

The brain at this age showed the following primitive features which was represented by; the thickening which observed in the previous age grew into two lateral outpockings at the rostrolateral part of the brain stem, they were enlarged rostrally, caudally, laterally and slightly dorsally representing the primitive cerebral hemispheres (Fig. 4/1). Caudal to this primitive hemispheres there was an oval dorsal elevation represented the diencephalon and the mesenceophalon. This elevation followed caudally by the interventricular portion of the rhombic lip which bounded the pontine flexure rostrodorsally (Fig. 4/3).

The mesencephalon was separated from the caudally situated rhompic lip by a narrow farrow, the rhombincephalic isthmus (Fig. 4/5).

The telencephalon was represented by two primitive hemispheres which were completely smooth or agyric without any evidence of sulci or gyri. Moreover. The two hemispheres were separated dorsally by a space which was narrow rostrally and wide caudally. The olfactory bulb began to appear at the most rostral part of the ventral surface of each hemisphere as white primitive knot (Fig. 4/6).

The diencephalon, mesencephalon and rhombincephalon were still primitive.

Microscopically the brain at this age revealed the first appearance of the diencephalic choroid plexus at the roof of the third ventricle, lateral and ventral to the latter, the thalamus followed by the hypothalamus were observed. In addition theire was a accumulation of nerve fibers represented thalamic tracts which were seen in this section. (Fig. 5.a/5)

The choroid plexus was lined with cuboidal epithelium, few cells were lightly stained while the most of the cells contained vaculated cytoplasm. The nucleus was spherical, centrally or apically situated. (Fig. 5.b)

The tracts was formed of condensed cell groups, their axons were very long and extended ventrally. (Fig. 5.c and 5.d)

At 4.3 cm C.V.R length (34 days) : (Tables 2 and 3, Fig.6)

The brain measured 5 mm length and 2 mm width.

The cerebral hemispheres were relatively larger, still agyric and smooth, with a slight reduction in the space separating them dorsally.

The olfactory bulb became more elongated and slightly enlarged.

The diencephalon began to exhibit a certain degree of differentiation where, the mamillary body appeared as a very faint prominence at the ventral surface of the diencephalon (Fig.6/3). In addition the infundibulum could be seen as a very minute slit-like opening rostral to the mamilary body (Fig. 6/4).

Otherwise the brain was similar to the previous age.

At 5.7 cm C.V.R length (36 days) : (Tables 2 and 3, Fig. 7)

The length of the brain was 7 mm and the width was 3 mm.

The cerebral hemispheres increased in length that it became larger than the mesencephalon, they still smooth without any sulci or gyri (Fig. 7/1). The cerebral surface was translucent indicating a very faint telencephalic or lateral ventricle without macroscopic evidence of the choroid plexus.

The caudoventral end of each cerebral hemisphere presented a bulged prominence which indicated the appearance of the caudal part of the piriform lobe (Fig. 7/2).

The mamillary body and the infundibulum were more pronauced (Fig. 7/ 3,4).

The mesencephalon exhibited a less bulged appearance, became more elongated with the presence of a shallow longitudinal fissure separating it into two longitudinal masses (Fig. 7/5).

The two rhombic lips approached each other rostrocaudally forming the cerebellar plate (Fig. 7/7), it was followed caudally by a wide fossa surrounded by two thickenings. This fossa represented an early appearance of the rhombic fossa (Fig. 7/8).

On the ventral surface of the metencephalon, the pons could be identified as a transverse band without evidence of the basilar sulcus (Fig, 7/9).

A very faint ventral groove could be seen at the ventral aspect of the medulla oblongata (Fig. 7/10).

Microscopically, the two lateral ventricles, the interventricular foramen as well as the third ventricle were clear (Fig. 8).

The medial aspect of the lateral ventricle presented a primary convolutions which indicated the future choroid velli, the third ventricle was wide, the adhesion between the two thalami was incomplete at this level (Fig. 8)

From the histological point of view, the wall of the lateral ventricle (Fig. 9) composed of the following layers, a single layer of epindymal-like cells. (Fig. 9.a), followed by a layer of irregularly arranged polyhedral cells with large strongly basophilic nuclei. (Fig. 9.a), followed by a less cellular layer the previous, the cells were branched in shape and contained large spherical eccentric strongly basophilic nuclei. (Fig. 9.b), this layer was followed by the widest layer as it contained more nerve fibers than the previous layers.

(Fig.9.b.c). The outer most layer was narrow and the nerve cells were packed together in the form of patches separated by nerve fibers (Fig. 9.c).

The choroid plexus of the lateral ventricle was characterized by a long branched velli with a highly vascular core. The lining cells were cuboidal, few cells appeared dark or had acidophilic cytoplasm, other cells contained lightly stained cytoplasm (dark and light cells), the nuclei of the cells were apically situated and strongly basophilic.

The core of the velli was formed mainly of blood vessles lined with endothelial cells (Fig. 9.d).

At 8 cm C.V.R (44 days) : (Tables 2 and 3, Fig. 10)

The length of the brain was 1.1 cm while the width was 4 mm.

There was an increase in the length and width of the cerebral hemispheres.

The infundibulum was larger with a pronauced tuber cinerium surrounding it (Fig. 10/2,3).

The mamillary body appeared as two small prominances just caudal to the infundibulum (Fig. 10/4,4\).

A very shallow transverse groove appeared at the distal third of the mesencephalon (Fig. 10/5).

The cerebral crura appeared as two wedge-shaped prominances extended into a rostro-lateral direction (Fig. 10/6,6\).

The basilar sulcus appeared as a faint groove at the ventral surface of the pons (Fig. 10/7). In addition, prepontine sulcus appeared rostral to the pons and separated it from the cerebral crura.

The cerebellar plate differentiated into two lateral hemispheres separated by a transverse parenchymatous bridge (Fig. 10/9).

On the dorsal surface, the dorsal opened part of the medulla oblongata became partially covered by the cerebellum while the caudal part was completely divided into two symmetrical halves by a dorsal median sulcus (Fig. 10/10).

The medullary pyramids was differentiated into two longitudinal prominances on either sides of the ventral median groove (Fig. 10/11).

The choroid plexus of the lateral ventricle could be seen as a large convoluted structure occupying the roof of the ventricle.

The hippocampus followed the contour of the primitive lateral ventricle.

Microscopically, the cerebrum revealed the presence of the hippocampus as a caudal projection extended into the lumen of the lateral ventricle (Fig. 11).

At 8.3 cm C.V.R length (45 days) : (Tables 2 and 3, Fig. 12)

The length of the brain was 1.4 cm and the width was 0.7 cm.

The cerebral hemispheres, the olfactory bulb as well as the piriform lobe exhibited a degree of enlargement.

The cerebral hemispheres attained a kidney-shape with a rostral and caudal ventral projections separated by a ventral indentation (Fig. 12/4).

The body of the pineal gland appeared as a small rounded evagination projected dorsally from the roof of the third ventricle (Fig. 12/5).

The corpus trapizodium appeared as a transverse band just caudal to the pons (Fig. 12/6).

The medullary pyramids were more clear without decussation.

Microscopically, the cerebellum showed a cerebeller foliation. The premordia of the choroid plexus of the fourth ventricle appeared at the caudoventral aspect of the cerebellum as a transverse mass of mesenchyme. This results were confirmed by sagital histological section of the rhombincephalon (Fig. 13).

At 9.5 cm C.V.R (50 days) : (Tables 2 and 3, Fig. 14)

The length of the brain was 2 cm while the width was 0.9 cm.

The ventral indentation of each cerebral hemisphere extended more laterally in the form of a faint sulcus which indicated the appearance of the fossa lateralis of the cerebral hemispheres (Fig. 14/1).

The pineal gland was more demarcated, the infundibulum, the mamillary body and the tuber cinerium were well pronounced.

The transverse groove of the mesencephalon was still shallow.

Generally, brain of the first group was elongated in all specimens.

The telencephalon presented two cerebral hemispheres which began to develope as lateral thickening and then two lateral outpockings of the neural tube which increased in length and width gradually and by the end of this group it presented a ventrolateral sulcus as a primary appearance of the lateral fossa of the brain, the olfactory bulb appeared as a white knot ventrally which slightly enlarged at the end of this group. In addition, the caudal part of the piriform lobe was also appeared and together with the olfactory bulb gave the cerebral hemispheres a kidney-shape at the late specimens of this group.

The diencephalon by the end of this stage, presented most of its components where it was represented by the infundibulum surrounded by a well marked tuber cinerium, the mamillary body as two small prominences and a considerably large pineal gland which may indicate an early physiological functioning of this gland.

The mesencephalon was the largest part of the brain at the early specimens of this group, then it attained a relative small size cartilage (in the early stage)due to the rapid enlargement of the cerebral hemispheres, at the early specimens it showed rhombincephalic isthmus while at the end of this stage it was represented dorsally by two longitudinal prominences separated by a longitudinal groove, a shallow transverse groove was observed at this time as

an early land mark of the future division of the tectum into two rostral and two caudal colliculi. Ventrally, the mesendephalon showed two wedge-shaped rostrolateral prominences which represented the early cerebral crura.

The rhombincephalon at the beginning of this stage presented a well marked rhombic lip dorsally which gave rise a marked cerebeller plate, the latter considered the primordium of the cerebellum which by the end of this group showed two cerebeller hemispheres with very low degree of foliation (microscopically). Ventrally, the pontine flexure appeared, by the end of this group it was represented by the pons with a faint basilar sulcus. The medulla oblongata at the early specimens of this group presented a very shallow ventral groove which by the end of this stage separated two shallow medullary pyramids without decussation, while dorsally, a dorsal median sulcus appeared at 8 cm CVR length which separated the caudal part of this surface into two symmetrical halves, while the rostral opened part of this surface was partially covered by the cerebellum.

The hippocampus and the caudate nucleus appeared at 8 cm CVR length.

The premordium of the choroid plexus of the third ventricle could be seen at 3.8 cm CVR length, while that of the lateral ventricle appeared at 5.7 cm C.V.R length. On the other hand the premordia of the choroid plexus of the fourth ventricle could be observed latter (at 8.3 cm C.V.R length).

2- GROUP II (From 10-20 cm CVR length)

Brain of the second group was characterized by an elongated outline similar to the previous group.

At 11cm C.V.R length : (Tables 2 and 3, Fig.15)

The length of the brain was 2.2 cm and the width was 1.2 cm.

The lateral fossa which appeared in the previous stage still shallow indentation (Fig. 15/1), no sulci or gyri cauld be noticed in the cerebral hemispheres. The caudate nucleus and the hippocampus were well identified (Fig. 15/18,19).

The body of the pineal gland was slightly enlarged, the infundibulum, the tuber cinerium and the mamillary body remained unchanged. The thalamus (Fig. 15/13) was observes in sagital section as an ovoid area caudolateral and dorsal to it, there was a low prominence which represented the premordium of the lateral geniculate body. Moreover, the caudal coliculi connected with a triangular area rostral to the cerebral crura by a long and narrow band which represented the brachium of the caudal collicili and the triangular, area to which it was connected, represented the premordia of the medial geniculate body.

The interventricular foramen was clear, the third ventricle was clear caudal, ventral and rostral to the thalamus dorsal to which it was faint, the interthalamic adhesion was incomplete (Fig. 15/14). The premordium of the choroid plexus of the third ventricle was observed macroscopically at the rostrodorsal aspect of the thalamus (Fig. 15/15).

The transverse groove of the mesencephalon became deeper which resulted in division of the tectum into two rostral and two caudal colliculi (Fig. 15/6,7) .

The mesencephalic aqueduct was narrow rostrally and wide caudally (Fig. 15/16), while the fourth ventricle (Fig. 15/17) was wide due to the wide and shallow rhomboid fossa which conistitute its floor, in addition an incomplete medullary vellum could be noticed.

Otherwise no other obvious changes could be seen in the other parts of the brain.

At 12 cm C.V.R length : (Tables 2 and 3, Fig.16)

The length of the brain was 2.3 cm, the width was 1.3 cm.

No changes could be seen at the lateral fossa.

The olfactory bulb became more prominent at the rosrtoventral end of each cerebral hemisphere (Fig. 16/2). The piriform lobe was still represented by the caudal part only which remained as a rounded mass at the caudoventral end of each cerebral hemisphere (Fig. 16/3).

The diencephalic components remained unchanged.

The mesencepphalon was reduced in length, the rostral collicli attained a more rounded appearance being separated by a distinct longitudinal groove, while the caudal ones became more elliptical in shape and continued with each other. The cerebral crura (Fig. 16/4,4\) were more identified as two longitudinal prominences at the ventral surface of the mesencephalon was separated by an intercrural fossa which was more identified caudally (Fig. 16/5).

The lateral and medial geniculate bodies as well as the brachia connected them with the rostral and caudal colliculi became more clear.

The pons and the cerebellum did not show marked differentiation.

The dorsal surface of the medulla oblongata presented a well marked rhomboid fossa rostrally and longitudinal fissure caudally which was surrounded by a faintly developed tracts.

The lateral ventricle became wider and more elongated, the velli of the telencephalic choroids plexus became more branched and showed a more extention inside the lumen of the ventricle (Fig. 17).

At 12.6 cm C.V.R length : (Tables 2 and 3, Fig.18)

The length of the brain was 2.4 cm while, the width was 1.4 cm.

At this age a faint groove appeared separating the olfactory bulb and the piriform lobe from the cerebral hemispheres (Fig. 18/ 2), this groove represented ***sulcus rhinalis lateralis***. The olfactory bulb became more identified and attained a more elongated appearance (Fig. 18/3), two fiber tracts extended caudally from each bulb and represented the first appearance of the medial and lateral olfactory tracts (Fig. 18/4,5).

Concerning the diencephalic components, the pineal gland was markedly enlarged and exhibited a more ovoid shaped glandular mass just rostral to the rostral colliculi (Fig.18/6). The two prominances representing the mamillary body fused forming a single mamillary body.

The rostral colliculi were very prominent while the caudal ones were less prominent, the transverse groove separating them was deeper (Fig. 18/9,10).

The pons, and medulla oblongata as well as the brain ventricles remained unchanged.

Histological section indicated the increase of the depth and number of the cerebeller fissures, in addition the velli of the choroids plexus of the fourth ventricle became more branched with a well marked vascular core (Fig. 19).

At 12.9 cm C.V.R length : (Tables 2 and 3, Fig. 20)

The length of the brain was 2.5 cm and the width was 1.4 cm.

A shallow wide indentation was observed at the medial aspect, close to the dorsal border, of each cerebral hemisphere this groove indicated the early development of the ***sulcus splenialis*** (Fig. 20/1).

The pineal gland became pointed dorsally (Fig. 20/8).

At 14 cm C.V.R length : (Tables 2 and 3, Fig.21,22)

The length of the brain was 2.7 cm and the width was 1.6 cm.

Sulcus rhinalis lateralis pars rostralis and caudalis were very clear (Fig. 21/1,1\), the rostral part run along the lateral border of the lateral olfactory tract to a point just rostral to the rostral end of the caudal part of the piriform lobe, while the caudal part continued along the lateral border of the piriform lobe separating it from the cerebral hemispheres and ended at the caudal pole of the cerebral hemispheres.

Fissura Sylvia began to appeare as a dorsolateral extention of the lateral fossa (Fig. 21/2).

The lateral geniculate body (Fig. 22/1) enlarged, being curved over the dorsal border of the thalamus (Fig. 22/1,2) and connected with the rostral collicili by a more clear brachium (Fig. 22/5). In addition the medial geniculate body became more clear, the brachium connecting it with the caudal colliculi was a prominent elongated fibrous band (Fig. 22/8).

The pineal gland, the infundibulum, the tuber cinerium and the mamillary body resembeled previous sample.

The rostral colliculi were large, rounded and darker in color , the caudal colliculi were smaller and elliptical in shape, apart of each other and connected by a fibrous band, the isthmus of the caudal colliculi (Fig. 21/15,16&22/19,20).

The ventral surface of the pons showed a more clear basilar sulcus (Fig. 21/13), in addition the pons was separated from the rostrally located cerebral crura by a prepontine sulcus (Fig. 22/24) and for the first time a fine nerve fibers originated from the caudolateral aspect of the pons reflecting the early development of the trigeminal nerve (Fig. 21/12).

The cerebellum assumed nearly adult form which reflected by the presence of two cerebeller hemispheres, vermis and the deep as well as the

shallow fissures which gave the cerebellum its tree-like appearance. In addition, the rostral medullay vellum was clear (Fig. 22/18).

The medullary pyramids were well developed, moreover, the trapezoid body was also very clear with a very minute nerve fibers originated from its lateral aspect which indicated the early development of the facial nerve (Fig. 21/19&22/13).

The lateral ventricle was clear, cresentic and extended rostrally and caudoventrally (Fig. 22/12).

At 16.5 cm C.V.R length : (Tables 2 and 3, Fig.23)

The length of the brain was 2.7cm and the width was 1.6 cm.

Gyrus diagonalis was observed as a transverse band separated between the rosteral and caudal parts of the piriform lobe (Fig. 23/1), ***sulcus rhinalis lateralis*** and the poorly developed ***fissura sylvia*** resembled the previous sample.

The diencephalon, mesencephalon and rhombincephalon did not show marked variations.

At 17 cm C.V.R length : (Tables 2 and 3, Fig.24)

The length of the brain was 2.8 cm and the width was 1.8 cm.

A dorsal indentation appeared at the rostral third of the cerebral hemisphere (Fig. 24/1), another indentation appeared at the middle of the dorsolateral surface of each cerebral hemisphere (Fig. 24/2). At the medial surface ***sulcus splenialis*** extended caudally as ***sulcus calcarinus***.

The other components of the brain remained unchanged.

Histologically, the wall of the cerebrum showed adult cellular structure, it was composed of, outer molecular layer, external granular layer; pyramidal cell layer, internal granular layer and multiform cell layer (Fig. 25).

At 17.5 cm C.V.R length : (Tables 2 and 3, Fig.26)

The length of the brain was 2.9 cm while, the width was 1.9 cm.

The middle part of ***fissura sylvia*** became deeper and presented more dorsal extention (Fig. 26/1). The middle indentation observed in the previous age attained a cresentic shape hanged over The middle part of ***fissura sylvia*** (Fig. 26/3), and formed the origin of ***sulcus ectosylvius rostralis.***

The longitudinal fissure between the two cerebral hemispheres became shallow and turned rostroventrally and caudally around the rostral end of the corpus callosum, the latter appeared as a transverse partition between the two cerebral hemispheres (Fig. 26/4,5).

At 18.3 cm C.V.R. length : (Tables 2 and 3, Fig.27)

The length of the brain was 2.9 cm and the width was 1.9 cm.

The rostral branch of ***fissura sylvia*** appeared as a rostral extention of the previously oriented middle part (Fig. 27/1,2), this rostral branch run parallel to the rostral branch of ***sulcus rhinalis lateralis***. On the medial surface ***corpori callosi sulcus*** was seen parallel to the body of the corpus callosum (Fig. 27/6). The other sulci remained unchanged.

The occulomotor nerve appeared as a delicate nerve fiber originated from the middle of the medial surface of the cerebral crura (Fig. 27/7).

The choroid velli of the lateral ventricle were well developed, it occupied the whole length of the ventricle, it presented a well identified vascular cores (Fig. 28).

Moreover, histological figures showed an increase in the depth and number of cerebeller fissures, the velli of the choroids plexus of the fourth ventricle were more branched and well developed (Fig. 29).

At 19.3 cm C.V.R length : (Tables 2 and 3, Fig.30)

The length of the brain was 3 cm and the width was 1.9 cm.

The middle part of ***fissura sylvia*** presented more dorsal extention which gave more projection of ***gyrus sylvius*** (Fig. 30/1).

The rostral indentation which was previously appeared at the dorsal surface of each cerebral hemisphere became deeper and attained the site of ***sulcus suprasylvius rostralis*** (Fig. 30/2) it run parallel to the rostral third of the dorsal longitudinal fissure.

Sulcus ectosylvius rostralis presented an extention hanged over ***gyrus Sylvius***, this extention may be considered as sulcus ectosylvius medius, in addition, ***Sulcus ectosylvius rostralis*** presented a very faint caudal extention (Fig. 30/3).

Sulcus rhinalis medialis appeared as a short sulcus separated the olfactory bulb from the medial aspect of the cerebral hemisphere (Fig. 30/4), ***gyrus olfactorius medialis*** was differentiated here as the short part of the neupalium medial to this sulcus (Fig. 30/5).

At the most rostral point of the ventral surface of each cerebral hemisphere ***gyrus proreus*** developed, which lodged the olfactory bulb between its two short limbs (Fig. 30/6), this gyrus was bounded laterally by a short sulcus which was the early development of ***sulcus proreus*** (Fig. 30/7).

The vermis cerebelli nearly approached the adult folial and fissural arrangement, where it presented the main transverse fissures of varying depths (Fig. 30/8).

The other parts of the brain remained unchanged.

At 19.5 cm C.V.R length: (Tables 2 and 3, Fig.31)

The length of the brain was 3.1 cm and the width was 2.2 cm.

The middle part of ***fissure sylvia*** became deeper and more dorsally extended, the rostral part (Fig. 31/1) extended to the rostral pole of the cerebral hemispheres, while the caudal part was not yet fully developed (Fig. 31/2).

Sulcus ectosylvius rostralis and ***sulcus suprasylvius rostralis***, were deeper.

Sulcus marginalis (Fig. 31/5) appeared as a short and shallow indentation parallel to the caudal third of the dorsal longitudinal fissure.

The olfactory bulb markedly increased in size, became elongated and extended from the rostral end of the ventral surface of each cerebral hemisphere (Fig. 31/6), the medial and lateral olfactory tracts were well developed (Fig. 31/7,8).

The caudal part of the piriform lobe was larger and more bulged ventrally (Fig. 31/9).

The infundibulum, the tuber cinerium surrounded it were well pronaunced, the mamillary body was large rounded eminence occupying the rostral part of the intercrural fossa (Fig. 31/10,11&12).

The medial and lateral geniculate bodies and the brachia connected them with the caudal and rostral colliculi respectively, were well developed.

The mesencephalon presented two cerebral crura in the form of two longitudinal ridges at its ventral surface (Fig. 31/13), they were separated by a well distinict intercrural fossa (Fig. 31/14), while at the dorsal surface it presented the tectum which now composed of well developed two rostral and two caudal colliculi, the former were larger, rounded and lighter in color and the latter were smaller, elleptical and connected by a well marked isthmus.

The pons (Fig. 31/17) was well developed with a clear basilar and prepontine sulci.

The cerebellum presented a high degree of differentiation where both the vermis and the cerebellar hemispheres showed nearly adult folial and sulcal arrangement (Fig. 31/18).

The medulla oblongata presented a well observed pyramids and trapezoid body (Fig. 31/20,19).

The caudate nucleus attained the form of a rounded prominence at the rostral part of the floor of the lateral ventricle while the hippocampus presented a horn-like appearance, it resembled greatly the adult form and it was separated from the caudate nucleus by the choroid plexus of the lateral ventricle.

The brain of the second group was elongated in outline, and characterized by the appearance of several sulci.

Sulcus rhinalis lateralis was the first to appeare, it was observed for the first time at 12.6 cm CVR length, its rostral and caudal parts were clear at 14 cm CVR length. ***Sulcus calcarinous*** appeared at 12.9 cm CVR length. Then at 14 cm CVR length ***fissure Sylvia*** began to appear as a dorsolateral extention of the lateral fossa, its middle branch was the first to appeare at 17.5 cm CVR length followed by the rostral one at 18.3 cm CVR length. The middle branch underwent a gradual dorsal extention leading to the appearance of ***gyrus sylvius*** at 19.3 cm CVR length. ***Sulcus suprasylvius rostralis*** and ***sulcus ectosylvius rostralis*** appeared together as shallow identations at 17 cm CVR length and became clear at 19.3 cm CVR length, at this age, ***sulcus calcarinus*** appeared as a caudal extention of ***sulcus splenialis***. In addition, ***corpora callosi sulcus*** appeared at 18.3 cm CVR length followed by ***sulcus rhinalis medialis*** and the ***gyrus olfactorius medialis*** at 19.3 cm CVR length. ***sulcus and gyrus proreus*** appeared at 19.3 cm CVR length and the last one to appeare at this group was the marginal sulcus which firstly observed at 19.5 cm CVR length.

The olfactory tracts began to develope at 12.6 cm CVR length and became well developed at 19.5 cm CVR length, the olfactory bulb began to be

more prominent than the previous group at 12 cm CVR length, it increased gradually in size and attained a more elongated appearance.

The body of the pineal gland showed a marked gradual increase in size and an ovoid shape through this stage, the two prominances which represented the mamillary body at the previous group fused forming single mamillary body at 12.6 cm CVR length, in addition, the infundibulum and the tuber cinerium became well developed by the end of this group.

