First Trimester Scanning

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First Trimester Scanning

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- Ultrasound Detection Of Chromosomal Anomalies

EMBRYONIC DEVELOPMENT

EMBRYONIC DEVELOPMENT

CONTENT

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STAGES OF EMBRYONIC DEVELOPMENT

(Stages 1–3) Fertilization and Implantation

Table 1.1 Human embryonic development and growth

Period	Conception* (d)	Gestational age** (d)	CR length (mm)	External characterizations	Carnegie staging
Blastogenesis					
First 2 weeks	0–14	0–28	0–0.4	Unicellular to bilaminar plate	1–6b
Days 14–28	15–28	29–35	0.4–4.6	Trilaminar embryo to open neural groove	7–10
Organogenesis					
Second 4 weeks	22–35	36–49	4.6–8	Neural tube closure to limb buds	11–13
Days 32–56	36–60	50–75	8–30	Limb growth to fused eyelids	14–22
Fetal	61–266	75–280	35–350	Fetal maturation	

* Embryonic development is dated from fertilization.

** Prenatal growth evaluation by ultrasound is dated from day of last menstrual period. This is termed "gestational age."

Adaped from Wilson RD: Prenatal evaluation of growth by ultrasound, *Growth Genetics & Hormones*, v.9(1), 1993.

STAGES OF EMBRYONIC DEVELOPMENT

(Stages 1–3) Fertilization and Implantation

Table 1.2 Measurements of gestation age by ultrasound

Mean gestational age (wk)*	Mean gestational sac diameter (mm)†	Embryo CR length (mm)	BPD (mm)	Femur length (mm)
5 + 0	2	–	–	–
6 + 0	10	6	–	–
7 + 0	18	10	–	–
8 + 0	26	17	–	–
9 + 0	–	25	–	–
10 + 0	–	33	–	–
11 + 0	–	43	–	6
12 + 0	–	55	17	9
13 + 0	–	68	20	12
14 + 0	–	85	25	15

* From 1st day of last menstrual period †Daya et al., 1991 ‡Jeanty, 1983

Adaped from Wilson RD: Prenatal evaluation of growth by ultrasound, *Growth Genetics & Hormones*, v.9[1], 1993.

STAGES OF EMBRYONIC DEVELOPMENT

(Stages 1–3) Fertilization and Implantation

Table 1.4 Summary of embryonic development highlights

CR length (mm)	Days after ovulation	Carnegie stage	Main external features
0.1	0–2	1	Fertilized oocyte
	4–6	3	Blastocyst
0.2–0.4	6–15	5	Trilaminar embryo with primitive streak
1.5–2.0	20–22	9	Heart tubes begin to fuse
2.0–3.0	22–24	10	Neural folds begin to fuse; heart begins to beat
3.0–4.0	24–26	11	Rostral neuropore closing
4.0–5.0	26–30	12	Upper limb buds appear
5.0–6.0	28–32	13	Four pairs of branchial arches
6.0–7.0	31–35	14	Lens pits and nasal pits visible

STAGES OF EMBRYONIC DEVELOPMENT

(Stages 1–3) Fertilization and Implantation

Table 1.4 Summary of embryonic development highlights

CR length (mm)	Days after ovulation	Carnegie stage	Main external features
Highlights 35–56 days, organogenesis			
7.0–10.0	35–38	15	Hand plates formed; retinal pigment visible
10.0–12.0	37–42	16	Foot plates formed
12.0–14.0	42–44	17	Finger rays appear; auricular hillocks developed
14.0–17.0	44–48	18	Toe rays appear
16.0–20.0	48–51	19	Trunk elongating; midgut herniation to umbilical cord
20.0–22.0	51–53	20	Fingers distinct but webbed
22.0–24.0	53–54	21	Fingers free and longer
24.0–28.0	54–56	22	Toes free and longer
28.0–30.0	56–60	23	Head more rounded; fusing eyelids

STAGES OF EMBRYONIC DEVELOPMENT

(Stages 1–3) Fertilization and Implantation

Table 1.5 Major landmarks for early development

Retinal pigment 35–37 days
Separation of common aorticopulmonary trunk (A & PA separate) 42 days
Distinct elbow and/or developing eyelids 44 days
Scalp vascular plexus 49 days
Intestines into umbilical cord 7–10 weeks
Perforation of anal membrane 51 days
Lack of tail 56 days
Fingernails and a well-defined neck 10–12 weeks (a fetus not embryo)

STAGES OF EMBRYONIC DEVELOPMENT

(Stages 4 and 5) Second Week of Development

- During the 2nd week, a bilaminar embryonic disc forms, amniotic and primary yolk sac cavities develop, and there are two layers of trophoblast.
- The two-layered disc separates the blastocyst cavity into two unequal parts (a smaller amniotic cavity and a larger primary yolk cavity). The thick layer of embryonic cells bordering the amniotic cavity is called the epiblast and a thin layer bordering the primary yolk cavity is called the hypoblast.