The division of the tectum into two rostral and two caudal colliculi occurred at the beginning of this stage (at 11 cm CVR length), this was accompanied by reduction in the length of the mesencephalon, the rostral colliculi attained a gradual rounded appearance with a distinct longitudinal groove separating them, while the caudal ones became elliptical and continuous with each other, the division and the arrangement of the tectum which resembled to a great extent the adult arrangement occurred early at this group. In addition the cerebral crura became elongated and separated by a clear intercrural fossa at 14 cm CVR length, this indicated that the mesencephalon showed an early gross morphological development. The occulomotor nerve appeared at 18.3 cm CVR length.

The premordia of the medial and lateral geniculate bodies as well as the brachia connected them with the caudal and rostral colliculi respectively, appeared at 11 cm CVR length and became more prominent at 12 cm CVR length, and attained a well developed appearance resembled adult at the end of this group.

The pons began to show clear changes at 14 cm CVR length which reflected by the appearance of slightly distinct basilar sulcus and the prepontine sulcus and the early development of the trigeminal nerve as a very fine nerve fibers originated at its lateral aspect, this structures became well identified at the end of this stage.

At 14 cm CVR length, the cerebellum assumed nearly adult form by the presence of two cerebeller hemispheres, vermis and a well marked choroid plexus of the fourth ventricle and the rostral medullary vellum, the vermis approached nearly the adult form at 19.3 cm CVR length, by the end of this group the cerebeller hemispheres and the vermis showed nearly the adult folial and sulcal arrangement.

The medulla oblongata began to exhibite a marked change at 12 cm CVR length by the development of the caudal part of the rhomboid fossa and a caudal longitudinal fissure at the dorsal surface, in addition to the development of tracts, at 14 cm CVR length, the medullary pyramids and the trapezoid body were very clear. The facial nerve estimated for the first time at this age.

At the beginning of this group, the interventricular foramen was clear, the third ventricle had the form of a narrow ring surrounded the thalamus and the premordium of its choroid plexus was observed at the rostrodorsal aspect of the thalamus. The mesencephalic aqueduct was narrow rostrally and wide caudally, while the fourth ventricle was wide due to the wide and shallow rhomboid fossa which constituted its floor.

By the end of this stage the caudate nucleus attained the form of a rounded prominence at the rostral part of the floor of the lateral ventricle while the hippocampus presented a horn-like appearance, it resembled greatly the adult form and it was separated from the caudate nucleus by the choroid plexus of the lateral ventricle.

3- GROUP III (goat embryo over 20 cm C.V.R length)

The brain of this group were characterized by an ovoid shape.

At 20.5 cm C.V.R length : (Tables 2 and 3, Fig. 32)

The length of the brain was 3.2 cm and the width was 2.2 cm.

The middle and rostral branches of ***fissura sylvia*** were more clear (Fig. 32/1,2), ***sulcus suprasylvius rostralis*** (Fig. 32/3), as well as ***sulcus ectosylvius rostralis*** (32/4) were deeper. ***Sulcus marginalis*** (32/5) was still shallow indentation.

A very narrow impression was observed just rostral to the rostral branch of ***fissura sylvia*** which indicated the very early appearance of ***sulcus presylvius*** (32/6).

The pineal gland presented a dorsal elongation and became relatively smaller in size (32/8).

The rosteral and caudal colliculi were more identified.

The vestibulocochlear nerve appeared as a delicate nerve fiber just caudal to the previously appeared facial nerve (32/10).

the vermis and the cerebeller hemispheres as well as the fissures and the folia were very clear.

The medullary pyramides were more clear

A very delicate nerve rootlets were observed at the lateral aspect of the medulla oblongata which indicated very early development of the glossopharyngeal, vagus and spinal accessory cranial nerves. (32/11)

At 21 cm C.V.R length : (Tables 2 and 3, Fig. 33)

The length of the brain was 3.2 cm and the width was 2.2 cm.

It could be observed that the rostral branch of ***fissura sylvia*** extended rostrally and dorsally as ***sulcus proreus*** which run along the caudal aspect of ***gyrus proreus*** (33/3)

The basilar sulcus of the pons increased markedly in depth that it divided the pons into two symmetrical halves.

The corpous trapizodium, the facial, the vestibulocochlear as well as the rootlets of the glossopharyngeal, vagus and spinal accessory nerves were more obvious.

At 22 cm C.V.R length : ((Tables 2 and 3, Fig. 34)

The length of the brain was 3.2 cm and the width was 2.4 cm.

On the medial surface of the cerebral hemispheres a short sulcus appeared parallel to the genue of the corpus callosum which represented the first appearance of sulcus genualis (34/18).

The previously mentioned sulci were deeper, ***sulcus splenialis*** as well as ***sulcus calcarinuus*** became separated from the corpus callosum by a very clear ***gyrus cinguli*** (34/12).

Otherwise the other parts resembled previous age.

At 23 cm C.V.R length : (Tables 2 and 3, Fig. 35)

The length of the brain was 3.5 cm and the width was 2.5 cm.

Sulcus cruciatus began to appear as an indentation on both sides of the rostral part of the dorsal longitudinal fissure as a rostral extention of sulcus splenialis, each sulcus was bounded rostrally and caudally by a narrow gyrus, gyrus precruciatus and postcruciatus (35/2,3).

The other parts of the brain resembled the previous age.

At 24 cm CVR length : (Tables 2 and 3, Fig. 36)

The length of the brain was 3.8 cm and the width was 2.7 cm.

Gyrus insularis became identified between the rostral branches of fissure Sylvia and sulcus rhinalis lateralis (36/3).

Sulcus presylvius increased in length.

On the dorsal surface of each cerebral hemisphere a short transverse sulcus appeared just rostral to ***sulcus marginalis*** as an early impression of the ***sulcus ansatus*** (36/5)

On the medial surface ***sulcus rostralis internus*** appeared as a very shallow indentation parallel to the rostral pole of each hemisphere (36/16)

A very delicate nerve fibers appeared at the lateral aspect of the caudal third of the medullary pyramids as a first development of the hypoglossal nerve (36/15).

At 26 cm CVR length : (Tables 2 and 3, Fig. 37)

The length of the brain was 4.3 cm and the width was 2.8 cm.

The sulci were narrower and deeper. The caudal branch of fissure sylvia was clear, it was shorter than the rostral one (37/1)

Gyrus sylvius became oriented in its position being separated by the middle branch of fissure Sylvia into ***gyrus sylvius rostralis*** and ***gyrus sylvius caudalis*** (37/2,3), the caudal one was larger and separated from the caudal part of the piriform lobe by the caudal part of ***sulcus rhinalis lateralis***.

Sulcus ectosylvius attained nearly adult arrangement where it possessed rostral and caudal branches (37/9,10), the rostral one was longer and extended over the dorsal border of gyrus sylvius which might be considered as sulcus ectosylvius medius from which arise two small branches one directed rostrodorsally and the other directed caudodorsally (37/7,8), that resulted in formation of ***gyrus ectosylvius*** with the same manner of sulcal division, the sulcus and gyrus ectosylvius had a characteristic undulating course over gyrus sylvius. The caudal part of the ***gyrus sylvius*** connected with ***gyrus ectosylvius caudalis*** at the caudal pole of each cerebral hemisphere forming the caudal ***gyrus compositus caudalis*** and in a similar manner the rostral part of ***gyrus***

sylvius connected with gyrus ectosylvius rostralis forming ***gyrus compositus rostralis.***

On the medial surface ***sulcus calcarinus*** (37/15) extended parallel to the dorsal border of each hemisphere beginning from the most caudal pole to about the end of the distal third and then continue rostrally with ***sulcus splenialis*** (37/16), the latter ended by combination with the medial extention of ***sulcus cruciatus*** .It could be also observed that there was a short extention of both ***sulcus marginalis*** and ***sulcus ansatus*** on this surface.

Gyrus marginalis (37/14) was more identified as a longitudinal gyrus parallel to the dorsal longitudinal fissure along its caudal halve, it was continued caudally with ***gyrus occipitalis*** at the most caudal point of the caudal pole of each cerebral hemisphere.

The pineal gland markedly reduced in size and compressed laterally.

The mesencephalon exhibited the typical adult arrangement, the caudal colliculi was nearly completely covered by the cerebellum.

The lateral ventricle had a well marked hippocampus and caudate nucleus, in addition, the telencephalic septum as well as the choroid plexus were well identified. The roof of the third ventricle was well oriented with its choroids plexus.

At 32.5 cm CVR length : (Tables 2 and 3, Fig. 38)

The length of the brain was 5.5 cm and the width was 3.3 cm.

Sulcus suprasylvius caudalis was observed along the middle third of the dorsal surface of the cerebral hemispheres parallel to ***sulcus marginalis*** (38/1), between this two sulci ***gyrus ectomarginalis*** was located in its position and separated from gyrus marginalis by sulcus marginalis (38/2).

At 35 cm CVR length : (Tables 2 and 3, Fig. 39, 40, 41&42)

The length of the brain was 5.6 cm and the width was 3.4 cm.

The cerebral hemispheres presented adult sulcal and gyral arrangement, since in addition to the sulci and gyri which were observed in previous ages ***sulcus genualis*** appeared on the medial surface, where it turned parallel to the genue of the corpus callosum, to end caudally on ***gyrus cinguli*** between the sulcus splenialis and sulcus corpori callosi, a short sulcus extended rostrally and dorsally from sulcus genualis(42/23).

Fissure Sylvia was divided into three branches, rostral, middle and caudal (41/3,4,5). The rostral branch was long, it passed rostrally parallel to the rostral branch of sulcus rhinalis lateralis being separated from the latter by ***gyrus insularis***, the middle branch extended dorsally where it divided the sylvian gyrus into rostral and caudal parts, the caudal branch was the shortest of the three branches, it did not reach the caudal pole of the cerebral hemisphere.

Sulcus presylvius was oriented as a short sulcus located between the rostral and middle branches of fissure Sylvia (41/6), where it run nearly parallel to the rostral branch, it communicated rostrally with sulcus ectosylvius rostralis .

The rostral and caudal parts of ***sulcus ectosylvius*** (41/7,9), attained an undulating course over the dorsal border of gyrus sylvius, the rostral part was longer, extended caudally and dorsally over the dorsal border of gyrus sylvius it gave rise to two small branches, sulcus obliqus rostralis and caudalis (accoing to AMIN, 1982 in goat), the former directed dorsally and rostrally and the latter directed dorsally and caudally (41/8\,8\\), the caudal part was short and passed into a dorsomedial direction, it reached the caudal pole of the cerebral hemisphere to end at gyrus composit caudalis (41/13). The gyrus ectosylvius exhibited the same manner of sulcal division.

Sulcus suprasylvius (39/3,4), represented by two parts, ***sulcus suprasylvius rostralis*** which was located at the rostral third of the dorsal surface

of each cerebral hemisphere, nearly parallel to the dorsal longitudinal fissure, it was separated from sulcus suprasylvius caudalis by gyrus precruciatus and postcruciatus 39/10,11). ***Sulcus suprasylvius caudalis*** was observed at the middle third of the dorsal surface of the cerebral hemisphere parallel to the sulcus marginalis, it did not reach the caudal pole of the cerebral hemisphere.

Sulcus proreus (42/12) was a short sulcus which made the dorsal boundary of the ***gyrus proreus*** (39/9).

Sulcus marginalis (39/2), run along the middle halve of the dorsal surface of the cerebral hemisphere parallel to the dorsal longitudinal fissure, it ended at the caudal pole of the hemisphere, the rostral end of this sulcus turned around the dorsal border of the cerebral hemisphere to end at the medial surface of each hemisphere caudal to the medial extension of the sulcus ansatus.

Sulcus ansatus (39/7) was a short transverse sulcus which located at about the middle of the dorsal convex surface of the cerebral hemisphere, it curved around the dorsal border to extend at the medial surface just rostral to the medial extention of gyrus marginalis.

Sulcus cruciatus (39/8), located at the rostral third of the cerebral hemisphere, being separated from the rostral suprasylvius sulcus by gyrus precruciatus and postcruciatus, it separated between the last two gyri and it extended at the medial surface of the cerebral hemisphere to be communicated with the rostral end of sulcus splenialis.

Sulcus calcarinus (42/19), was a considerably large sulcus which situated at the caudal third of the medial surface of the cerebral hemisphere, it run parallel to the splenium of the corpus callosum and being separated from it by ***gyrus cinguli*** (42/17), it continued rostrally with sulcus splenialis.

Sulcus splenialis (42/20), run parallel to the body of the corpus callosum on the medial surface of the cerebral hemisphere, it continued rostrally as sulcus cruciatus.

Sulcus rostralis internus (42/22), was another medial sulcus which situated at the most rostral pole of the medial surface of the cerebral hemisphere, it course parallel to sulcus rhinalis medialis.

Sulcus corpori callosi (42/12), was situated along the corpus callosum and lined dorsally by gyrus cinguli.

Sulcus rhinalis lateralis(41/1,2), was the longest of the sulci of cerebral hemisphere separating the cerebral hemispheres from the rhinencephalon, it was subdivided by the middle part of the sylvian fissure into rostral and caudal parts, the rostral part, run parallel to the rostral branch of the fissure sylvia being separated from it by the gyrus insularis, it terminated at the rostral pole of the cerebral hemisphere parallel to sulcus proreus.The caudal part of the lateral rhinal sulcus separated the caudal part of the piriform lobe from the cerebral hemisphere

Sulcus rhinalis medialis, run parallel to the sulcus rostralis internus where it separated the rhinencephalon from the cerebral hemispheres.

Due to the complete development and arrangement of the medial sulci of the cerebral hemispheres, ***gyrus cinguli*** was located in its position as a large gyrus separated from gyrus marginalis by sulcus calcarinus, sulcus splenialis and sulcus cruciatus and lined medially by sulcus corpori callosi.

In addition to the previously mentioned results, the caudate nucleus and the hippocampus were very clear (42/25,26).

According to the results mentioned in the previous samples and those which were recorded in the present sample the brain at this age presented all adult gross morphological features.

B- PRENATAL MORPHOMETRIC DEVELOPMENTAL STUDIES.

The measurements recorded in tables (2,3,4,5,6,7,8,9,10 and 11) and Fig. (43, 44, 45, 46, 47, 48, 49, 50, 51 and 52) indicated the relation between the rate of growth of the body (CVR length) and the brain and also the relation between the rate of growth of the brain and cerebrum, cerebellum and medulla oblongata. In general, the available data indicated that, there was a direct proportion between CVR length and length and width of brain in goat embryo and also the same relationship between the brain measurements and measurements of its different parts.

Relation between CVR length and length of the brain :

Table (2) and Fig. (43) indicated that this relation varied along the available ages.

In group I, (up to 10 cm CVR length) the early stage of development (up to 10 cm CVR length), the graphic contours showed two different stages. The first (3.3-5.7 cm CVR length), the brain length gradually increased in a slow rate (0.4-0.7 cm), during this stage the average percentage of the brain length to the CVR length was 11.6%. the second stage (5.7-9.5 cm CVR length) the brain length abruptly increased (0.7-2 cm) with the average percentage of 17.2%, this indicated that the brain in the second stage grew faster than CVR length.

At group II, (10-20 cm CVR length) the length of the brain showed a gradual increase from 2.2-3.1 cm while the CVR length increased from 11-19.5 cm, the average percentage of the brain length to CVR length increased in this group to 17.8%. In this group also the brain grew faster.

At group III, (over 20 cm CVR length), the length of the brain grew faster than the previous stages from 3.2-5.9 cm with the maturation of the cvr length from 20.5-38 cm it could be noticed that the rate of growth in the CVR length was higher than the rate of increase in the length of brain, and accordingly the

percentage of the length of brain to CVR length in this stage reduced to 15.7%. This indicated tht the brain assumed its nearly mature form while CVR length still grew faster to reach full term CVR length.

Relation between CVR length and width of the brain :

Table (3) and Fig. (44) indicated that there was a great similarity between the pattern of growth of brain width and length in relation to the growth in the CVR length. Where at group I, (up to 10 cm CVR length) graphic contours indicated two different stages, the first stage (3.3-8 cm CVR length) the width of brain increased gradually in a slow rate from 0.1-0.4 cm, the average percentage of the brain width to CVR length was 4.12%. In the second stage (8-9.5 CVR length), the brain width increased abruptly and grew in a faster rate from 0.4-0.9 cm, the percentage of the brain width to CVR length was 8.95% cm, it was clear that during the first group the brain width increased in a higher rate than CVR length.

At group II, (10-20 cm CVR length) the width of the brain increased gradually from 1.2-2.2 cm while CVR length increased from 11-19.5 cm, the average percentage of the brain width to CVR length was 10.8%. in this group he width of the brain had nearly the same rate of growth of CVR length.

Group III, (over 20 cm CVR length) characterized by a faster increase in the brain width from 2.2-4 cm, in contrast, CVR length increased from 20.5-38 cm both had nearly the same rate of growth, in addition the average percentage of the brain width to CVR length was 10.5%.

Relation between the length of the brain and the length of the cerebrum :

Table (4) and Fig. (45) showed that the length of the cerebrum was about 1cm while the brain length increased gradually from 2-2.4 cm, the cerebral length constituted 50% of the total brain length at the end of the first group,

while, at the early period of the second group it presented 44.5% of the total brain length. At the late age of the second group there was a gradual increase in the length of the cerebrum from 1-1.8 cm with the maturation in the brain length from 2.4-3.1 cm, that indicated higher rate of growth in cerebral length than the total brain length, the average percentage of the cerebral length to the total brain length at this age was 53.9%.

At the third group (over 20 cm CVR length) there was a marked rapid increase in the cerebral length from 1.8-3.7 cm with the increase in the total brain length from 3.2-5.9 cm, here the rate of growth of cerebral length was clearly higher than that of the whole brain, the percentage of the cerebral length to the total brain length at the end of this group was 62.7 %, while, the average value of this group was 60.7%.

Relation between the length of the brain and the length of the cerebellum :

Table (5), Fig. (46) indicated that the length of cerebellum showed a gradual increase from 0.02-1.4 cm through the whole CVR lengths with the increase in the total brain length from 2.2-5.9 cm, the rate of growth of cerebellum proportionally higher than that of the whole brain, the value of the cerebeller length was nearly constant at the end of the second group 10-20 cm CVR length), the average percentage of the cerebeller length to the total brain length was 12% at the second group and 21 % at the third group (over 20 cm CVR length).

Relaion between the length of the brain and the length of pons :

Table (6), Fig. (47) reflected that the length of pons was 0.1 cm while the brain length increased from 2-3.2 cm, after which the length of pons increased gradually from 0.1-0.4 cm while the total brain length increased from 3.2-5.9 cm. the average percentage of the length of pons to the total brain length was

4.7% and 4.9% at the second and the third groups respectively, and it was clear that the rate of growth in total brain length was higher than that in the pons length.

Relation between the length of the brain and the length of the medulla oblongata :

Table (7), Fig. (48), indicated that there was a gradual increase in the length of medulla from 0.3-0.7 cm with the increase in the length of brain from 2.2-3.1 cm, at this stage the percentage of the medullary length to the total brain length was 18.3%, the third group (over 20 cm CVR length) presented a faster increase in the length of the medulla from 0.9-1.4 cm while the total brain length increased from 3.2-5.9 cm, the average percentage of the medullary length to the total brain length at this group was 26.1%.

Relation between the width of the brain and the width of a cerebral hemisphere:

Table (8), Fig. (49), showed that, the width of the cerebral hemisphere was 0.5 cm while the brain width increased from 0.9-1.6 cm, the width of the cerebral hemisphere was o.7 cm while the brain width increased from 1.6-2.2 cm, the percentage of the cerebral hemisphere width to the total brain width at the second group was 37.2%, at the third group (over 20 cm CVR length) the cerebral hemisphere width increased gradually from 0.8-1.7 cm with the increase in the total brain width from 2.2-4 cm, the percentage of the cerebral hemisphere width to the total brain width at this group was 40%.

Relation between the width of the brain and the width of the cerebellum:

Table (9), Fig. (50) indicated that, the width of cerebellum was 0.6 cm with the gradual increase in the width of the brain from 1.2-1.8 cm the width of cerebellum was 0.7 cm while brain width increased from 1.8-2.2 cm, this

indicated a slower rate of growth in width of cerebellum than the width of the brain, the percentage of the width of the cerebellum to the width of the brain at the second group (10-20 cm CVR length) was 39.9%. The third group (over 20 cm CVR length) characterized by a gradual increase in the width of cerebellum from 0.7-1.5 cm with the increase in the brain width from 2.2-4 cm, which indicated that both had nearly the same rate of growth, the percentage of the width of the cerebellum to the width of brain in this group was 35.7%.

Relation between the width of the brain and the width of pons :

Table (10) Fig. (51), showed that the width of pons increased gradually from 0.3-0.5 cm while the width of the brain increased from 0.9-1.4 cm, and then the width of pons was 0.5 cm while the width of brain increased from 1.4-1.6 cm, after which the width of pons was 0.6 cm with the increase in the brain width from 1.6-2.5 cm, this was followed by a gradual increase in the width of pons from 0.6-1 cm by the end of the third group, this accompanied by the increase in the brain width from 2.5-4 cm, this indicated that, the rate of growth in the width of pons was generally slower than that of the width of the brain, the percentage of the width of pons to the brain width was 30% and 25.6% at the second and the third groups respectively.

Relation between the width of the brain and the width of the medulla oblongata :

Table (11), Fig. (52), indicated that the width of medulla oblongata was 0.4 cm while the width of the brain increased from 1.2-1.4 cm and then it was 0.5 cm while the width of the brain increased from 1.2-2.2 cm, the percentage of the medullary width to the brain width in the second group (10-20 cm CVR length) was 28.7%. The third group (over 20 cm CVR length) showed a gradual increase in the medullary width from 0.5-1.1 cm with the increase in brain width

from 2.2-4 cm, which indicated that both parameters had nearly the same rate of growth at this group, the percentage of the medullary width to the brain width in the third group was 25.3%.

Legends of Figures of Group I (up to 10 cm CVR length)

Fig.1.Cross section of goat embryo at 1.79 cm CVR length.
(H&E, X=4).
N, neural tube.
1. Epindymal layer.
2. Mantle layer.
3. Marginal layer.

Fig.2.Cross section of goat embryo at 1.99 cm CVR length.
(H&E, X=4).
N, neural tube.
NC, neural crest.
1. Epindymal layer.
2. Mantle layer.
3. Marginal layer.

Fig.3.Brain of goat embryo at 3.3 cm CVR length.
A, dorsal view; B, ventral view; C, lateral view.
1. Prosencephalon.
2. Mesencephalon.
3. Metencephalon.
4. Mylencephalon.
5. Pontin flexure.

Fig.4.Brain of goat embryo at 3.8 cm CVR length.
A, dorsal view; B, ventral view; C, lateral view.
1. Cerebral hemisphere.
2. Dienceohalon and mesencephalon.
3. Interventricular portion of rhombic lip.
4. Pontin flexure.
5. Rhombincephalic isthmus.
6. Bulbus olfactorius.

Fig.5a.Sagital section of the diencephalon at 3.8 cm CVR length.
(H&E, X=4).
1. Choroid plexus of the third ventricle.
2. Third ventricle.
3. Thalamus.
4. Hypothalamus.
5. Thalamic tracts.

Fig.5b.Choroid plexus of the third ventricle.
(H&E, X=40).
1. Lining epithelium.
2. Vascular cure.

Fig.5c.Thalmic tracts.
(H&E, X=10).
1. Condensed cell layer.
2. Layer of nerve fibers.

Fig.5d.Thalamic tracts.
(H&E, X=40).
1. Condensed cell layer.
2. Layer of nerve fibers.

Fig.6.Brain at 4.3 cm CVR length.
A, dorsal view; B, ventral view; C, lateral view.
1. Cerebral hemispheres.
2. Bulbus olfactorius.
3. Corpus mamillare.
4. Infundibulum of hypophysis.
5. Mesencephalon.
6. Pontin flexure.
7. Rhombencephalic isthmus.

Fig.7.Brain of goat embryo at 5.7 C.V.R length.
A, dorsal view; B, ventral view; C, lateral view.
1. Cerebral hemispheres.
2. Pars caudalis of lobus piriformis.
3. Corpus mamillare.
4. Infundibulum of hypophysis.
5. Mesencephalon.
6. Fissure longitudinalis cerebri.
7. Cerebellar plat.
8. Fossa rhomboidea.
9. Pons.
10. Medulla oblongata.

Fig.8.Cross section of the diencephalon at 5.7 cm CVR length.
(H&E, X=4).

1. Lateral ventricle.
2. Choroid plexus of the lateral ventricle.
3. Interventricular foramen.
4. Third ventricle.
5. Thalamus.

Fig.9.Cross section of cerebral hemispheres at 5.7 cm CVR length.
(H&E, X=4).

1. Lateral ventricle.
2. Velli of the telencephalic choroid plexus.
3. Vascular core.
4. First layer.
5. Second layer.
6. Third layer.
7. Fourth layer.
8. Fifth layer.

Fig.9a.b.c.Structure of the 1st, 2nd, 3rd, 4th and 5th layers.
(H&E, X=40).

1. first layer.
2. Second layer.
3. Third layer.
4. Fourth layer.
5. Fifth layer.

Fig.9d.Cross section in the telencephalic choroid plexus at 5.7 cm CVR length.
(H&E, X=100).

1. Epithelial lining.
2. Vascular core.

Fig.10.Brain of goat embryo at 8 cm CVR length.
A, dorsal view; B, ventral view; C, lateral view.

1. Cerebral hemisphere.
2. Infundibulum of hypophysis.
3. Tuber cinerium.
4. ,4\ Corpus mamillare.
5. Transverse groove.
6. , 6\ Crura cerebri.
7. Sulcus basilaris.
8. Cerebellar hemispheres.
9. Parenchymatous bridge.
10. Sulcus dorsalis median
11. Medullary pyramids.

Fig.11.Cross section of the lateral ventricle at 8 cm CVR length showing the hippocampus.
(H&E, X- 40).

1. cerebral wall.
2. Lateral ventricle.
3. Choroid plexus of the lateral ventricle.
4. Hippocampus.

Fig.12.Brain of goat embryo at 8.3 cm CVR length.
A, dorsal view; B, ventral view; C, lateral view.

1. Cerebral hemisphere.
2. Bulbus olfactorius.
3. Pars caudalis of lobus piriformis.
4. Ventral indentation.
5. Glandulae pinealis.
6. Corpus trapizodium
7. Medullary pyramids.
8. Cerebellum.

Fig.13.Sagital section of the cerebellum and fourth ventricle at 8.3 cm CVR length.
(H&E, X=40).

1. Cerebeller fissures.
2. cerebellum.
3. Choroid plexus of the fourth ventricle.
4. Fourth ventricle.

Fig.14.Brain of goat embryo at 9.5 cm CVR length.
A, dorsal view; B, ventral view; C, lateral view.

1. Fossa lateralis.
2. Infundibulum of hypophyis.
3. Tuber cinerium.
4. Corpus mamillare.
5. Crura cerebri.
6. Pons.
7. Mesencephalon.
8. Cerebellum.
9. Fossa rhomboidea
10. Glandulae pinealis.

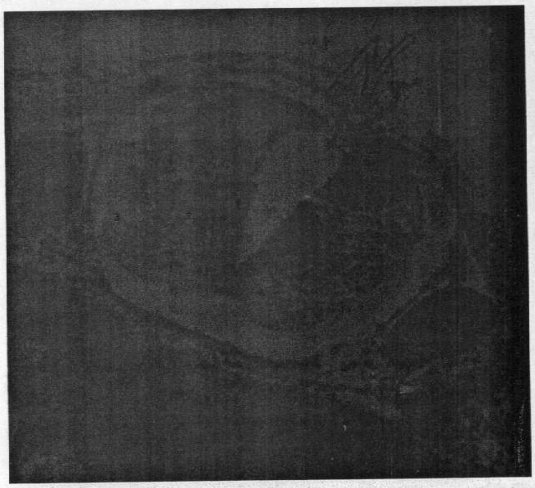

Fig. 1. Cross section of goat embryo at 1.79 cm CVR length.

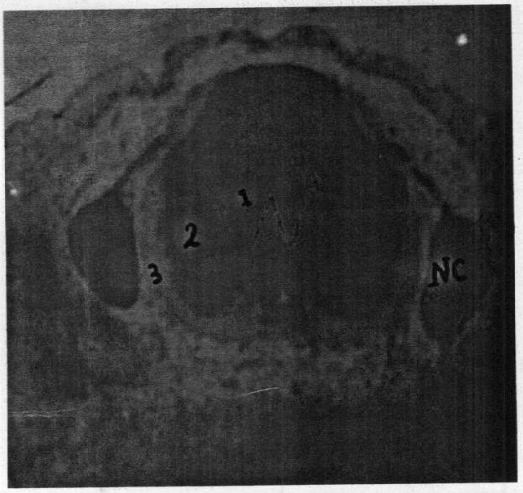

Fig. 2. Cross section of goat embryo at 1.99 cm CVR length

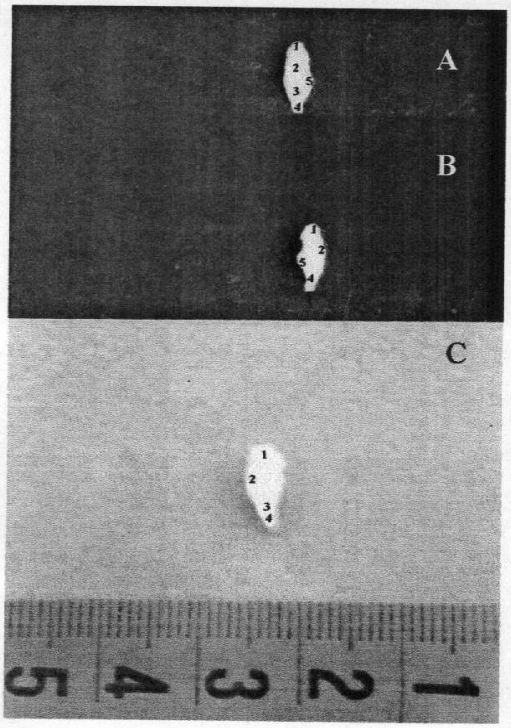

Fig. 3. Brain of Goat Embryo at 3.3 cm CVR length

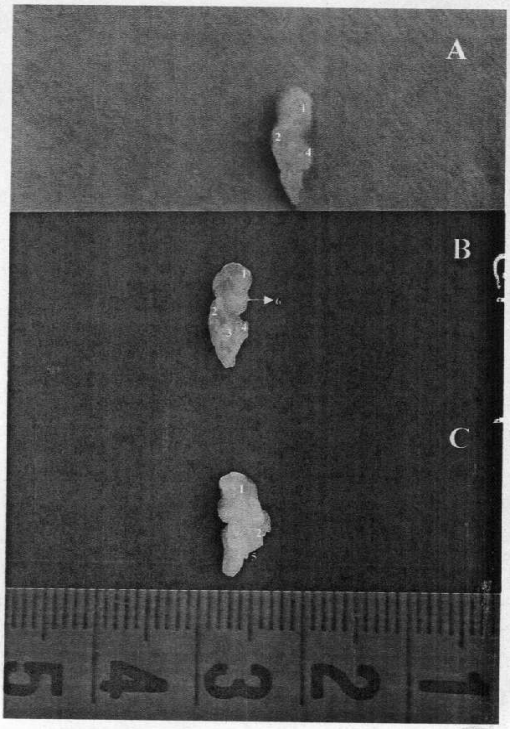

Fig. 4. Brain of Goat Embryo at 3.8 cm CVR length

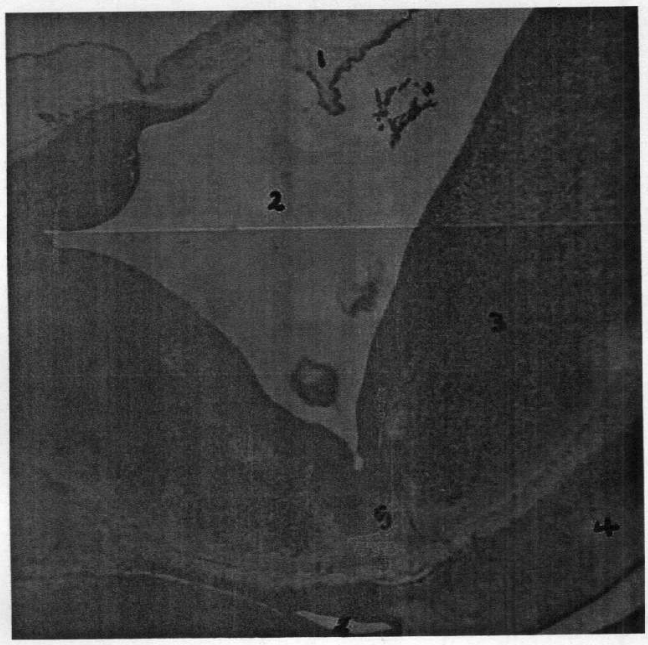

Fig. 5a. Sagital section of the diencephalon at 3.8 cm CVR length.

Fig. 5b. Choroid plexus of the 3rd ventricle 3.8 cm CVR length.

Fig. 5c. Thalamic tracts at 3.8 cm CVR length.

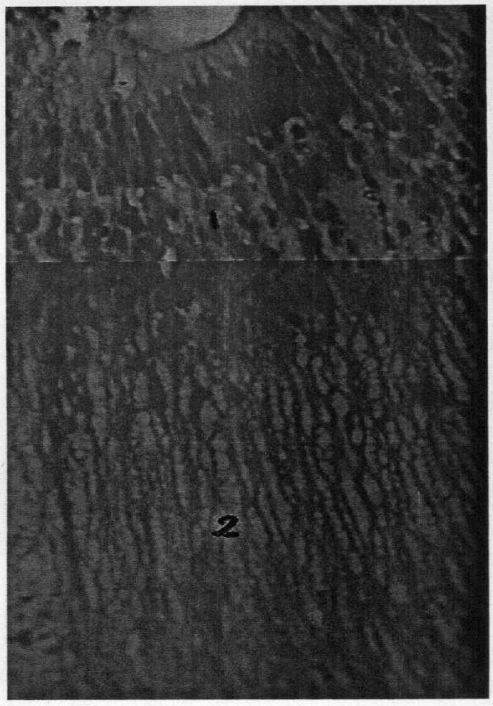

Fig. 5d. Thalamic tracts

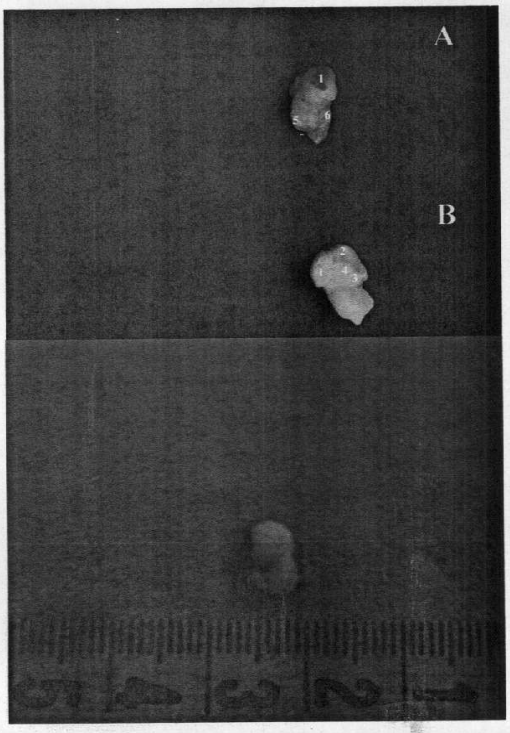

Fig. 6. Brain of Goat Embryo at 4.3 cm CVR length

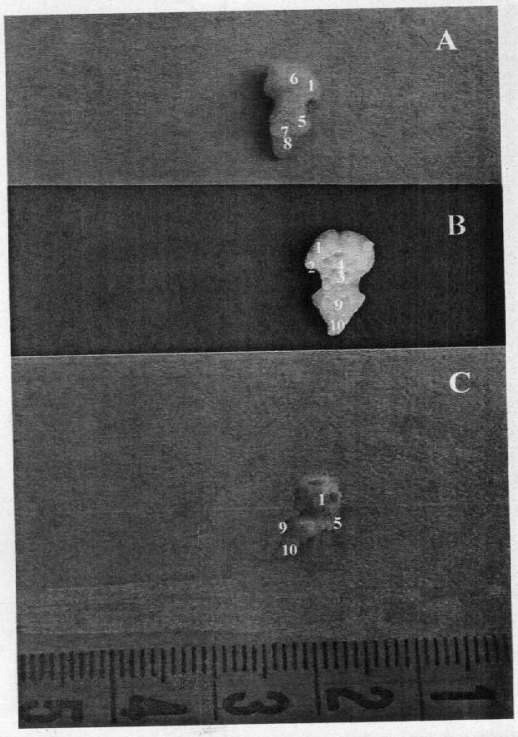

Fig. 7. Brain of Goat Embryo at 5.7 cm CVR length

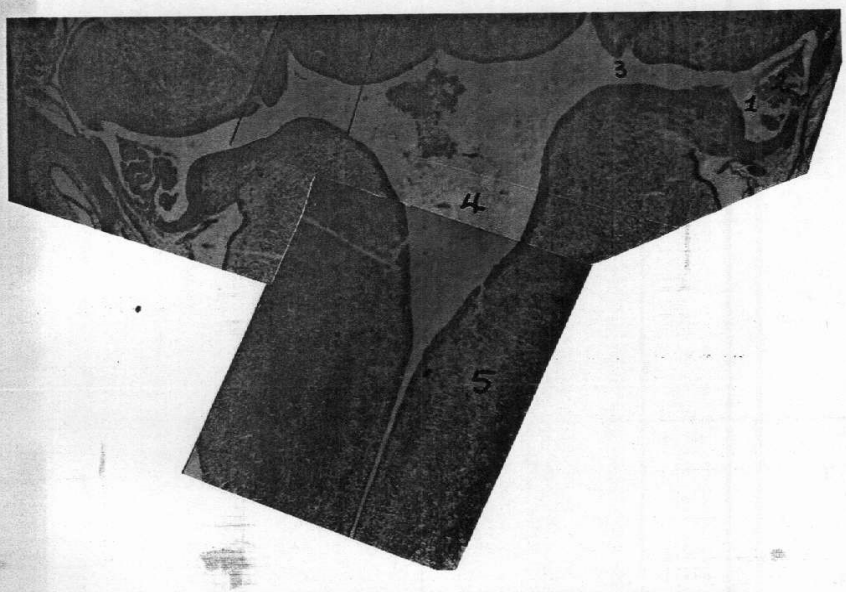

Fig. 8. Cross section of the diencephalons at 5.7 cm CVR length

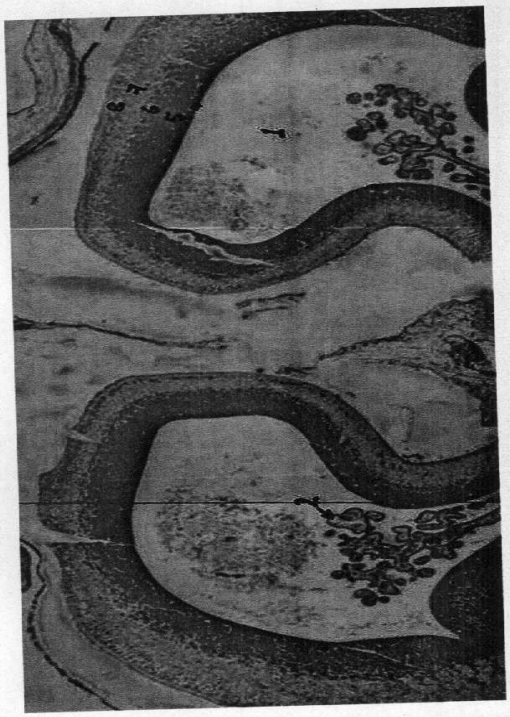

Fig. 9. Cross section of cerebral hemispheres at 5.7cm CVR length

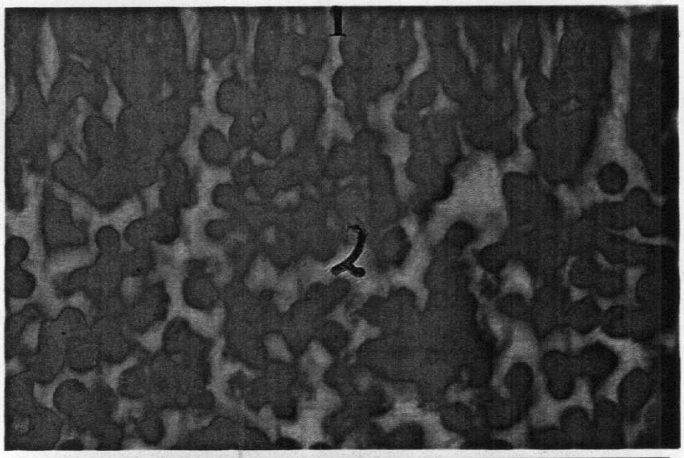

Fig. 9a. Structure of the first & second layers.

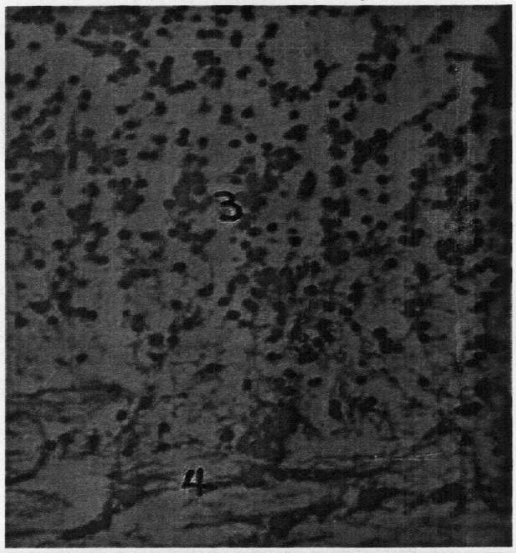

Fig. 9b. Structure of the third & fourth layers.

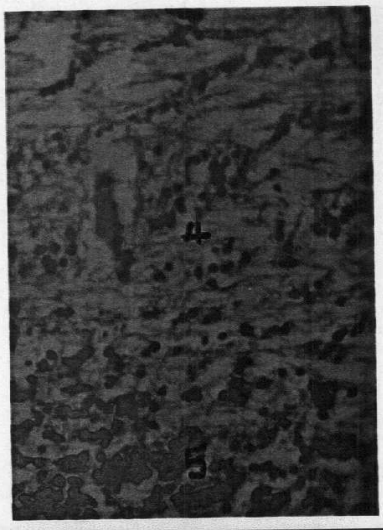

Fig. 9c. Structure of the fourth & fifth layers.

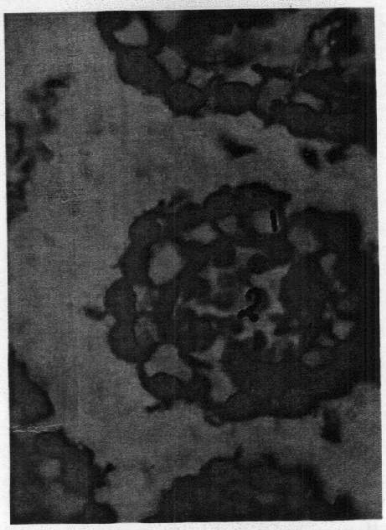

Fig. 9d. Cross section in the diencephalic choroids plexus at 5. cm CVR length.

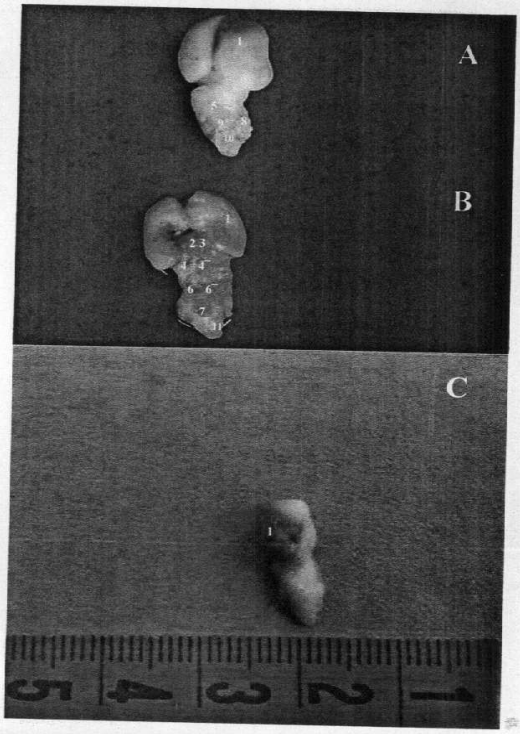

Fig. 10. Brain of Goat Embryo at 8 cm CVR length

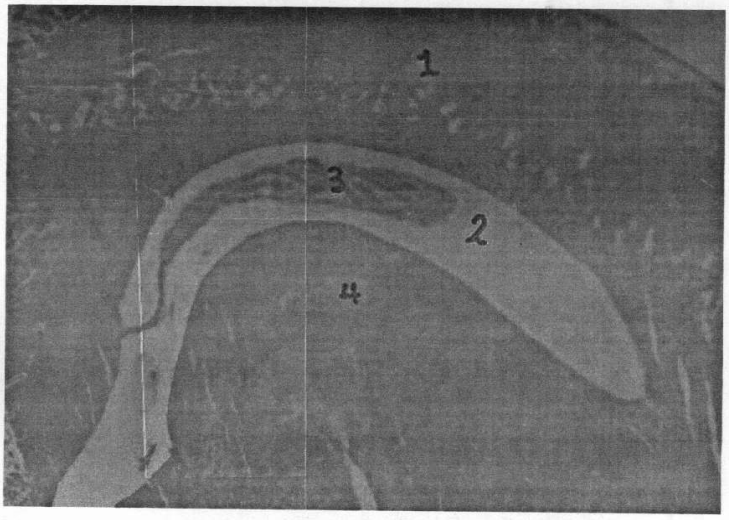

Fig. 11. The lateral ventricle at 8 cm CVR length showing the hippocampus

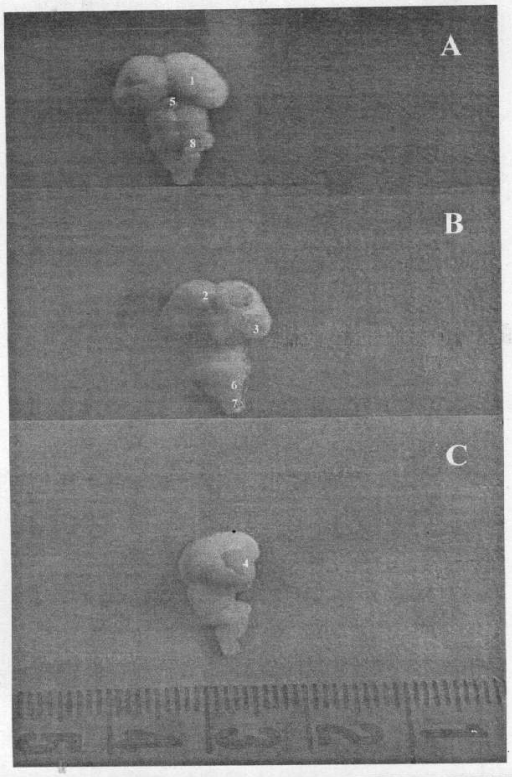

Fig. 12. Brain of Goat Embryo at 8.3 cm CVR length

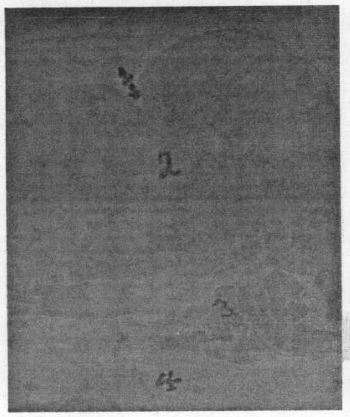

Fig. 13. Cerebellum and 4th ventricle at 8.3 cm CVR length

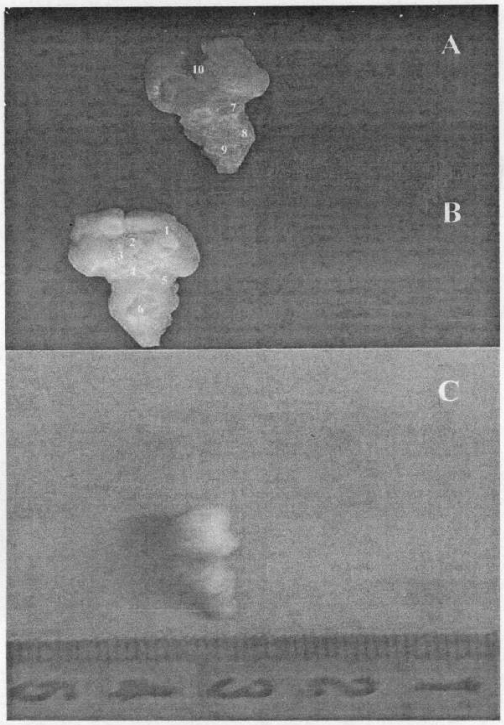

Fig. 14. Brain of Goat Embryo at 9.5 cm CVR length

Legends of Figures of Group II (10-20 cm CVR length)

Fig.15.Brain of goat embryo at 11 cm CVR length.
A, dorsal view; B, ventral view; C, lateral view; D, midsagital section.

1. Fossa lateralis.
2. Glandulae pinealis.
3. Infundibulum of hypophyis.
4. Tuber cinerium.
5. Corpus mamillare.
6. 6\ Rostral colliculi.
7. 7\ Caudal colliculi.
8. 8\ Crura cerebri.
9. Fossa intercruralis.
10. Pons.
11. Cerebellum.
12. Medullary pyramids.
13. Thalamus.
14. Ventriculus tertius.
15. Choroid plexus of the third ventricle.
16. Aquiductus mesencephali.
17. Fourth ventricle.
18. Nucleus caudatus.
19. Hippocampus.

Fig.16.Brain of goat embryo at 12 cm CVR length.
A, ventral view; B, lateral view.

1. Fossa lateralis.
2. Bulbus olfactorius.
3. Pars caudalis of lobus piriformis.
4. 4\ Crura cerebri.
5. Fossa intercruralis.

Fig.17.Lateral ventricle at 12 cm CVR length.
(H&E, X=10).

1. Wall of the lateral ventricle.
2. Lateral ventricle.
3. Choroid plexus of the lateral ventricle.

Fig.18.Brain of goat embryo at 12.6 cm CVR length.
A, A\ dorsal view; B, ventral view; C, lateral view.

1. Fossa lateralis.
2. Sulcus rhinalis lateralis.
3. Bulbus olfactorius.
4. Tractus olfactorius lateralis.
5. Tractus olfactorius medialis.
6. Glandulae pinealis.
7. Corpus geniculatum lateralis.
8. Brachium of the rostral colliculi.
9. Colliculi rostralis.
10. Colliculi caudalis.
11. Cerebellum.
12. Fossa rhomboidea.

Fig.19.Cerebellum and fourth ventricle at 12.6 cm CVR length.
(H&E, X=10).

1. Cerebeller fissure.
2. Cerebellum.
3. Choroid plexus of the fourth ventricle.
4. Fourth ventricle.

Fig.20.Brain of goat embryo at 12.9 cm CVR length.
A, dorsal view; B, ventral view; C, lateral view.

1. Sulcus calcarinus.
2. Fossa lateralis.
3. Sulcus rhinalis lateralis.
4. Bulbus olfactorius.
5. Tractus olfactorius medialis.
6. Tractus olfactorius lateralis.
7. Pars caudalis of lobus piriformis.
8. Glandulae pinealis.
9. Rostral colliculi.
10. Caudal colliculi.
11. Crura cerebri.
12. Pons.
13. Memedulla oblongata.
14. Cerebellum.

Fig.21.Brain of goat embryo at 14 cm CVR length.
A, dorsal view; B, ventral view; C, lateral view.

1. 1\, Pars rostralis and pars caudalis of sulcus rhinalis lateralis.
2. Fissura Sylvia.
3. Bulbus olfactorius.
4. Tractus olfactorius medialis.
5. Tractus olfactorius lateralis.
6. Pars caudalis of lobus piriformis.
7. Infundibulum of hypophysis.
8. Tuber cinerium.
9. Corpus mamillare.
10. Crura cerebri.
11. Pons.
12. Trigeminal nerve.
13. Sulcus basilaris.
14. Ventral median fissure.
15. Colliculus rostralis.
16. Colliculus caudalis.
17. Cerebellum.
18. Dorsal median sulcus.
19. Facial nerve.

Fig.22.Brain of goat embryo at 14 cm CVR length.
D, dorsal view of brain stem and medial view of cerebral hemispheres; E, ventral view of brain stem showing trigeminal nerve; F, sagital section of brain stem.

1. Thalamus.
2. Thalamus.
3. Glandulae pinealis.
4. Corpus geniculatum lateralis.
5. Brachium of the rostral colliculi.
6. Colliculus rostralis.
7. Colliculus caudalis.
8. Brachium of the caudal colliculi.
9. Sulcus calcarinus.
10. Nucleus caudatus.
11. Hippocampus.
12. Trigeminal nerve.
13. Facial nerve.
14. Thalamus.
15. Ventriculus tertius.
16. Aquiductus mesencephali.
17. Fourth ventricle.
18. Medullary vellum.
19. Colliculus rostralis.
20. Colliculus caudalis.

Fig.23.Brain of goat embryo at 16.5 cm CVR length.
A, dorsal view; B, ventral view; C, lateral view.

1. Gyrus diagonalis.

Fig.24.Brain of goat embryo at 17 cm CVR length.
A, dorsal view; B, ventral view; C, lateral view.

1. Dorsal indentation.
2. Middle indentation.

Fig.25.Cerebral wall at 17 cm CVR length.
(H&E, X=4).

1. First layer.
2. Second layer.
3. Third layer.
4. Fourth layer.
5. Fifth layer.

Fig.26.Brain of goat embryo at 17.5 cm C.V.R length.
A, dorsal view; B, ventral view; C, lateral view.

1. Middle branch of fissure Sylvia.
2. Dorsal indentation.
3. Middle indentation.
4. Dorsal median fissure.
5. Corpus callosum.

Fig.27.Brain of goat embryo at 18.3 cm CVR length.
A, dorsal view; B, ventral view; C, lateral view.

1. Middle branch of fissura Sylvia.
2. Rostral branch of fissura Sylvia.
3. Sulcus rhinalis lateralis.
4. Sulcus calcarinus.
5. Sulcus splenialis.
6. Sulcus corpori callosi.
7. Occulomotor nerve.

Fig.28.Telencephalic choroid plexus at 18.3 cm CVR length.
(H&E, X=10).

1. Lateral ventricle.
2. Choroid plexus of the lateral ventricle.

Fig.29.Sagital section of the cerebellum and fourth ventricle at 18.3 cm CVR length. (H&E, X=4).

1. Cerbeller fissure.
2. Cerebellum.
3. Choroid plexus of the fourth ventricle.
4. Fourth ventricle.

Fig.30.Brain of goat embryo at 19.3 cm CVR length.
A, dorsal view; B, ventral view; C, lateral view.

1. Middle branch of fissure Sylvia.
2. Sulcus suprasylvius rostralis.
3. Sulcus ectosylvius medius.
4. Sulcus rhinalis medialis.
5. Gyrus olfactorius medialis.
6. Gyrus proreaus.
7. Sulcus proreaus.
8. Vermis.

Fig.31.Brain of goat embryo at 19.5 cm CVR length.
A, dorsal view; B, ventral view; C, lateral view.

1. Middle branch of fissura Sylvia.
2. Rostral branch of fissura Sylvia.
3. Sulcus suprasylvius rostralis.
4. Sulcus ectosylvius rostralis.
5. Sulcus marginalis.
6. Bulbus olfactorius.
7. Tractus olfactorius medialis.
8. Tractus olfactorius lateralis.
9. Lobus piriformis caudalis.
10. Infundibulum of hypophysis.
11. Tuber cinerium.
12. Corpus mamillare.
13. Crura cerebri.
14. Fossa intercruralis.
15. Colliculus rostralis.
16. Colliculus caudalis.
17. Pons.
18. Cerebellum.
19. Corpus trapizodium.
20. Medullary pyramids.

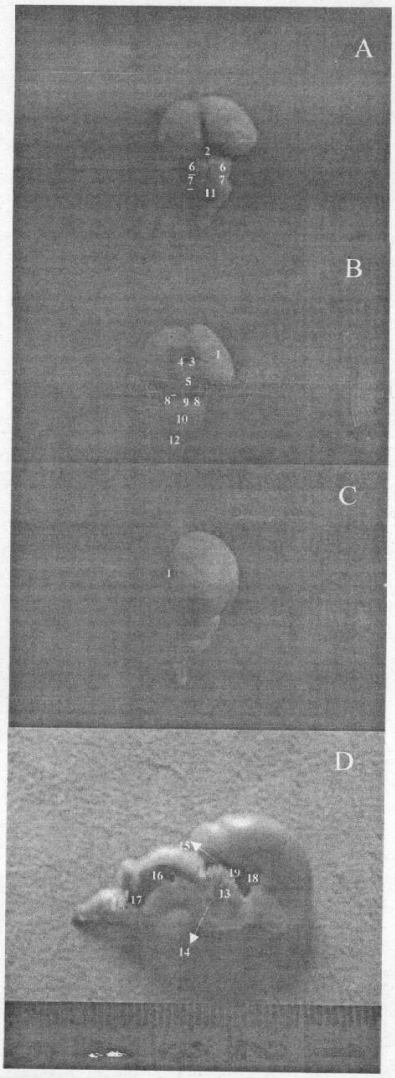

Fig. 15. Brain of Goat Embryo at 11 cm CVR length

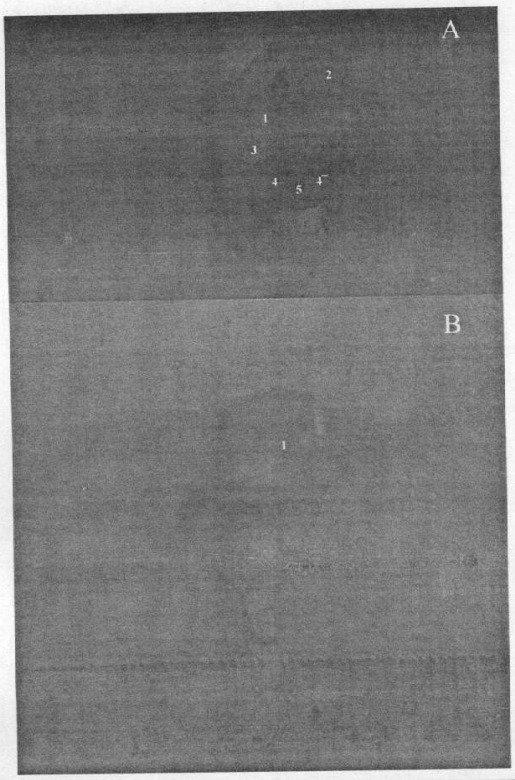

Fig. 16. Brain of Goat Embryo at 12 cm CVR length

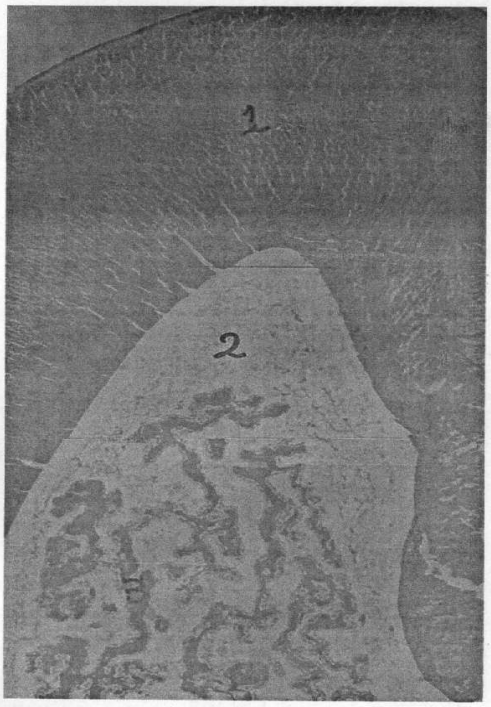

Fig. 17. lateral ventricle at 12 cm CVR length

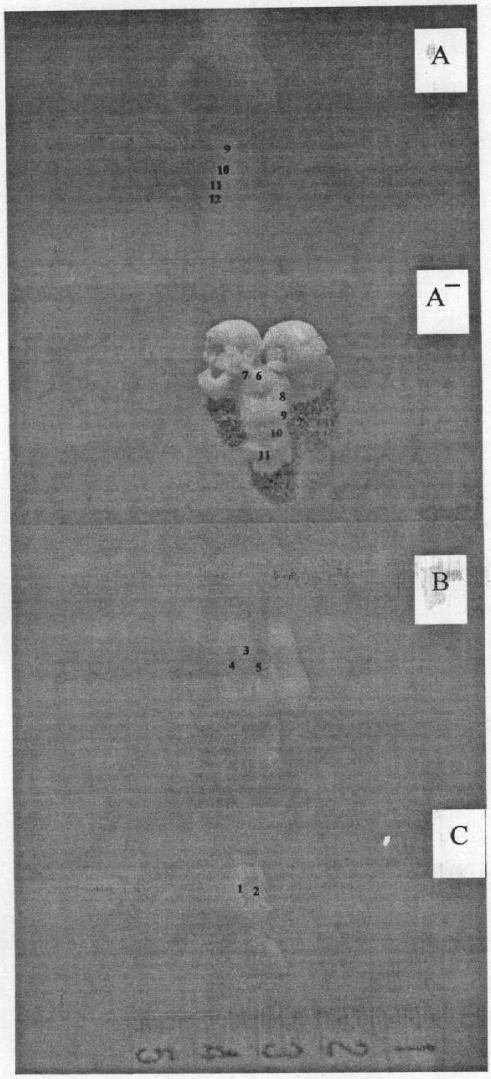

Fig. 18. Brain of goat embryo at 12.6 cm CVR length

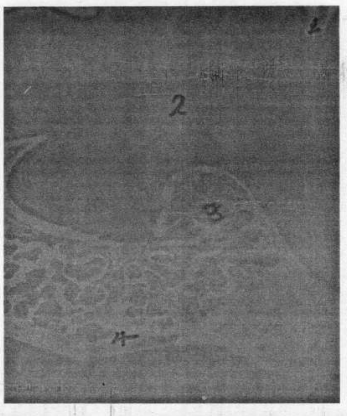

Fig. 19. Cerebellum and 4th ventricle at 12.6 cm CVR length.

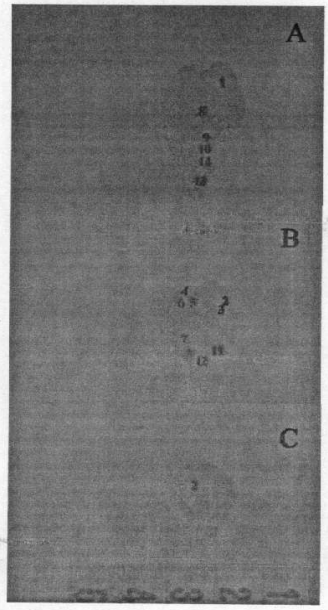

Fig. 20. Brain of Goat Embryo at 12.9 cm CVR length

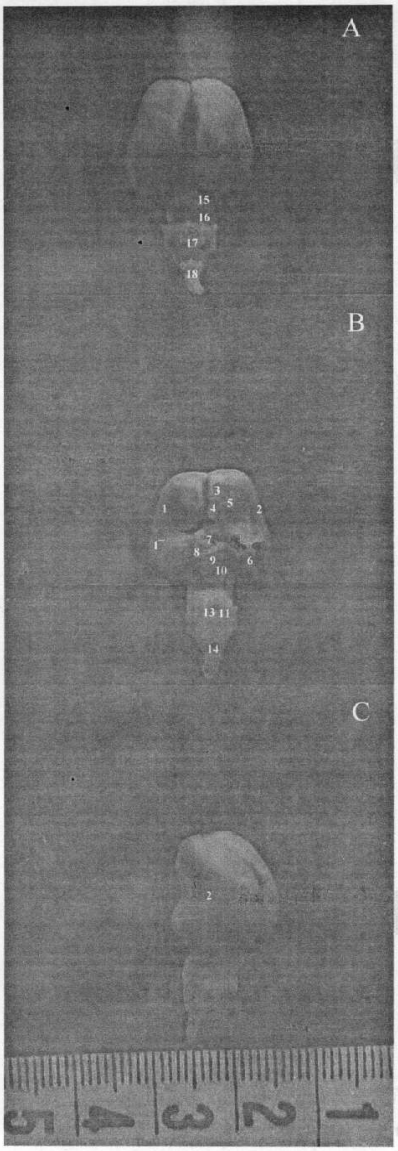

Fig. 21. Brain of Goat Embryo at 14 cm CVR length

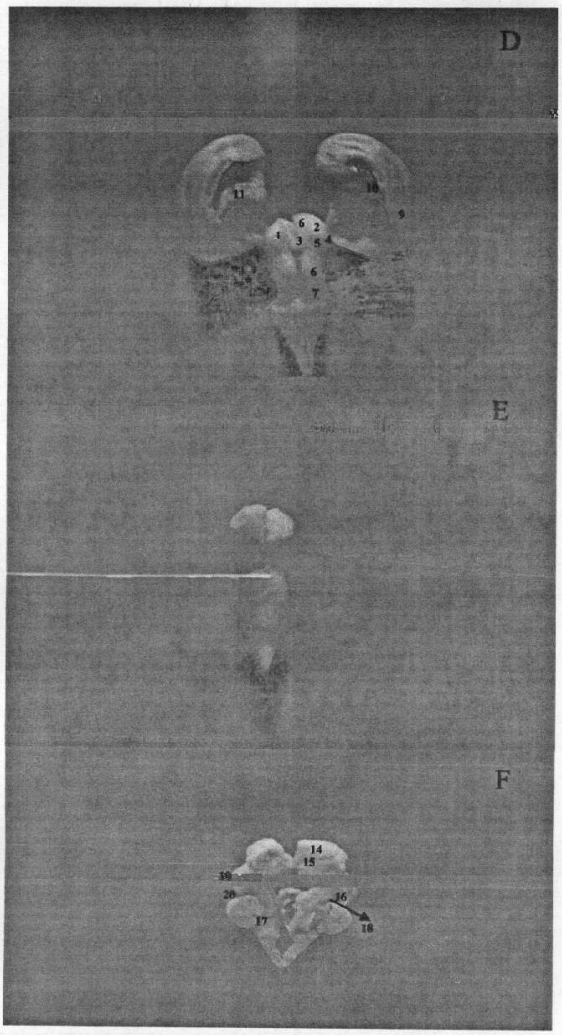

Fig. 22. Brain of Goat Embryo at 14 cm CVR length

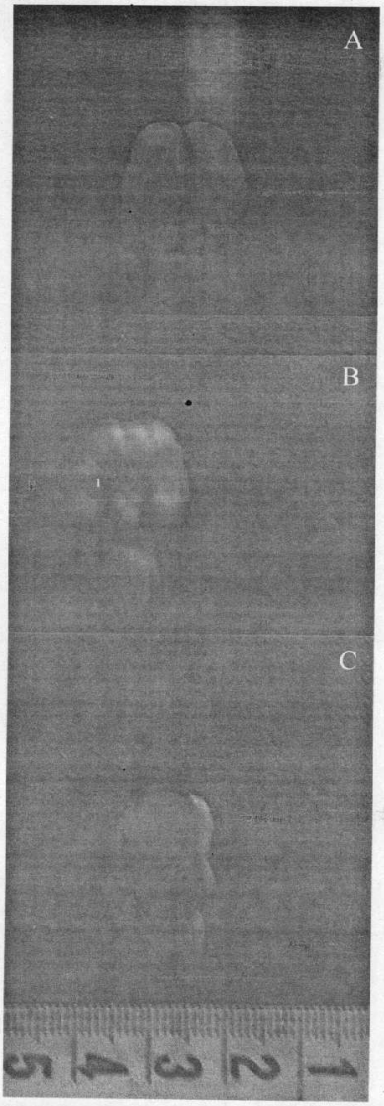

Fig. 23. Brain of goat embryo at 16.5 cm CVR length

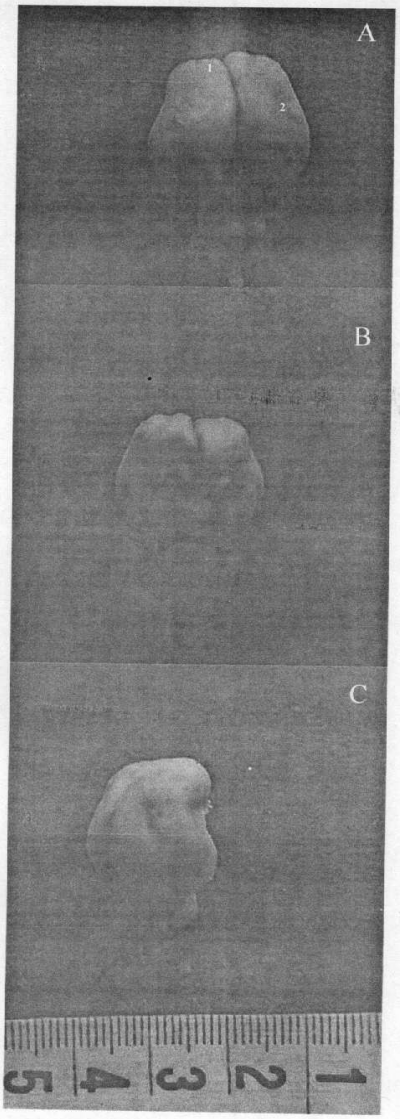

Fig. 24. Brain of goat embryo at 17 cm CVR length

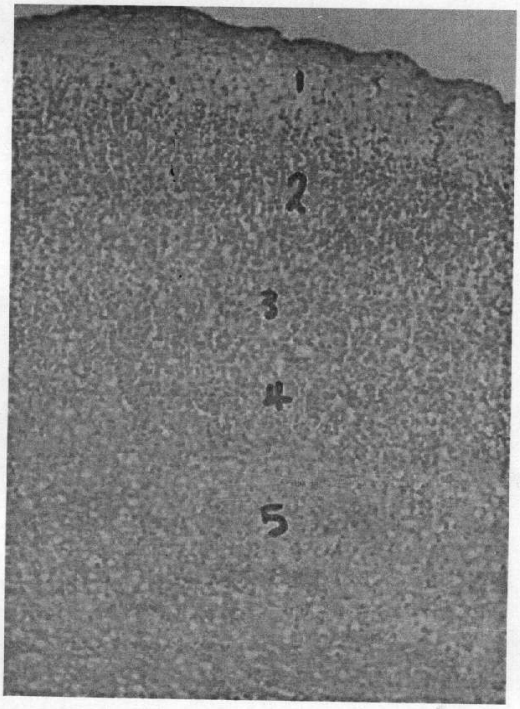

Fig. 25. cerebral wall at 17 cm CVR length

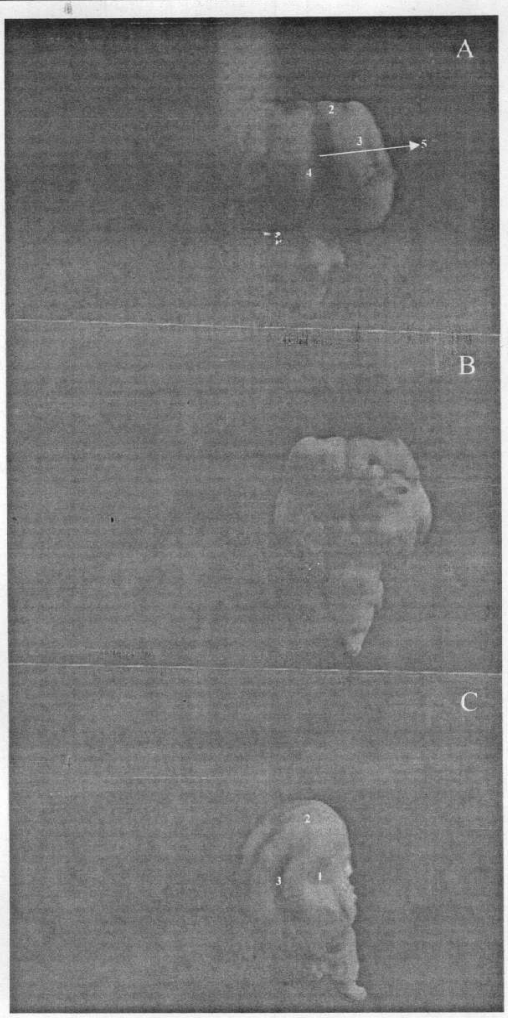

Fig. 26. Brain of Goat Embryo at 17.5 cm CVR length

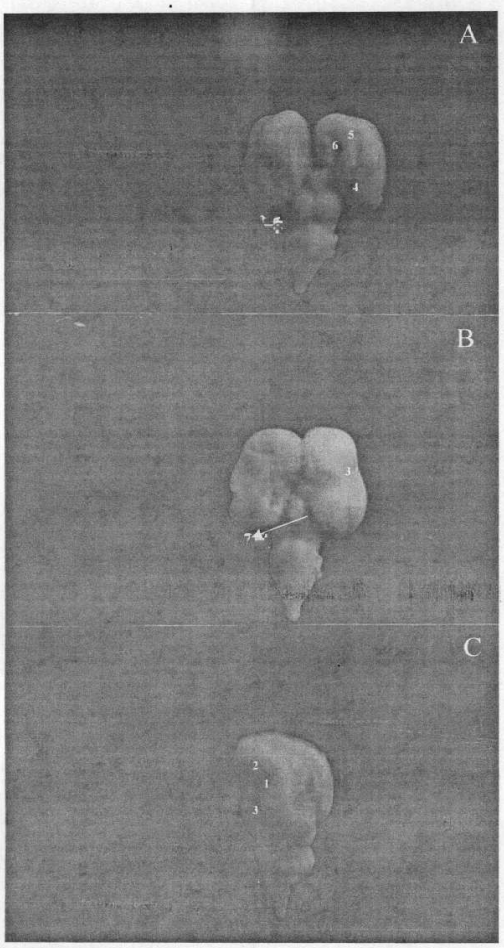

Fig. 27. Brain of Goat Embryo at 18.3 cm CVR length

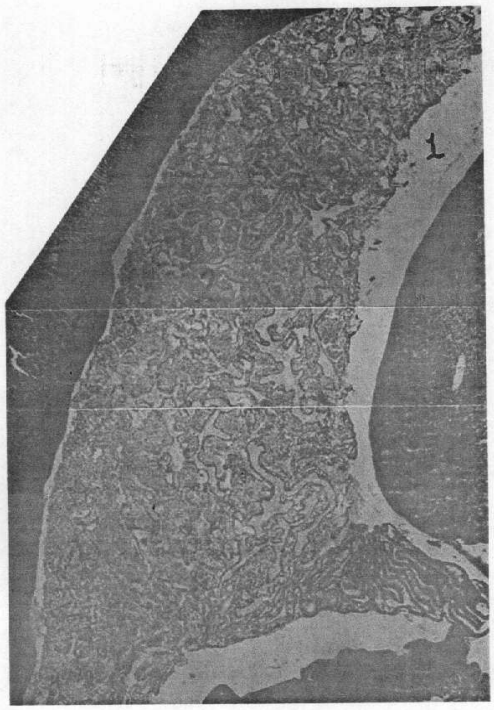

Fig. 28. Telencephalic choroid plexus at 18.3 cm CVR length.

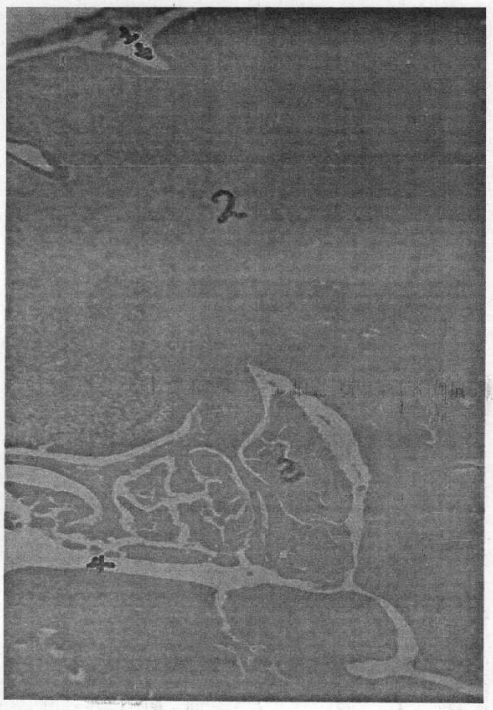

Fig. 29. Cerebellum and fourth ventricle at 18.3 cm CVR length.

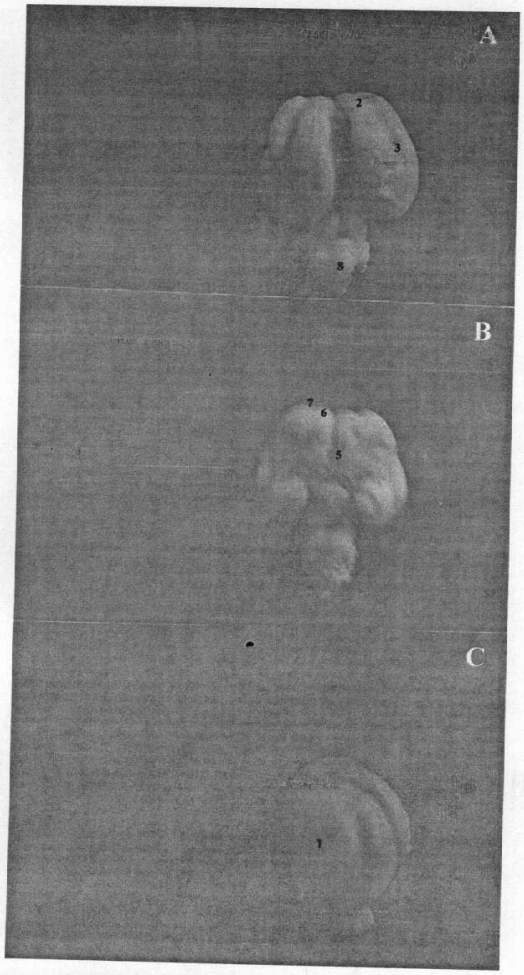

Fig.30. Brain of Goat Embryo at 19.3 cm CVR length

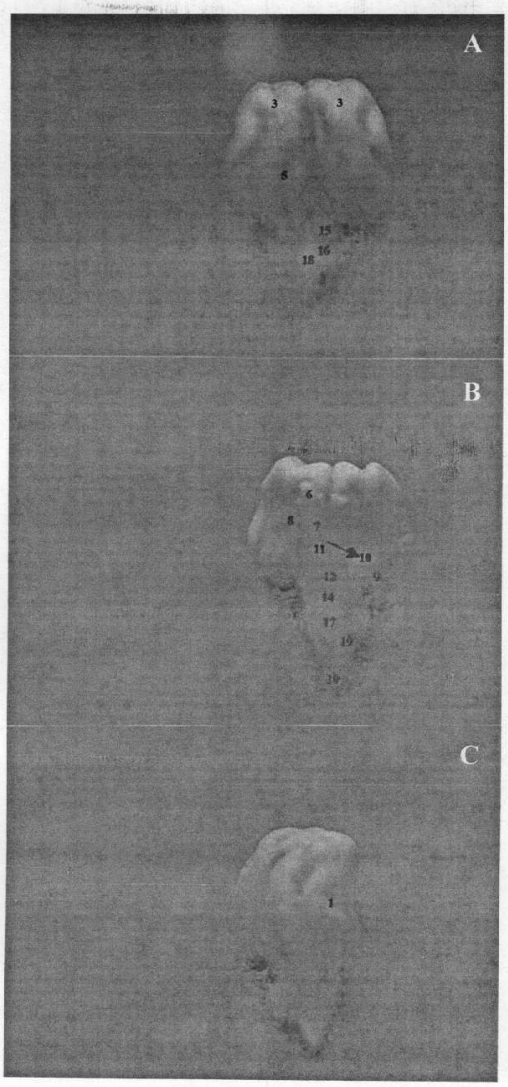

Fig. 31. Brain of Goat Embryo at 19.5 cm CVR length

Legends of figures of Group III, (over 20 cm CVR length)

Fig.32.Brain of goat embryo at 20.5 cm CVR length.
A&A\, dorsal view; B, ventral view; C, lateral view.

1. Middle branch of fissura Sylvia.
2. Rostral branch of fissura Sylvia.
3. Sulcus suprasylvius rostralis.
4. Sulcus ectosylvius rostralis.
5. Sulcus marginalis.
6. Sulcus presylvius.
7. Sulcus calcarinous.
8. Glandulae pinealis.
9. Facial nerve.
10. Vestibulocochlear nerve.
11. Rootlets of glossopharyngeal, vagus and spinal accessory nerves.

Fig.33.Brain of goat embryo at 21 cm CVR length.
A, dorsal view; B, ventral view; C, lateral view.

1. Middle branch of fissura Sylvia.
2. Rostral branch of fissura Sylvia.
3. Sulcus proreaus.
4. Sulcus presylvius.
5. Sulcus ectosylvius rostralis.
6. Pars caudalis of sulcus rhinalis lateralis.
7. Pars rostralis of sulcus rhinalis lateralis.
8. Gyrus proreus.

Fig.34.Brain of goat embryo at 22 cm CVR length.
A, dorsal view; B, ventral view; C, lateral view; D, ventral view of brain stem and medial view of cerebral hemispheres.

1. Middle branch of fissura Sylvia.
2. Sulcus presylvius.
3. Sulcus ectosylvius rostralis.
4. Sulcus suprasylvius rostralis.
5. Sulcus proreus.
6. Sulcus marginalis.
7. Colliculus rostralis.
8. Cerebellum.
9. Dorsal surface of medulla oblongata.
10. Pons.
11. Ventral surface of medulla oblongata.
12. Gyrus cinguli.
13. Sulcus calcarinous.
14. Sulcus corpori callosi.
15. Genu corporis callosi.
16. Splenium corporis callosi.
17. Truncus corporis callosi.
18. Sulcus genualis.

Fig.35.Brain of goat embryo at 23 cm C.V.R length.
A, dorsal view; B, ventral view; C, lateral view.

1. Sulcus cruciatus.
2. Gyrus precruciatus.
3. Gyrus postcruciatus.

Fig.36.Brain of goat embryo at 24 cm CVR length.
A, dorsal view; B, ventral view; C, lateral view; D, midsagial section.

1. Pars rostralis of sulcus rhinalis lateralis.
2. Pars caudalis of sulcus rhinalis lateralis.
3. Gyrus insularis.
4. Sulcus presylvius.
5. Sulcus ansatus.
6. Sulcus marginalis.
7. Sulcus cruciatus.
8. Sulcus suprasylvius rostralis.
9. Sulcus ectosylvius rostralis.
10. Occulomotor nerve.
11. Trigeminal nerve.
12. Facial nerve.
13. Vestibulocochlear nerve.
14. Rootlets of glossopharyngeal, vagus and spinal accessory nerve.
15. Hypoglossal nerve.
16. Sulcus rostralis internus.
17. Sulcus genualis.
18. Rostral medullary vellum.

Fig.37.Brain of goat embryo at 26 cm CVR length.
A, dorsal view; B, ventral view; C, lateral view; D, medial view of cerebral hemispheres and dorsal view of mesencephalon.

1. Caudal branch of fissure Sylvia.
2. Gyrus sylvius rostralis.
3. Gyrus sylvius caudalis.
4. Gyrus composit caudalis.
5. Gyrus composit rostralis.
6. Sulcus ectosylvius rostralis (caudal extension).
7. Sulcus obliqus rostralis.
8. Sulcus obliqus caudalis.
9. Sulcus ectosylvius rostralis.
10. Sulcus ectosylvius caudalis.
11. Gyrus ectosylvius rostralis.
12. Gyrus ectosylvius rostralis
13. Gyrus ectosylvius caudalis.
14. Gyrus marginalis.
15. Sulcus calcarinous.
16. Sulcus splenialis.
17. Sulcus cruciatus.
18. Sulcus ansatus.
19. Sulcus marginalis.
20. Hippocampus.
21. Nucleus caudatus.
22. Corpus geniculatum lateralis.
23. Thalamus.
24. Colliculi rostralis.
25. Colliculi caudalis.

Fig.38.Brain of goat embryo at 32.5 cm CVR length
A, dorsal view; B, ventral view; C, lateral view.

1. Sulcus suprasylvius caudalis.
2. Gyrus ectomarginalis.
3. Sulcus marginalis.
4. Gyrus marginalis.
5. Sulcus ansatus.
6. Sulcus cruciatus.
7. Sulcus suprasylvius rostralis.
8. Sulcus ectosylvius rostralis(caudal extension).
9. Rostral branch of Sulcus ectosylvius rostralis.
10. Caudal branch of Sulcus ectosylvius rostralis.
11. Sulcus ectosylvius rostralis.
12. Sulcus ectosylvius caudalis.
13. Gyrus composit caudalis.
14. Gyrus composit rostralis.

Fig.39.Brain of goat embryo at 35 cm CVR length, Dorsal view.

1. Fissure longituginalis cerebri.
2. Sulcus marginalis.
3. Sulcus suprasylvius caudalis.
4. Sulcus suprasylvius rostralis.
5. Sulcus ectosylvius rostralis
6. Sulcus ectosylvius caudais.
7. Sulcus ansatus.
8. Sulcus cruciatus.
9. Gyrus proreaus.
10. Gyrus precruciatus.
11. Gyrus postcruciatus.
12. Gyrus ectosylvius rostralis.
13. Gyrus ectosylvius caudalis.
14. Gyrus occipitalis.
15. Gyrus composit caudalis.
16. Gyrus marginalis.
17. Gyrus ectomarginalis.
18. Cerebeller hemisphere.
19. Vermis.

Fig.40.Brain of goat embryo at 35 cm CVR length, Ventral view.

1. Fissure mediana ventralis.
2. Medullary pyramids.
3. Corpus trapizodium.
4. Pons.
5. Sulcus basilaris.
6. Prepontin groove.
7. Crura cerebri.
8. Fossa intercruralis.
9. Corpus mamillari.
10. Tuber cinerium.
11. Infundibulum of hypophysis.
12. Sulcus rhinalis medialis.
13. Bulbus olfactorius.
14. Pedunculus olfactorius.
15. Pars caudalis of lobus piriformis.
16. Occulomotor nerve.
17. Trigeminal nerve.
18. Facial nerve.
19. Vestibulocochlear nerve.
20. Glossopharyngeal, vagus and spinal accessory nerves.
21. Hypoglossal nerve.

Fig.41.Brain of goat embryo at 35 cm C.V.R length, Lateral view.

1. Pars rostralis of sulcus rhinalis lateralis.
2. Pars caudalis of sulcus rhinalis lateralis.
3. Rostral branch of fissura Sylvia.
4. Middle branch of fissura Sylvia.
5. Caudal branch of fissura Sylvia.
6. Sulcus presylvius.
7. Sulcus ectosylvius rostralis.
8. Rostral branch of Sulcus of Sulcus ectosylvius rostralis; 8\, caudal branch of Sulcus ectosylvius rostralis.
9. Sulcus ectosylvius caudalis.
10. Gyrus sylvius rostralis.
11. Gyrus sylvius caudalis.
12. Slcus proreaus.
13. Gyrus composit caudalis.
14. Gyrus composit rostralis.
15. Gyrus insularis.
16. Cerebellum.
17. Pons.
18. Medulla oblongata.
19. Bulbus olfactorius.
20. Pars caudalis of lobus piriformis.

Fig.42.Brain of goat embryo at 35 cm CVR length, Midsagital section.

1. Medulla oblongata.
2. Pons.
3. Cerebellum.
4. Crura ceredri.
5. Colliculus rostralis.
6. Aquiductus messencephali.
7. Glandulae pinealis.
8. Thalamus.
9. Corpus mamillari.
10. Ventriculus tertious
11. Choroids plexus of the third ventricle.
12. Sulcus corpora callosi.
13. Truncus corporis callosi.
14. Splenium corporis callosi.
15. Genu corpris callosi
16. Gyrus proreus
17. Gyrus cinguli.
18. Sulcus ansatus.
19. Sulcus calcarinous.
20. Sulcus splenialis.
21. Sulcus cruciatus.
22. Sulcus rostralis internus.
23. Sulcus genualis.
24. Sulcus endosplenialis.
25. Nucleus caudatus.
26. Hippocampus.
27. Fourth ventricle.
28. Choroid plexus of the fourth ventricle.
29. Rostral medullary vellum.

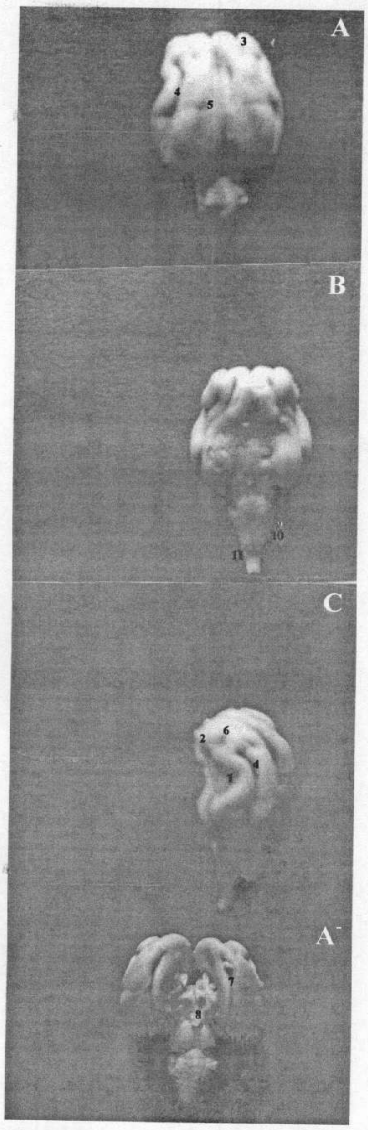

Fig. 32. Brain of Goat Embryo at 20.5 cm CVR length

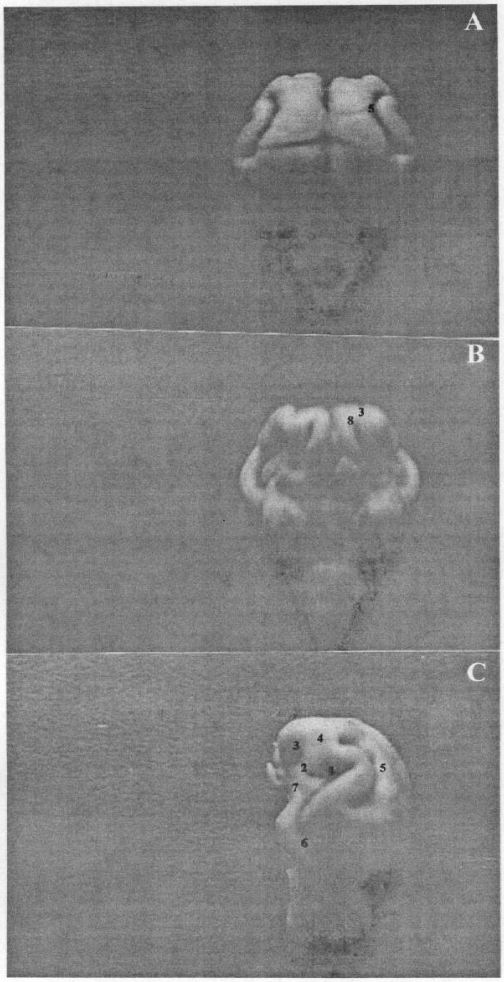

Fig. 33. Brain of Goat Embryo at 21 cm CVR length

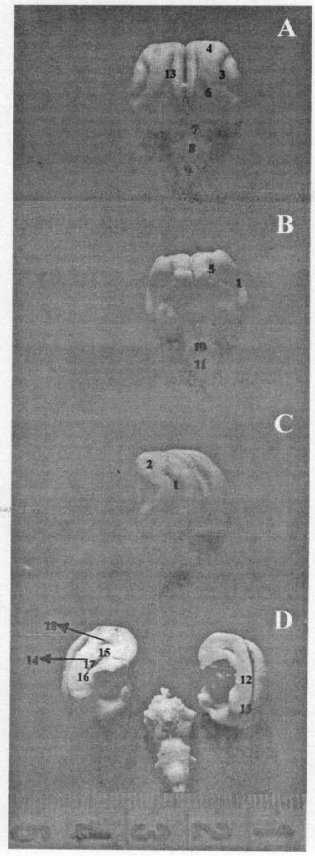

Fig. 34. Brain of Goat Embryo at 22 cm CVR length

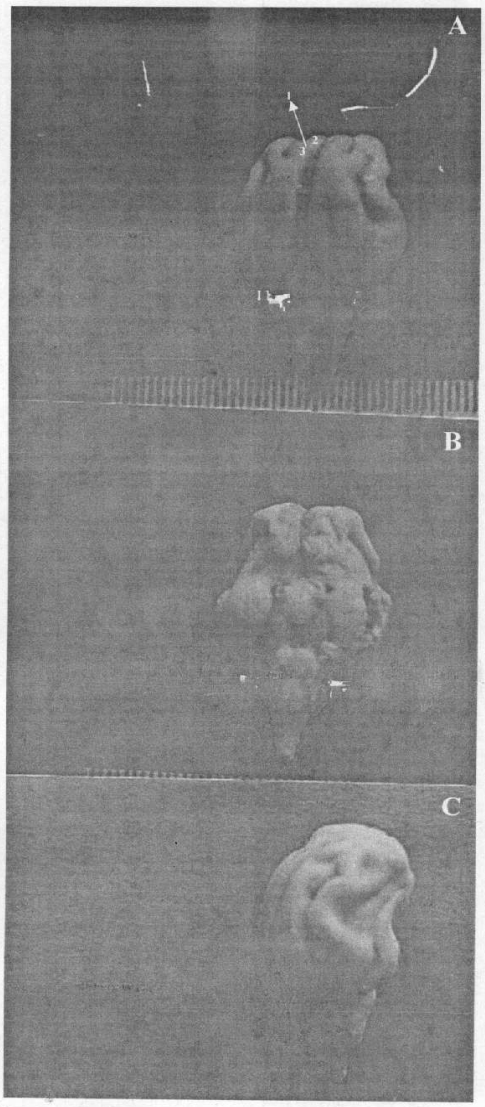

Fig. 35. Brain of Goat Embryo at 23 cm CVR length

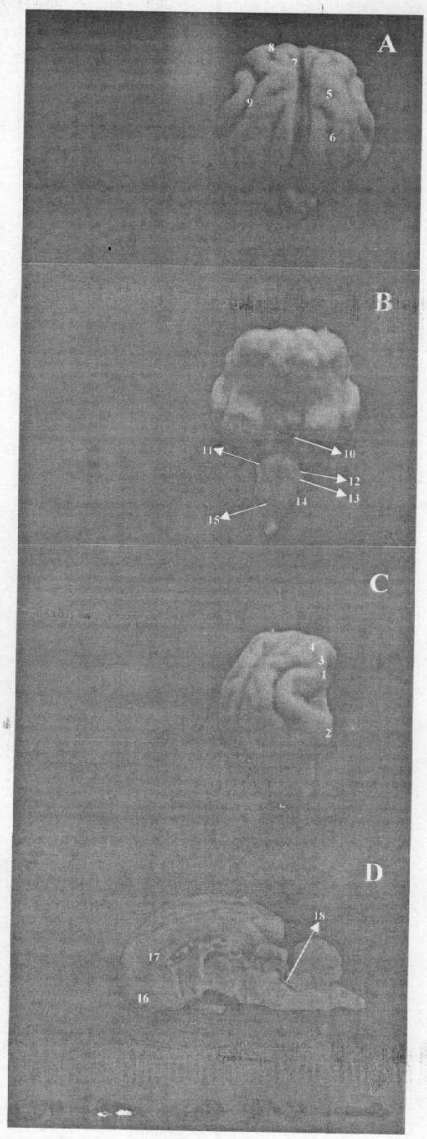

Fig. 36. Brain of Goat Embryo at 24 cm CVR length

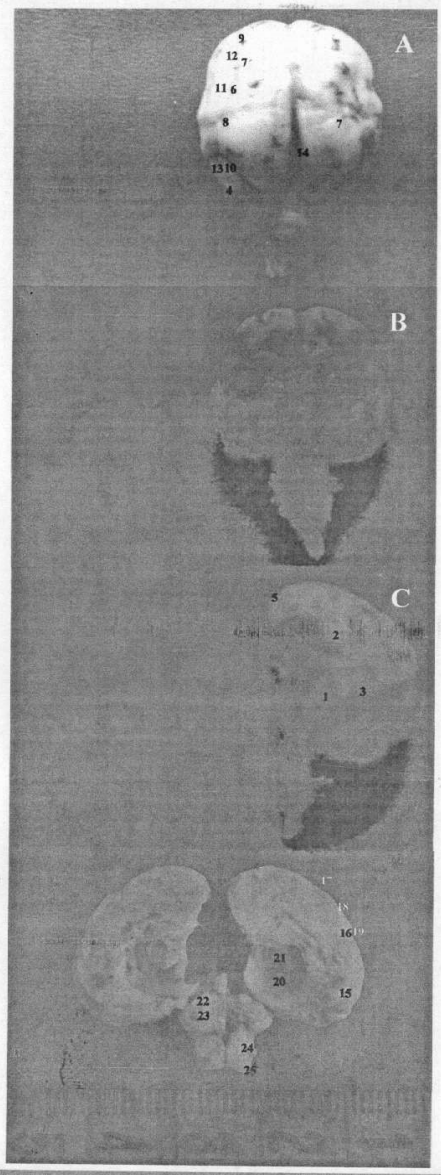

Fig. 37. Brain of Goat Embryo at 26 cm CVR length

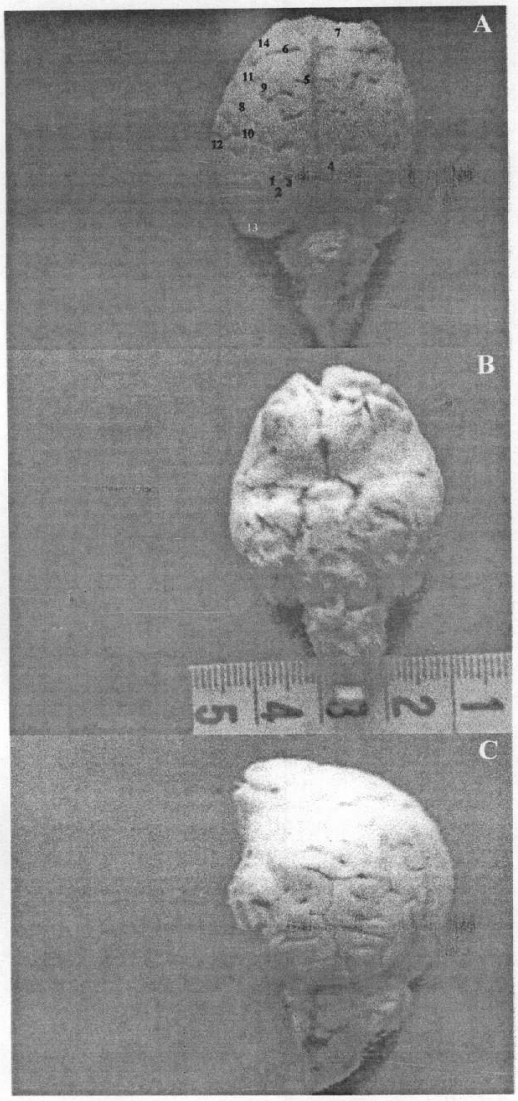

Fig. 38. Brain of Goat Embryo at 32.5 cm CVR length

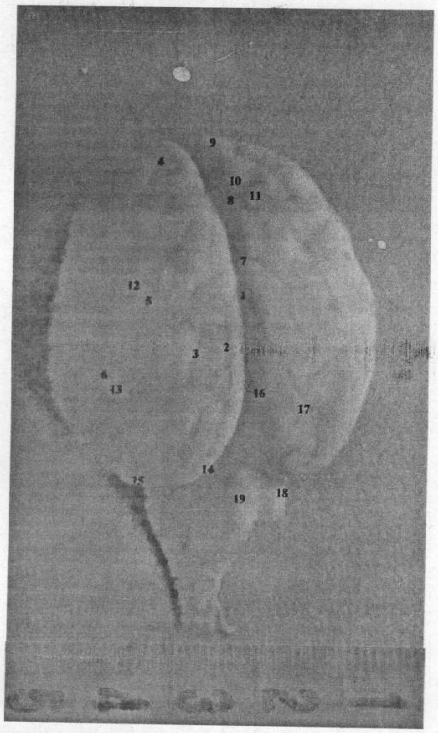

Fig. 39. Brain of Goat Embryo at 35 cm CVR length (Dorsal View)

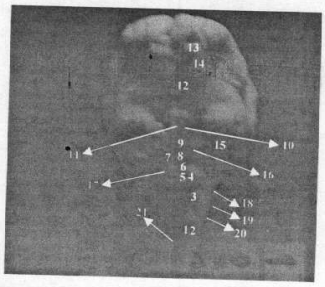

Fig. 40. Brain of Goat Embryo at 35 cm CVR Length (Ventral View)

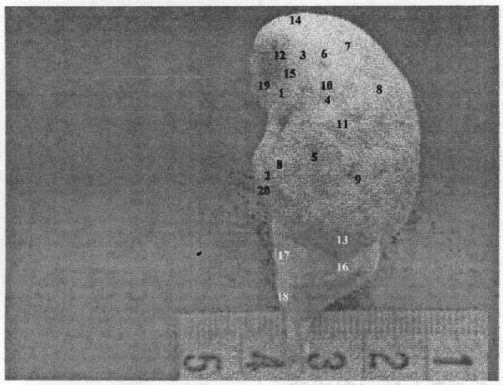

Fig. 41. Brain of Goat Embryo at 35 cm CVR length (Lateral View)

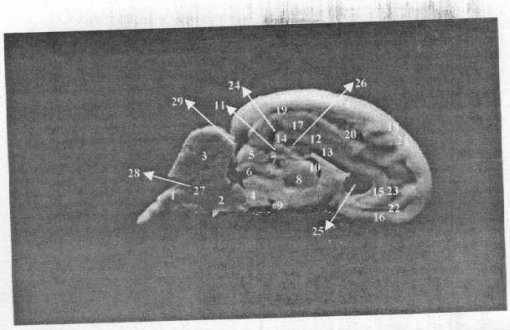

Fig. 42. Brain of Goat Embryo at 35 cm CVR length (midsagital section)

Fig. 43. The relation between CVR Length and length of brain

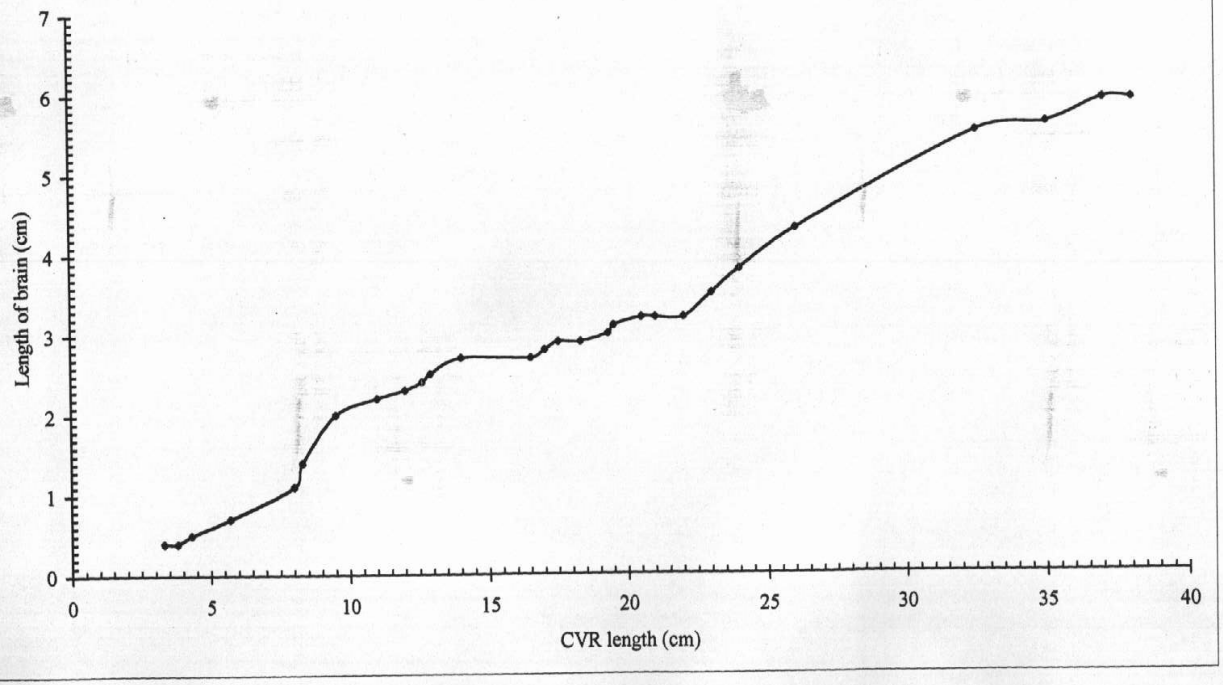

Table 2. Relation between CVR length and length of the brain (cm)

Group number	CVR length	brain length	%
GROUP (I)	3.3	0.4	12.12
	3.8	0.4	10.53
	4.3	0.5	11.63
	5.7	0.7	12.28
	8	1.1	13.75
	8.3	1.4	16.87
	9.5	2	21.05
GROUP (II)	11	2.2	20.00
	12	2.3	19.17
	12.6	2.4	19.05
	12.9	2.5	19.38
	14	2.7	19.29
	16.5	2.7	16.36
	17	2.8	16.47
	17.5	2.9	16.57
	18.3	2.9	15.85
	19.3	3	15.54
	19.5	3.1	15.90
GROUP (III)	20.5	3.2	15.61
	21	3.2	15.24
	22	3.2	14.55
	23	3.5	15.22
	24	3.8	15.83
	26	4.3	16.54
	32.5	5.5	16.92
	35	5.6	16.00
	37	5.9	15.95
	38	5.9	15.53

Fig. 44. The relation between CVR length and width of the brain.

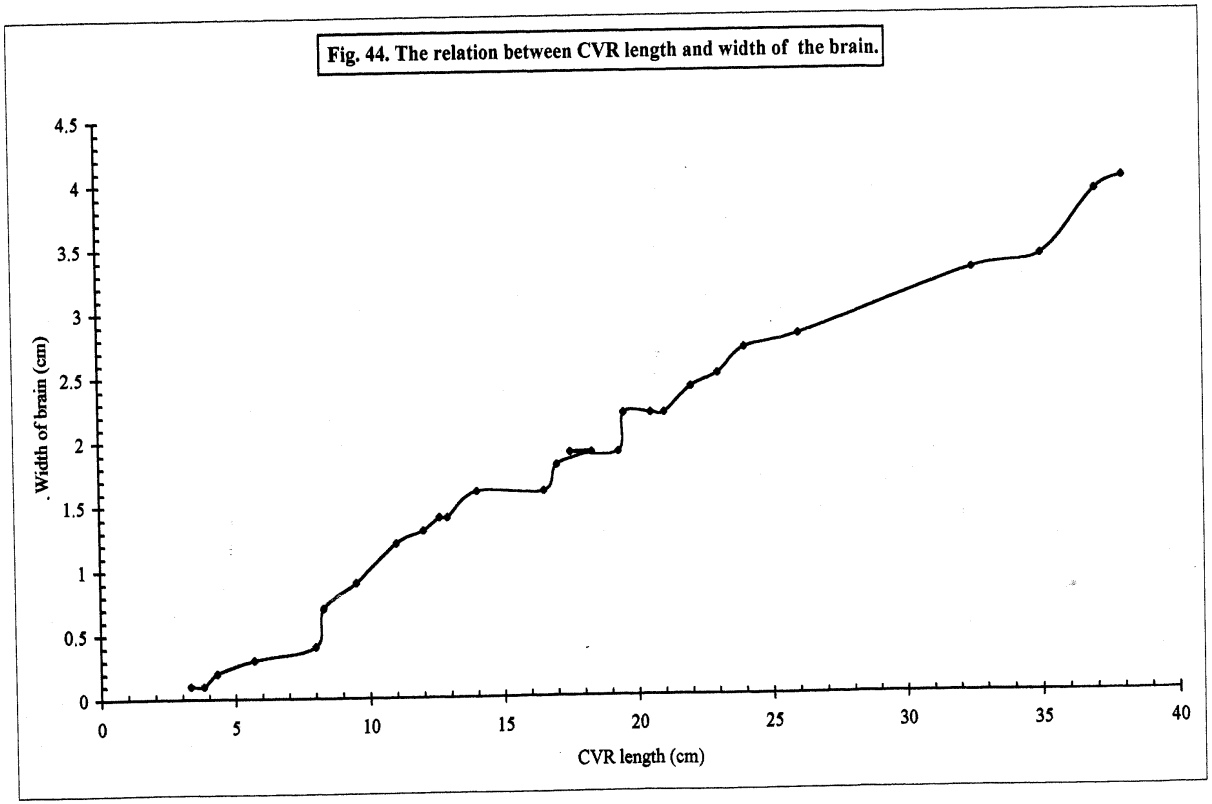

Table 3. Relation between CVR length and width of the brain (cm)

Group number	CVR length	brain width	%
GROUP (I)	3.3	0.1	3.03
	3.8	0.1	2.63
	4.3	0.2	4.65
	5.7	0.3	5.26
	8	0.4	5.00
	8.3	0.7	8.43
	9.5	0.9	9.47
GROUP (II)	11	1.2	10.91
	12	1.3	10.83
	12.6	1.4	11.11
	12.9	1.4	10.85
	14	1.6	11.43
	16.5	1.6	9.70
	17	1.8	10.59
	18.3	1.9	10.38
	17.5	1.9	10.86
	19.3	1.9	9.84
	19.5	2.2	11.28
GROUP (III)	20.5	2.2	10.73
	21	2.2	10.48
	22	2.4	10.91
	23	2.5	10.87
	24	2.7	11.25
	26	2.8	10.77
	32.5	3.3	10.15
	35	3.4	9.71
	37	3.9	10.54
	38	4	10.53

Fig. 45. Relation betwwen length of brain and length ofcerebrum

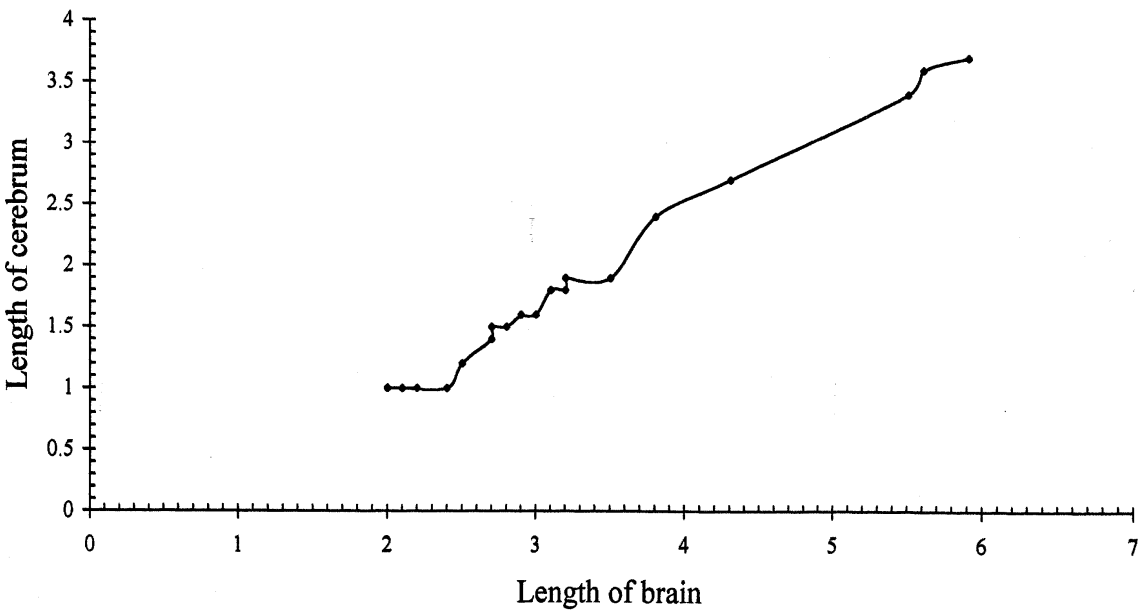

Table 4. Relation between CVR length and length of cerebrum (cm)

Group number	CVR length	Length of brain	length of cerebrum	%
Group(I)	9.5	2	1	50
GROUP (II)	11	2.2	1	45.45
	12	2.1	1	47.62
	12.6	2.4	1	41.67
	12.9	2.5	1.2	48.00
	14	2.7	1.4	51.85
	16.5	2.7	1.5	55.56
	17	2.8	1.5	53.57
	17.5	2.9	1.6	55.17
	18.3	2.9	1.6	55.17
	19.3	3	1.6	53.33
	19.5	3.1	1.8	58.06
GROUP (III)	20.5	3.2	1.8	56.25
	21	3.2	1.9	59.38
	22	3.2	1.9	59.38
	23	3.5	1.9	54.29
	24	3.8	2.4	63.16
	26	4.3	2.7	62.79
	32.5	5.5	3.4	61.82
	35	5.6	3.6	64.29
	37	5.9	3.7	62.71
	38	5.9	3.7	62.71

Fig. 46. Relation between length of brain and length of cerebellum

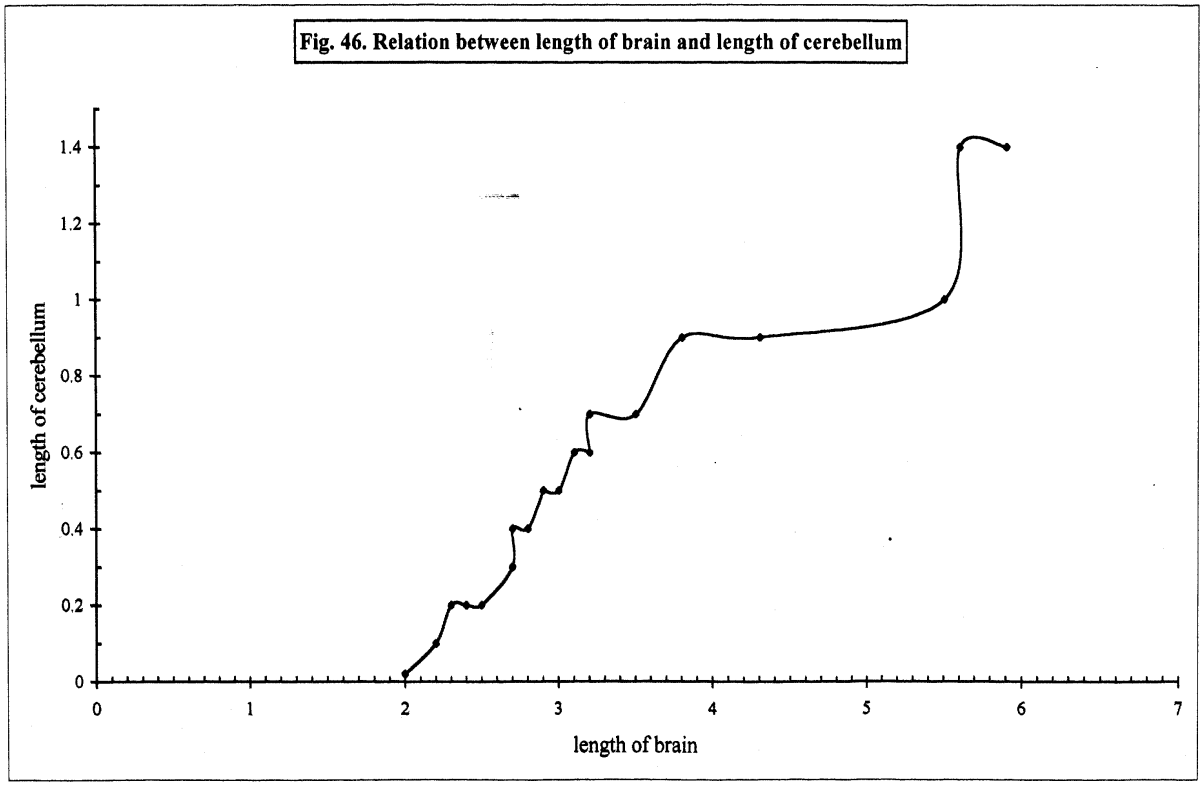

Table 5. Relation between length of brain and length of cerebellum (cm)

Group number	CVR length	length of brain	length of cerebellum	%
Group(I)	9.5	2	0.02	1.00
GROUP (II)	11	2.2	0.1	4.55
	12	2.3	0.2	8.70
	12.6	2.4	0.2	8.33
	12.9	2.5	0.2	8.00
	14	2.7	0.3	11.11
	16.5	2.7	0.4	14.81
	17	2.8	0.4	14.29
	17.5	2.9	0.5	17.24
	18.3	2.9	0.5	17.24
	19.3	3	0.5	16.67
	19.5	3.1	0.6	19.35
GROUP (III)	20.5	3.2	0.6	18.75
	21	3.2	0.6	18.75
	22	3.2	0.7	21.88
	23	3.5	0.7	20.00
	24	3.8	0.9	23.68
	26	4.3	0.9	20.93
	32.5	5.5	1	18.18
	35	5.6	1.4	25.00
	37	5.9	1.4	23.73
	38	5.9	1.4	23.73

Fig. 47. The betwee Length of the brain and length of pons

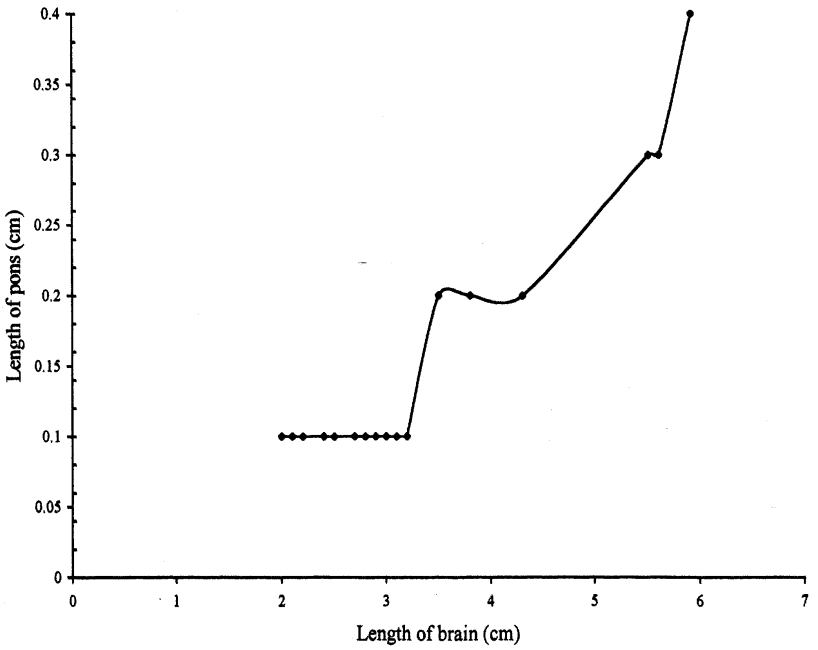

Table 6. Relation between legth of brain and length of pons (cm)

Group number	CVR	length of brain	length of pons	%
Group(I)	9.5	2	0.1	5.00
GROUP (II)	11	2.2	0.1	4.55
	12	2.1	0.1	4.76
	12.6	2.4	0.1	4.17
	12.9	2.5	0.1	4.00
	14	2.7	0.1	3.70
	16.5	2.7	0.1	3.70
	17	2.8	0.1	3.57
	17.5	2.9	0.1	3.45
	18.3	2.9	0.1	3.45
	19.3	3	0.1	3.33
	19.5	3.1	0.1	3.23
GROUP (III)	20.5	3.2	0.1	3.13
	21	3.2	0.1	3.13
	22	3.2	0.1	3.13
	23	3.5	0.2	5.71
	24	3.8	0.2	5.26
	26	4.3	0.2	4.65
	32.5	5.5	0.3	5.45
	35	5.6	0.3	5.36
	37	5.9	0.4	6.78
	38	5.9	0.4	6.78

Fig. 48. The relation between Length of the brain and length of medulla oblongata

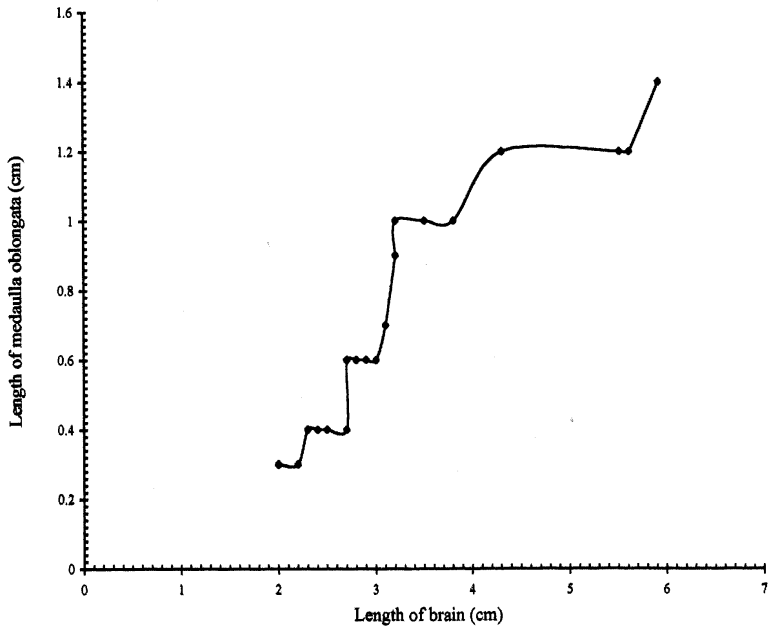

Table 7. Relation between length of brain and length of M.O (cm)

Group number	CVR length	length of brain	length of medulla	%
Group(I)	9.5	2	0.3	15
GROUP (II)	11	2.2	0.3	13.64
	12	2.3	0.4	17.39
	12.6	2.4	0.4	16.67
	12.9	2.5	0.4	16.00
	14	2.7	0.4	14.81
	16.5	2.7	0.6	22.22
	17	2.8	0.6	21.43
	17.5	2.9	0.6	20.69
	18.3	2.9	0.6	20.69
	19.3	3	0.6	20.00
	19.5	3.1	0.7	22.58
GROUP (III)	20.5	3.2	0.9	28.13
	21	3.2	0.9	28.13
	22	3.2	1	31.25
	23	3.5	1	28.57
	24	3.8	1	26.32
	26	4.3	1.2	27.91
	32.5	5.5	1.2	21.82
	35	5.6	1.2	21.43
	37	5.9	1.4	23.73
	38	5.9	1.4	23.73

Fig.49.The relation between width of brain and width of a cerebral hemisphere

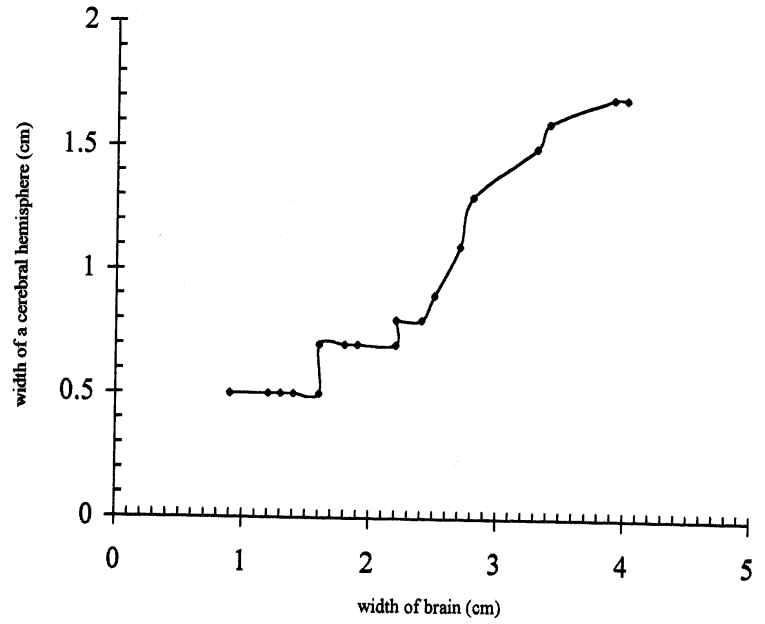

Table 8. Relation between width of the brain and width of a cerebral hemisphere (cm)

Group number	CVR length	width of brain	width of a cerebral hemisphere	%
Group(I)	9.5	0.9	0.5	55.56
GROUP (II)	11	1.2	0.5	41.67
	12	1.3	0.5	38.46
	12.6	1.4	0.5	35.71
	12.9	1.4	0.5	35.71
	14	1.6	0.5	31.25
	16.5	1.6	0.7	43.75
	17	1.8	0.7	38.89
	17.5	1.9	0.7	36.84
	18.3	1.9	0.7	36.84
	19.3	1.9	0.7	36.84
	19.5	2.2	0.7	31.82
GROUP (III)	20.5	2.2	0.8	36.36
	21	2.2	0.8	36.36
	22	2.4	0.8	33.33
	23	2.5	0.9	36.00
	24	2.7	1.1	40.74
	26	2.8	1.3	46.43
	32.5	3.3	1.5	45.45
	35	3.4	1.6	47.06
	37	3.9	1.7	43.59
	38	4	1.7	42.50

Fig. 50. The relation between width of brain and width of cerebellum

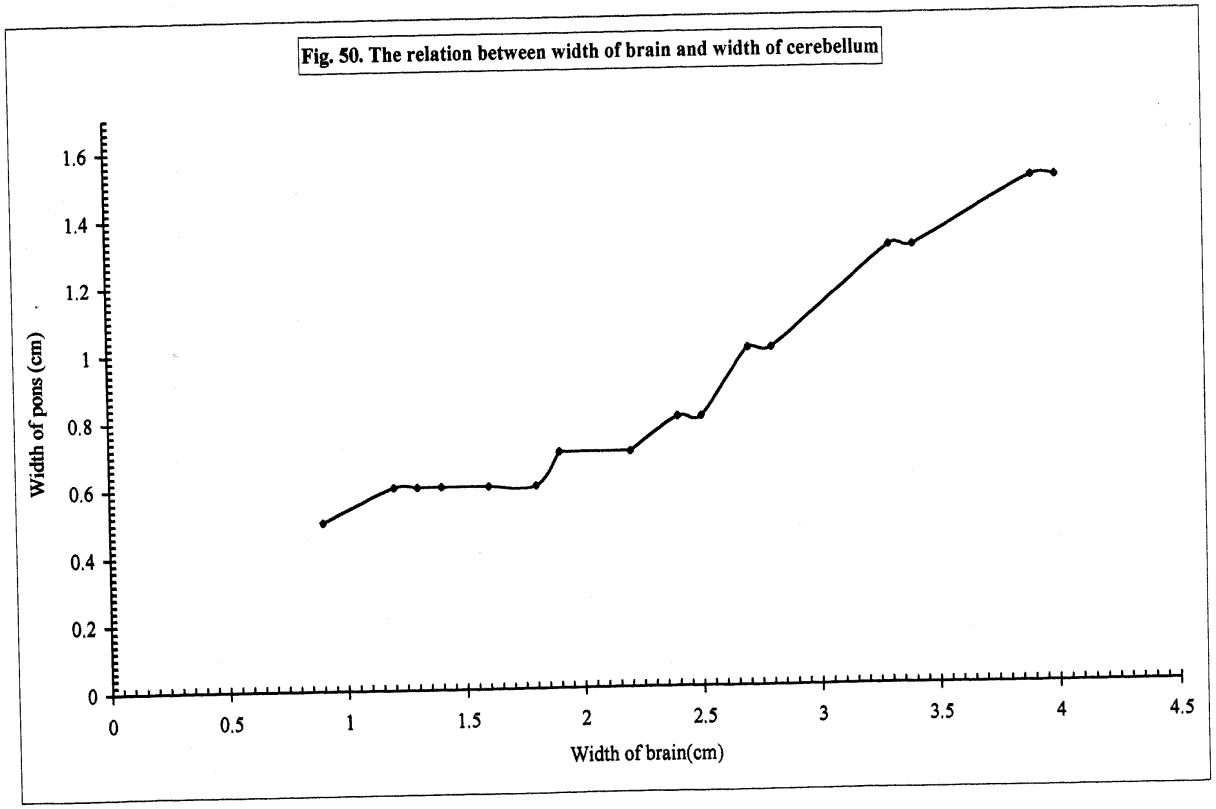

Table 9. Relation between width of brain and width of cerebellum (cm)

Group number	CVR length	width of brain	width of cerebellum	%
Group(I)	9.5	0.9	0.5	55.56
GROUP (II)	11	1.2	0.6	50.00
	12	1.3	0.6	46.15
	12.6	1.4	0.6	42.86
	12.9	1.4	0.6	42.86
	14	1.6	0.6	37.50
	16.5	1.6	0.6	37.50
	17	1.8	0.6	33.33
	17.5	1.9	0.7	36.84
	18.3	1.9	0.7	36.84
	19.3	1.9	0.7	36.84
	19.5	2.2	0.7	31.82
GROUP (III)	20.5	2.2	0.7	31.82
	21	2.2	0.7	31.82
	22	2.4	0.8	33.33
	23	2.5	0.8	32.00
	24	2.7	1	37.04
	26	2.8	1	35.71
	32.5	3.3	1.3	39.39
	35	3.4	1.3	38.24
	37	3.9	1.5	38.46
	38	4	1.5	37.50

Fig. 51. The relation between width of the brain and width of pons

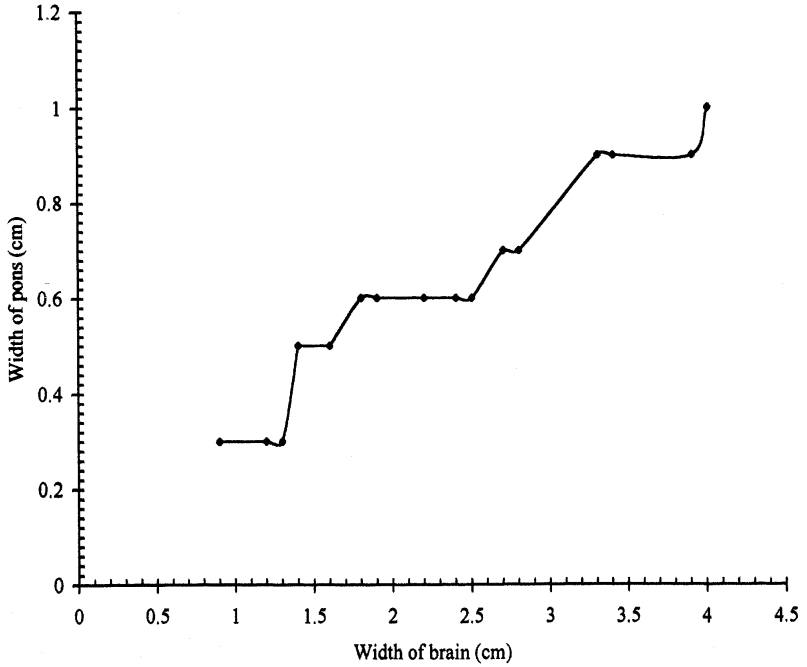

Table 10. Relation between width of brain width of pons (cm)

Group number	CVR length	Width of brain	width of pons	%
Group(I)	9.5	0.9	0.3	33.33
GROUP (II)	11	1.2	0.3	25.00
	12	1.3	0.3	23.08
	12.6	1.4	0.5	35.71
	12.9	1.4	0.5	35.71
	14	1.6	0.5	31.25
	16.5	1.6	0.5	31.25
	17	1.8	0.6	33.33
	17.5	1.9	0.6	31.58
	18.3	1.9	0.6	31.58
	19.3	1.9	0.6	31.58
	19.5	2.2	0.6	27.27
GROUP (III)	20.5	2.2	0.6	27.27
	21	2.2	0.6	27.27
	22	2.4	0.6	25.00
	23	2.5	0.6	24.00
	24	2.7	0.7	25.93
	26	2.8	0.7	25.00
	32.5	3.3	0.9	27.27
	35	3.4	0.9	26.47
	37	3.9	0.9	23.08
	38	4	1	25.00

Fig. 52. The relation between width of brain and width of medulla oblongata

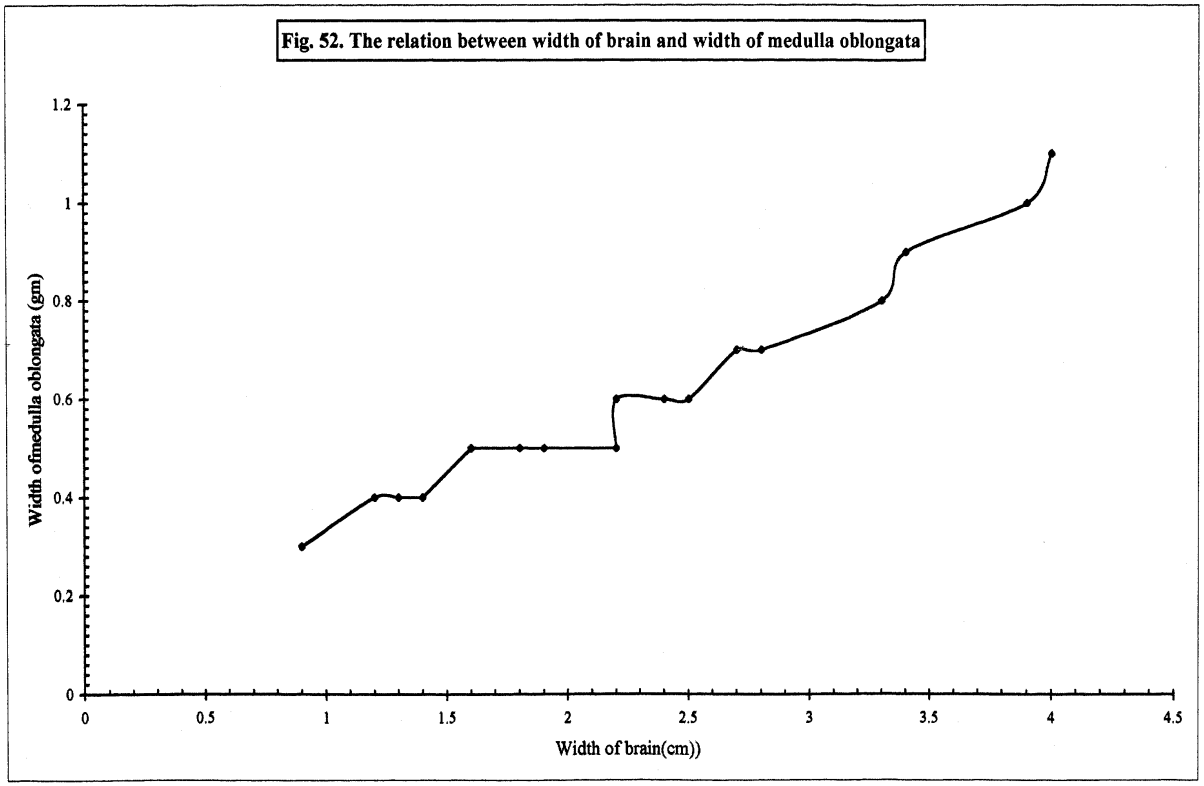

Table 11. Relation between width of brain and width of M.O (cm)

Group number	CVR length	Width of brain	width of M.O	%
Group(I)	9.5	0.9	0.3	33.33
GROUP (II)	11	1.2	0.4	33.33
	12	1.3	0.4	30.77
	12.6	1.4	0.4	28.57
	12.9	1.4	0.4	28.57
	14	1.6	0.5	31.25
	16.5	1.6	0.5	31.25
	17	1.8	0.5	27.78
	17.5	1.9	0.5	26.32
	18.3	1.9	0.5	26.32
	19.3	1.9	0.5	26.32
	19.5	2.2	0.5	22.73
GROUP (III)	20.5	2.2	0.5	22.73
	21	2.2	0.6	27.27
	22	2.4	0.6	25.00
	23	2.5	0.6	24.00
	24	2.7	0.7	25.93
	26	2.8	0.7	25.00
	32.5	3.3	0.8	24.24
	35	3.4	0.9	26.47
	37	3.9	1	25.64
	38	4	1.1	27.50

Table 12. The percentage of length and width of cerebrum, cerebellum, pons and medulla to total brain length and width

structure	% Of length		%of width	
	group II	group III	group II	group III
cerebrum	51.41	60.68	37.07	40.78
cereblium	12.75	21.46	39.32	35.53
pons	3.81	4.94	30.67	25.63
M. obl.	18.74	26.1	28.47	25.38

Discussion

DISCUSSION

A-PRENATAL MACROSCOPIC AND MICROSCOPIC DEVELOPMENTAL STUDIES :

A microscopic study of the brain of goat fetuses at 1.97 cm and 1.99 cm CVR lengths revealed the formation of the neural tube and the neural crest , the neural tube considered the early premordium of the brain vesicles and spinal cord as stated by NELSEN (1953) in vertebrates, AREY (1974) in human, FRANDSON (1981) in farm animals, PATTEN (1981) in pig, LATSHAW (1987) and DYCE and SACK (1996) in domestic animals.

The pontine flexure described by NELSEN (1953) in vertebrates, LATSHAW (1987) in domestic animals and AREY (1974) in human was firstly seen in this study at 3.3 cm CVR length. While, the interventricular portion of the rhombic lip, the premordium of the cerebellum which was described by LATSHAW (1987) in domestic mammals and AREY (1974) in human were evident in the present study at 3.8 cm CVR length.

The cerebral hemispheres were differentiated in this work as two lateral smooth outpockings at 3.8 cm CVR length. However, in camel they are firstly described by EL KHALIGI (1977) at 19 cm CVR length and in pig by PATTEN (1948) as the lateral telencephalic vesicle which appeared shortly after transition from three to five vesicle stage.

In the present study the external surface of the cerebral hemispheres remained smooth and agyric through the first group (up to 10 cm CVR length) which is in agreement with the results of SHRIVASTAVA et. al. (1987) in goat. Moreover, EL.KHALIGI (1977) in camel mentioned that, the cerebral hemispheres are smooth in fetuses up to 19 cm CVR length, on the other hand, EL.NAHLA (1982) in water buffalo stated that, the cerebral hemispheres of

group I fetuses (5-15.5 cm CVR length) are smooth with neither sulci nor gyri while, BRADLEY and GRAHAM (1946), in horse recorded that, the external surface of the cerebral hemispheres remains smooth in the early stages of prenatal development, in addition, PATTEN (1948), reported that the telencephalic lobes in pig are smooth in contour without showing striking local differentiation up to 100 mm embryos, and at later stages, they become much convoluted and certain regional divisions appear clearly marked. FOX (1963), JENKINS (1972) stated that, dog posses a lissencephalic brain, where the sulci and gyri are not completely developed until the first few monthes after birth, the smoothnes of the cerebral hemispheres in this age of goat embryo simulates the condition of a 21st week stage of human brain (GRAY, 1973).

The results of the present study included that, at 8.3 cm CVR length the cerebral hemispheres attained a kidney shape with a rostral and caudal ventral projections separated by a ventral indentation, this indentation showed a lateral extention at 9.5 cm CVR length to form the lateral fossa of the brain, this fossa reported by EL.KHALIGI (1977) in camel at the end of the first group (19-30 cm CVR length).

The first sulcus which appeared in the cerebral hemispheres in goat was the rostral part of ***sulcus rhinalis lateralis*** which was observed at 12.6 cm CVR length, moreover, SHRIVASTAVA et. al. (1987) in goat stated that the caudal part of ***sulcus rhinalis lateralis*** is the earliest sulcus to appear and at 12 cm the two parts of this sulcus are evident, EL.NAHLA (1982) in buffalo stated that, by the end of the first group (5-15.5 cm CVR length) the surface of the cerebral hemispheres presented a faint lateral rhinal sulcus separating the neocortex from the olfactory cortex, on the other hand EL.KHALIGI (1977) in camel stated that ***fissura sylvia*** is the first to appear among the cerebral fissures..

In the present work ***sulcus splenialis*** was the second sulcus to appear, it was observed at 12.9 cm CVR length, while, ***fissura sylvia*** began to appear at 14 cm CVR length, as a lateral continuation of the lateral fossa. On the other hand SHRIVASTAVA et. al. (1987) in goat stated that, ***fissura sylvia*** appears at 10 cm CRL, in addition EL.NAHLA (1982) observed an extremely faint and short sylvian sulcus at the third group (34-56 cm CVR length), the result that the sylvian fissure was a lateral continuation of the lateral fossa was in agreement with AMIN (1984) in goat, EL.KHALIGI (1977) and MANSOUR (1983) in camel, RAO/SHARMA (1974) in Indian buffalo and DELLMAN and McCLURE (1975) in horse. On the other hand, MULLER et.al. (1964) in dog, MAY (1970) in sheep, and DELMAN/McCLURE (1975) in pig, stated that ***fissura sylvia*** originates from ***sulcus rhinalis lateralis***

Sulcus suprasylvian rostralis appeared in this study as a shallow indentation at 17 cm CVR length, while, SHRIVASTAVA et. al. (1987) in goat stated that, ***sulcus suprasylvius*** appeares at 10 cm CRL and its rostral part is seen later. EL.KHALIGI (1977) in camel and EL.NAHLA (1982) in buffalo, stated that, ***sulcus suprasylvian rostralis*** appears in the second group (30-50 cm and 15.5-34 cm CVR lengths respectively).

Regarding ***sulcus ectosylvius*** in goat embryo; the present investigation showed that, it was formed of a large rostral and short caudal parts, the rostral part appeared at 17 cm CVR length, it was extended caudally and dorsally over the dorsal border of ***gyrus sylvius***, the caudal part observed at 26 cm CVR length. However, Illusterated Veterivary Anatomical Nominclature (1992) described sulcus ectosylvius as two parts only, sulcus ectosylvius rostralis and sulcus ectosylvius caudalis. On the other hand, SHRIVASTAVA et. al. (1987) in goat recorded that sulcus ectosylvius appears at the second group (10-20 cm CR length) and attains definitive form at the third group (above 20 cm CR

length). However, EL.KHALIGI (1977) in camel, recorded that, ***sulcus ectosylvius rostralis*** and ***caudalis*** appears at 38-46 cm CVR length. Moreover, EL.NAHLA (1982) in buffalo reported that, sulcus ectosylviu caudalis appears at 22 cm CVR length, while, sulcus ectosylviu rostralis appears at 34-43 cm CVR length.

In the present investigation ***sulcus and gyrus proreus*** appeared at 19.3 cm CVR length, this sulcus and its associated gyrus reported at the second group specimens (30-50 cm CVR length) of camel (EL.KHALIGI, 1977) and at the third group of buffalo fetuses (34-56 cm CVR length) as recorded by EL.NAHLA (1982). On the other hand the ***sulcus marginalis*** appeared in our study at 19.5 cm CVR length, SHRIVASTAVA et. al. (1987) observed this sulcus in goat fetuses at 10-12 cm CR length, on the other hand this sulcus appears in camel at group II (30-50 cm CVR length) as recorded by EL.KHALIGI (1977) and in group I (5-15.5 cm CVR length) buffalo fetuses (EL.NAHLA, 1982). our results revealed that ***sulcus presylvius*** appeared at 20.5 cm CVR length, However, SHRIVASTAVA et. al. (1987) in goat mentioned that, it is firstly observed at the second group specimens (10-20 cm CRL). On the other hand, EL.KHALIGI (1977) in camel, reported that this sulcus appears at 30-50 cm CVR length while EL.NAHLA (1982) reported this sulcus at 34-56 cm CVR length.

Our investigation recorded that, ***sulcus genualis*** appeared at 21 cm CVR length, ***sulcus calcarinous*** and ***sulcus splenialis*** were well oriented at 22 cm CVR length, ***sulcus cruciate*** and ***sulcus rostralis internus*** appeared at 23 cm CVR length, ***sulcus ansatus*** appeared at 24 cm CVR length, while the last one to appear was the caudal part of ***sulcus suprasylvius***, all of the previously mentioned sulci and their associated gyri exhibited the adult position and structure at 35 cm CVR length, EL KHALIGI (1977), in one humped camel

mentioned that, the cerebral sulci and gyri attains full properties and arrangement in group 3, (50-70 cm CVR length) and group 4, (above 70 cm CVR length), EL.NAHLA (1982) in water buffalo stated that, these sulci and gyri have adult form and arrangement at the fourth group (56-79 cm CVR length).

The olfactory bulb was firstly observed in this work as a white primitive knot at the rostral end of the ventral surface of each cerebral hemisphere at 3.8 cm CVR length, however, AREY (1974) stated that during the sixth week a swelling appears on the ventral surface of each cerebal hemisphere, these enlarges into distinct olfactory lobes each lobe is divided into rostral and caudal divisions, the former represents the olfactory bulb and tract, moreover, EL KHALIGI (1977) in camel recorded the first observation of the bulb at CVR from 19-30 cm CVR length as elongated oval to rectangular projection at the ventral surface of the rostral end of the cerebral hemisphere. EL.NAHLA (1982) in water buffalo recorded that this bulb appears at 5 cm CVR length fetuses (51 days) as a pin head in shape and size ventral to the rostral end of each cerebral hemisphere Moreover, FRANDSON (1981) in farm animals stated that the rhinencephalon is from the evolutionary stand point one of the oldest parts of the cerebrum.

In our investigation the mamillary body appeared as a very faint prominence at the ventral surface of the diencephalon at 4.3cm CVR length, at 8 cm CVR length it was represented by two small prominances which fused at 12.6 cm CVR length forming a single mamillary body, MAY (1970) and GANGULI/SINGH (1977) reported that in sheep the mamillary body is a circular mass with a medial fissure which indicates the caudal limit of the ventral aspect of the diencephalons. On the other hand DELLMAN/McCLURE (1975) in small ruminants asserted that he mamillary body is subdivided into

two symmetrical halves. On the other hand, EL. KHALIGI (1977) in camel recorded that the mamillary body is poorly differentiated at 19-30 cm CVR length. On the other hand EL.NAHLA (1982) in buffalo reported that, the mamillary body and the tuber cinerium collectively appears as a small oval prominence between the two cerebral hemispheres ventrally at the beginning of the first group (5-15.5 cm CVR length) and then becomes more clear by the end of this group.

The present work revealed that the body of the pineal gland appeared at 8.3 cm CVR length, attained an ovoid shape at 11.3 cm CVR length and showed a marked enlargement at 12.6 cm CVR length while at the beginning of the third group (over 20 cm CVR length), it attained a dorsal extention and a slight reduction in size, at 26 cm CVR length it was markedly reduced in size and compressed laterally and at 35 cm CVR length it attained adult size and shape, REGODON et. al. (1998), stated that, the ovin pineal outline begins to differentiate into a dorsal evagination of the diencephalic median line at around 30 days of prenatal life, it lies close to the anterior and posterior commissures. on the other hand, EL.KHALIGI (1977) in camel recorded that the pineal gland is well developed at the second group (30-50cm CVR length). On the other hand EL.NAHLA (1982), reported that, the pineal body of the buffalo fetuses can be recognized as a very small spherical body at the age of 34-56 cm CVR length. Moreover, AREY (1974), in human stated that, the pineal body evaginates during the seventh week (49 days of pregnancy), it becomes conical, solid and possibly glandular. CLABOUGH (1973), reported that, the pineal development in foetal rats occurs during the last eight days of gestation and in foetal hamster during the last five days of gestation, a comparative study was performed here between the histogenesis of the gland in both species. While, GABR et. al. (1992), recorded that, the pineal gland in bouscat rabbit appears firstly in 14-day old embryo. Moreover, PEITER (1981) stated that, in mammals the anlage of

the pineal diverticulum lies in the dorsal median area of the neural tube at the level of the neuroaxis, which will become the diencephalon between posterior and habenular commissures, but in opossum it obtains a subcommissural location.

In the present study the mesencephalon was proportionally large and elongated in the early group specimens, its size gradually declined in the later groups due faster growth of cerebrum and cerebellum, similler results were recorded by SHRIVASTAVA et. al. (1988) in goat. EL.KHALIGI (1977) in camel reported that , the corpora quadrugemina are the second in size to the cerebral hemispheres in camel fetuses of 19 cm CVR length, the same result was stated by EL.NAHLA (1982) in buffalo fetuses of 5-15 cm CVR length, In our investigation the mesencephalon exhibited its first feature of longitudinal division at 5.7 cm CVR length, while division of the tectum into two rostral and two caudal colliculi occurred at 11 cm CVR length, the mesencephalon exhibited nearly adult arrangement at 14 cm CVR length. Moreover, EL.NAHLA (1982) in buffalo recorded that by the beginning of the first group (5 cm CVR length) the corpora quadrigemina present a very faint mid-dorsal groove which deepens at 7-9.5 cm CVR length and becomes clear separating two rostral colliculi at 15.5 cm CVR length, in addition a very faint transverse groove appears thus the caudal colliculi are connected, the complete differentiation of the corpora quadrigemina occurs in buffalo fetuses by the end of the second group (15.5-34 cm CVR length). PATTEN (1948) in pig stated that the dorsolateral wall of the mesencephalon give rise to the corpora quadrigemina at fetuses of 100 mm. In addition, AREY (1974) recorded that, the mesencephalon begins to be differentiated after the third month. Moreover, WENISCH et. al. (1997) in cattle stated that the mesencephalon can be recognized for the first time at 0.8 cm CRL whereas the superior colliculus can

be clearly differentiated in embryos of 4.5 cm CRL, they added that the macroscopic features of this brain area reaches adult condition at 80 cm CRL.

In the present study the development of the lateral and medial geniculate bodies as well as the brachia connected them with the rostral and the caudal colliculi began at 11 cm CVR length, they became clear at 12 cm CVR length and attained adult arrangement at 35 cm CVR length. On the other hand, TEWARI and RAO (1977) stated that, the corpus geniculaum lateralis in indian buffalo is convex, swing in a semicircle around the thalamus and covered with the fibers of the optic tract.

The present work revealed that the cerebellum began to be differentiated into two hemispheres connected with each other by a parenchymatous bridge at 8 cm CVR length, cerebeller foliation degan at 8.3 cm CVR length, it differentiated gradually to reach nearly adult form at 14 cm CVR length and complete adult structure at 35 cm CVR length, BERUJON (1970) in bovines, recorded that, the vermis develops faster than the cerebeller hemispheres and added that the cerebellum is marked by fissures at 60 days, while, EL. KHALIGI (1977) in camel stated that the metencephalon shows two elevations, the premordia of the cerebellum at 19 cm CVR length, in later group (19-30) cm CVR length, while in the second group (30-50 cm CVR length), the cerebellum presents primary fissures, at the third group (50-70 cm CVR length) it enlarges to reach adult structure at 70 cm CVR length. Moreover, EL.NAHLA (1982) stated that, the premordia of the cerebellum is represented by a smooth transverse band in fetuses of 5-15 cm CVR length, complete development occurs at 52-56 cm CVR length. On the other hand, BRADLEY (1903) in pig recorded that at 40 days embryo, 52 mm long, the cerebellum of the pig embryo has no fissures. He added that development proceeds rapidly up to 44 days, 64 mm long where the vermis and the cerebeller hemispheres can be differentiated,

at 118 mm, 59 days the anterior surface is bearing a strong resemblence to adult appearance. On the other hand, LARSELL (1953) in pig, reported that the pig embryo of 12 mm length shows a commissure in the roof of the 4th ventricle immediately caudal to the midbrain but situated in the metencephalic division of the embryonic brain, at this stage fusion of the bilateral halves of the cerebellum has begin. PATTEN (1948) in pig said that the dorsolateral walls of the neural tube in the metencephalic region undergo very extensive growth and give rise to the cerebellum of the adult brain, where the early smooth contour of this region is broken up by the development of a complex series of foldes. LOESER (1972), stated that the cerbellar vermis in man begins to develop folia by the 13-14 weeks estimated gestational age and that the nine lobules of the vermis can be identified at approximately 15 weeks of gestation, he added that the development of the folia is not completed until about two months after term. Moreover, MULLER and O RAHILLY (1990) in human stated that at the end of the embryonic period (stage 23) , the rostral part of the rhombincephalon is covered by the cerebeller premordium which arches like a horse-shoe over the brain stem, when removed the entire rhomboid fossa becomes recognizable.

In the present study the pons firstly identified at 5.7 cm CVR length, the basilar sulcus appeared at 8 cm CVR length while the prepontin sulcus appeared at 14 cm CVR length, they became very clear at 19.5 cm CVR length. Moreover EL.KHALIGI (1977) in camel recorded that the pons appears as two elevations located in between the fibers of the pyramids in fetuses between 19 and 30 cm CVR length. Moreover, EL.NAHLA (1982) observed that the pons appears as a narrow transverse band at 15.5 cm CVR length buffalo fetuses. While, PATTEN (1948) in pig stated that, at about 100 mm fetuses, great groups of fibers which form the paths of intercommunication between the cerebellum and the other parts of the nervous system appears superficially in the walls of the metencephalon, this part is the pons.

Our investigation revealed that the medullary pyramides were differentiated for the first time at 8cm CVR length without any sort of decussation, while in camel and as stated by EL.KHALIGI (1977) primordial thickening of the medulla appears at 19 cm CVR length, on the other hand, in buffalo fetuses the pyramids are well defined at 70 cm CVR length and its decussation is recognized at 73.5 cm CVR length (EL.NAHLA, 1982). Moreover, AREY (1974) described the early development of the medulla at nine weeks human embryos.

In the present work, the corpus trapizodium firstly observed at 8.3 cm CVR length, while it could be recognized by EL.KHALIGI (1977) in camel fetuses of 30-50 cm CVR length as two rounded elevations and by EL.NAHLA (1982) in buffalo fetuses of 38.5 cm CVR length.

In the present investigation the trigeminal and facial nerves were observed for the first time at 14 cm CVR length. On the other hand EL.KHALIGI (1977) reported the first appearance of the trigeminal nerve in camel at the end of the third group (50-70 cm CVR length) and he also stated that the superficial origins of the cranial nerves from that of the 7^{th} to the last can hardly be separated at the second group (30-50 cm CVR length), they becomes obvious at the third group (50-70 cm CVR length). while, in buffalo fetuses the facial nerve appears at 15.5 cm CVR length and the trigeminal nerve originates at 34-56 cm CVR length (EL.NAHLA, 1982),

In our study the occulomotor nerve appeared at 18.3 cm CVR length, however, EL.KHALIGI (1977) in camel reported that, it arises at 30-50 cm CVR length.

In the present study the vestibulocohlear, glossopharyngeal, vagus and spinal accessory nerves appeared at 20.5 cm CVR length, EL.KHALIGI (1977) in camel observed this nerves at 50-70 cm CVR length. On the other hand, the

vestibulocochlear nerve arises at the age of 56-79 cm CVR length buffalo fetuses and the glossopharyngeal and vagus nerves are clearly differentiated at 79 cm CVR length buffalo fetuses (EL.NAHLA, 1982). On the other hand RUHRIG et. al. (1994) in cattle stated that, the nuclei of the vestibulocochlear nerve can be estimated at 1 cm CRL and reaches adult structure at 53 cm CRL.

The hypoglossal nerve observed for the first time in this study as a very delicate nerve fibers originated from the lateral aspect of the caudal third of the medullary pyramides at 24 cm CVR length, while EL.KHALIGI (1977) in camel recorded that, it arises at 50-70 cm CVR while the hypoglossal nerve can be see at 56 cm CVR length in buffalo fetuses (EL.NAHLA, 1982), moreover RUHRIG et. al. (1995) in cattle stated that at 1 cm CR length the caudal pole of the hypoglossal nerve nucleus form a uniform cell column with the ventral horn of the spinal cord, from 3.5 cm CR length onward all nuclear groups can be identified. At 53 cm CR length they correspond to the pattern as described in adult. Moreover, MULLER and ORAHILLY (1990), stated that, the arrangement of the tracts and nuclei of the human rhombencephalon at 8 weeks is shown to be closely similar to that present in the newborn. The opinion of the author was that rapid growth of the rhombencephalon during the embryonic period proper is associated with corresponding early functional activity.

The present investigation revealed that, the first choroid plexus to appear was that of the third ventricle which was observed at 3.8 cm CVR length, followed by the choroid plexus of the lateral ventricle at 5.7 cm CVR length while that of the fourth ventricle appeared at 8.3 cm CVR length. However, MALIK et. al. (1992) in goat stated that, the primordium of the telencephalic choroid plexus developed in fetuses of 5cm CR length, followed by that of the third and fourth ventricles. On the other hand, ELKHALIGI (1977) in camel stated that a dark red lateral choroid plexus could de observed at 19 cm CVR

length, the choroid plexus of the third ventricle appears at CVR length from 19-30 cm while that of the fourth ventricle appears at the second group fetuses (30-50 cm CVR length). On the other hand, EL.NAHLA (1982) in buffalo recorded that, the lateral ventricle of fetuses of 5-15 cm CVR length simulates that of camel fetuses at more than 19 cm CVR length and attains adult pattern at 67 cm CVR length, the choroids plexus of the fourth ventricle appears in buffalo fetuses of 15.5-34 cm CVR length. In addition, O"RAHILLY and MULLER (1990) in human stated that, the lateral ventricles begin to appear at stage 14 (4-1/2 weeks) and at stage 17-18 (6 weeks) cellular accumulations indicates the future choroid velli of the fourth and lateral ventricles, they added that at stage 19 (7 weeks) the choroid velli of the fourth ventricle are seen while those of the lateral ventricle are evident at stage 20 (7 weeks), the authores added that the choroid velli of the third ventricle are among the structures which can not be detected until the fetal period (over 8 weeks).

The caudate nucleus and the hippocampus appeared for the first time in the present work at 8 cm CVR length and became well identified at 11 cm CVR length, at 19.5 cm CVR length the caudate nucleus attained the form of a rounded prominence while the hippocampus became horn-like, they reached adult form at 35 cm CVR length. EL.KHALIGI (1977) mentioned that, a thin hippocampus appeared at 19-30 cm CVR length. On the other hand, (EL.NAHLA, 1982), the latter added that, the caudate nucleus and hippocampus are observed in buffalo fetuses of 32 cm CVR length.

B-PRENATAL MORPHOMETRIC DEVELOPMENTAL STUDY:

Results of this study revealed that, the brain attained an elongated outline at group I (up to 10 cm CVR length) and group II (10-20 cm CVR length) while at group III (over 20 cm CVR length) it became ovoid in outline, on the other hand, SHRIVASTAVA et al (1987) in goat stated that it is elongated in group I (up to 10 cm CR length) and ovoid in group II (10-20 cm CR length) and III (over 10 cm CR length).

Our results revealed that, the brain width is lesser than the length at all groups, similar results were recorded by SHRIVASTAVA et. al. (1987) in goat. The present investigation revealed that, the total increase in the width was larger than the total increase in the length, this revealed the tendency of the brain for lateral expantion and that it might bear a relative degree of cephalization and a possible evolutionay status of the mammalian brain, this supported the observations of SHRIVASTAVA et. al (1987) in goat, FOX (1963) in dog and HARPER and MASER (1975) in the American wild buffalo. Our results included that, the length of the cerebrum showed a greater increase over the width in all groups, similar results were recorded by SHRIVASTAVA et. al (1987) in goat, moreover and in agreement with SHRIVASTAVA et. al (1987), the higher percentage of the cerebral length than width was a indicative of the lengthening of the cerebral gyral convolutions, and as a whole reflected the linear length-wise body growth.

In the present study it was obsereved that the cerebellum followed a gradual upword trend from group I (up to 10 cm CVR length) to group III (over 20 cm CVR length) and showed its maximum total increase in width in group 3,

latter author stated that, the cerebeller length showed its maximum total increase in group 3 (over 20 cm CR length) while in the present work this occured in group 2 where group 3 presented a slight increase in cerebeller length.

Our results revealed that, the width of the pons was larger than its length in all of the age groups, the two parameters showed a gradual increase through the three groups, these results confirmed the results stated by SHRIVASTAVA et. al in goat (1987).

The present morphometric study indicated that the length of the medulla oblongata showed a very slight increase than the width in all groups, this results were aliened with the results observed by SHRIVASTAVA et. al (1987).

Summary

Summary

Studies on the prenatal development of the brain in domestic animals in general and especially in goat are either insufficient or incomplete.Accordingly, the aim of this work is to give a basis for histogenesis and organogenesis to some parts of the brain of the goat which may help in future studies in the field of veterinary neuroanatomy.

This work was carried out on sixty seven goat fetuses procured from Cairo small animals slaughter houses.

Each foetus, was subjected to the following measurements:

1-CVR (crown vertebral rump) length.

2-CR (crown rump) length.

The foetuses were classified into three groups according the CVR length:

Group 1 of CVR length up to 10 cm.

Group 2, of CVR length 10-20 cm.

Group 3, of CVR length over 20 cm.

This three groups represented the early, mid and late stages of gestation.

The brains were extracted from the cranium and subjected to the following investigations:

I- Gross developmental features:

II- Histogenic study:

III- Morphometric study: it included:

A-Measurements concerning the whole brain:

1-Length : from frontal pole to the end of the medulla oblongata.

2-Width : the widest part (interparietal).

B- Measurments concerning the cerebrum:

1-Length of the right and left cerebral hemispheres from frontal to occipital poles as well as the intermediate length.

2-Width of each cerebral hemisphere at anterior, posterior and middle levels .

C-Measurments concerning the cerebellum:

1-Length: rostro-caudal distance of the vermis .

2-Width : transeverse distance at the region of the brachium pontis .

D-Measurments concerning the pons:

1-Length : rostro-caudal distance from foramen caecum to the origin of the cerebral crura .

2-Width : transverse distance measured venterally between attatchements of the middle cerebellar peduncles .

E- Measurments concerning the medulla oblongata :

1-Length : from the caudal border of the pons to the caudal limit of the medulla .

2-Width : maximum transeverse distance of the medulla caudal to the pons.

The results of the investigation were divided into two parts:

A- Prenatal Macroscopic and Microscopic developmental studies.

B- Prenatal Morphometric Developmental Studies.

The prenatal Macroscopic and Microscopic developmental studies, revealed that, fetuses at 1.97 cm and 1.99 cm CVR lengths presented the formation of the neural tube and the neural crest, the neural tube considered the early premordium of the brain vesicles and spinal cord, The pontine flexure, firstly seen 3.3 cm CVR length. While, the interventricular portion of the rhombic lip, the premordium of the cerebellum appeared at 3.8 cm CVR length. The cerebral hemispheres were differentiated in this work as two lateral smooth

were differentiated in this work as two lateral smooth outpockings at 3.8 cm CVR length, The first sulcus which appeared in the cerebral hemispheres in goat was the rostral part of ***sulcus rhinalis lateralis***, while, ***fissure sylvia*** began to appear at 14 cm CVR length, as a lateral continuation of the lateral fossa.

Sulcus suprasylvian rostralis appeared as a shallow indentation at 17 cm CVR length

Regarding ***sulcus ectosylvius*** in goat embryo; the present investigation showed that, it was formed of a large rostral and short caudal parts, the rostral part appeared at 17 cm CVR length, it was extended caudally and dorsally over the dorsal border of gyrus sylvius, the caudal part observed at 26 cm CVR length. ***sulcus and gyrus proreus*** appeared at 19.3 cm CVR length. On the other hand ***sulcus marginalis*** appeared in our study at 19.5 cm CVR length, ***sulcus presylvius*** appeared at 20.5 cm CVR length, ***sulcus genualis*** appeared at 22 cm CVR length, ***sulcus calcarinous*** and ***sulcus splenialis*** were well oriented at 22 cm CVR length, ***sulcus cruciate*** appeared at 23 cm CVR length, ***sulcus rostralis internus*** and ***sulcus ansatus*** appeared at 24 cm CVR length, while, the last one to appear was the caudal part of ***sulcus suprasylvius***, all of the previously mentioned sulci and their associated gyri exhibited the adult position and structure at 35 cm CVR length,

The olfactory bulb was firstly observed in this work as a white primitive knot at the rostral end of the ventral surface of each cerebral hemisphere at 3.8 cm CVR length,

the mamillary body appeared as a very faint prominence at the ventral surface of the diencephalon at 4.3cm CVR length, at 8 cm CVR length it was represented by two small prominances which fused at 12.6 cm CVR length forming a single mamillary body, the body of the pineal gland appeared at 8.3 cm CVR length, attained an ovoid shape at 11.3 cm

group (over 20 cm CVR length), it attained a dorsal extension and a slight reduction in size, at 26 cm CVR length it was markedly reduced in size and compressed laterally and at 35 cm CVR length it attained adult size and shape.

The mesencephalon was proportionally large and elongated in the early group specimens, its size gradually declined in the later groups due faster growth of cerebrum and cerebellum, the mesencephalon exhibited its first feature of longitudinal division at 5.7 cm CVR length, while division of the tectum into two rostral and two caudal colliculi occurred at 11 cm CVR length, the the mesencephalon exhibited nearly adult arrangement at 14 cm. The development of the lateral and medial geniculate bodies as well as the brachia connected them with the rostral and the caudal colliculi began at 11 cm CVR length, they became clear at 12 cm CVR length and attained adult arrangement as at 35 cm CVR.

The cerebellum began to be differentiated into two hemispheres connected with each other by a parenchymatous bridge at 8 cm CVR length, cerebeller foliation degan at 8.3 cm CVR length, it differentiated gradually to reach nearly adult form at 14 cm CVR length and complete adult structure at 35 cm CVR length, the pons firstly identified at 5.7 cm CVR length, the basilar sulcus appeared at 8 cm CVR length while the prepontin sulcus appeared at 14 cm CVR length, they became very clear at 19.5 cm CVR length, the medullary pyramids were differentiated for the first time at 8cm CVR length without any sort of decussation, the corpus trapizodium firstly observed at 8.3 cm CVR length,

In the present investigation the trigeminal and facial nerves were observed for the first time at 14 cm CVR length. the occulomotor nerve appeared at 18.3 cm CVR length, the vestibulocochlear, glossopharyngeal, vagus and spinal accessory nerves appeared at 20.5 cm CVR length, The hypoglossal nerve observed for the first time in this study as a very delicate

nerve fibers originated from the lateral aspect of the caudal third of the medullary pyramides at 24 cm CVR length,

The first choroid plexus to appear was that of the third ventricle which was observed at 3.8 cm CVR length, followed by the choroid plexus of the lateral ventricle at 5.7 cm CVR length while that of the fourth ventricle appeared at 8.3 cm CVR length.

The caudate nucleus and the hippocampus appeared for the first time in the present work at 8 cm CVR length and became well identified at 11 cm CVR length, at 19.5 cm CVR length the caudate nucleus attained the form of a rounded prominence while the hippocampus became horn-like, they reached adult form at 35 cm CVR length.

The morphometric studies revealed that, the brain width is lesser than the length at all groups and that, the total increase in the width was larger than the total increase in the length, this revealed the tendency of the brain for lateral expantion and that it might bear a relative degree of cephalization and a possible evolutionay status of the mammalian brain, width in all groups, the cerebellum followed a gradual upword trend from group I (up to 10 cm CVR length) to group III (over 20 cm CVR length) and showed its maximum total increase in width in group 3, while group 2 (10-20 cm CVR length) showed a slight increase in width, the width of the pons was larger than its length in all the length of the cerebrum showed a greater increase over the of the age groups, the two parameters showed a gradual increase through the three groups and the length of the medulla oblongata showed a very slight increase than the width in all groups.

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Arabic Summary

الملخص العربى

تعتبر الدراسات التى أجريت على التطور الجنينى للمخ فى الحيوانات الأليفة على وجه العموم وفى الماعز بصفة خاصة غير كافية أو غير كاملة.

أجريت هذه الدراسة على سبعه وستين من أجنة الماعز والتى تم تجميعها من مجازر الحيوانات الصغيرة بالقاهرة.

تم تثبيت الأجنة فى ١٠% فورمالين بعد ازالة جزء من الجمجمة للسماح للمحلول بالوصول الى المخ.

تم أخذ قياسات خاصة بالجنين كامل ووزنه ثم تم فتح التجويف القحافىواستخراج المخ من كل جنين وأخذ القياسات الخاصة به.

ولقد أجريت على كل مخ نوعان من الدراسات:

١- دراسة التطور المورفولوجى:

حيث تم أخذ صور فوتوغرافية لكل عينة علويا وسفليا ووحشيا وتم رصد التطور الجنينى لكل أجزاء المخ بالعين المجردة أو بالعدسة المكبرة او باستخدام ستريوميكرسكوب.

٢- دراسة الانسجة:

وتشمل تمرير العينات وتحضير قطاعات ميكروسكوبيةوصباغتها وفحصها وتصويرها لتتبع التطور النسيجى لبعض أجزاء المخ.

اظهرت الدراسة ان الدماغ يبقى على حالته الملساء فى اجنة المجموعة الأولى التى تتراوح اعمارها بين٢٣ الى ٥٠ يوما (أقل من ١٠سم).

<u>٣- دراسات قياسية (مورفومترية):</u>

وهى تشمل قياسات خاصة بالمخ ككل وأخرى خاصة بالاجزاء الرئيسية بالمخ واستخدمت هذة القياسات فى عمل جداول ومنحنيات لتوضيح العلاقة بين معدل نمو المخ بالنسبة للجسم ومعدل نمو كل جزء من أجزاء المخ بالنسبة للمخ ككل.

ولقد تم تحديد عمر ظهور كل من الأخاديد والتلافيف المخية وكذلك الأجزاء الأخرى والتى تشمل الجهاز البطينى للدماغ.

اظهرت الدراسات القياسية وجود علاقة طردية بين القياسات الخاصة بالمخ وتلك الخاصة بالجسم، وكذلك القياسات الخاصة بالمخ وكل جزء من أجزائة.

جامعة طنطا - فرع كفر الشيخ
كلية الطب البيطرى
قسم التشريح والهستولوجيا

قرار لجنة الحكم والمناقشة

قـــررت لجـــنة الحكم والمناقشة بجلستها المنعقدة فى يوم الثلاثاء الموافق ٢٠٠٣/١٢/٢م بكلية الطب البيطرى بكفر الشيخ ما يلى :-

الرســـالة المقدمـــة مـــن السيدة **طب./ نجلاء أحمد أحمد شحاته** ترقى بها للحصول على درجة دكتوراه الفلسفة وتوصى اللجنة بترشيح سيادتها للحصول على درجة دكتوراه الفلسفة فى العلوم الطبية البيطرية (تشريح وأجنة).

اللجنـــة

١- أ.د/ **محمد المحرزى عبد المنعم**
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٢- أ.د/ **محمـــد السيـــد أمـــين**
أســـتاذ ورئـــيس قســـم التشـــريح والأجـــنة بكلـــية الطـــب البيطرى بإدفينا.

٣- أ.د/ **على عبد القادر منصور**
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٥- د **خليـل فتحى أبـو عيسى**
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نمو المخ قبل الولادة فى الماعز

رسالة مقدمة من

نجلاء أحمد أحمد شحاته

ماجستير العلوم الطبية البيطرية – ١٩٩٨

رسالة مقدمة للحصول على درجة الدكتوراه فى العلوم الطبية البيطرية (تشريح وأجنة)

تحت إشراف

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أستاذ التشريح والأجنة ووكيل الكلية للدراسات العليا

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