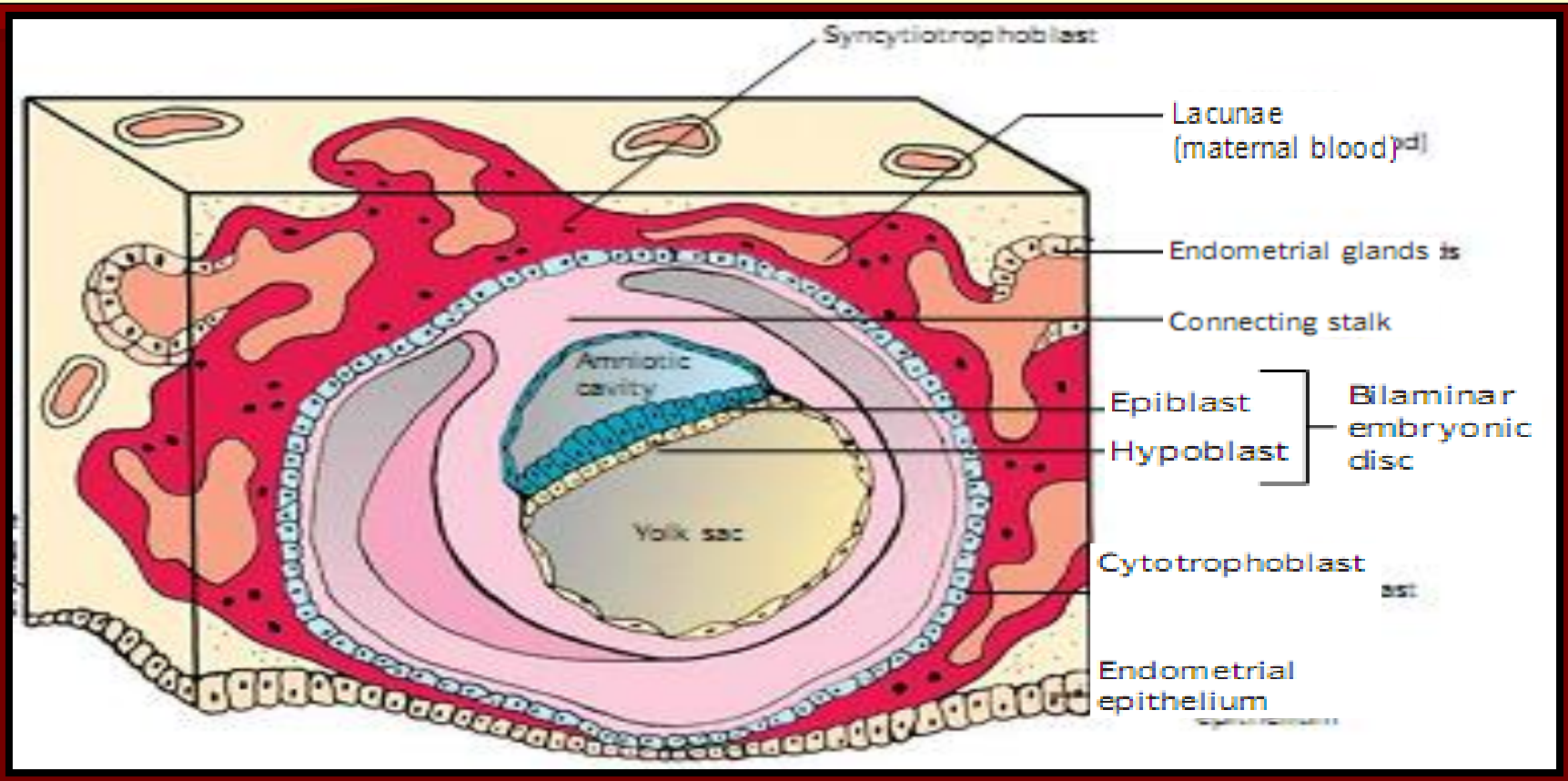
STAGES OF EMBRYONIC DEVELOPMENT

(Stages 4 and 5) Second Week of Development

- The trophoblast differentiates into two layers, an inner cytotrophoblast and an outer syncytiotrophoblast.
- The trophoblast continues to penetrate deeper into the endometrium. At the end of the 2nd week, the site of implantation is recognized as a small elevated area of endometrium having a central pore Filled with a blood clot.

STAGES OF EMBRYONIC DEVELOPMENT

(Stages 4 and 5) Second Week of Development



Bilaminar embryonicdisc in the 2nd week of development (stage 5), with amniotic and primary yolk sac cavities.

STAGES OF EMBRYONIC DEVELOPMENT

(Stages 10–12: Up to Day 28 End of Blastogenesis)
Fourth Week of Development

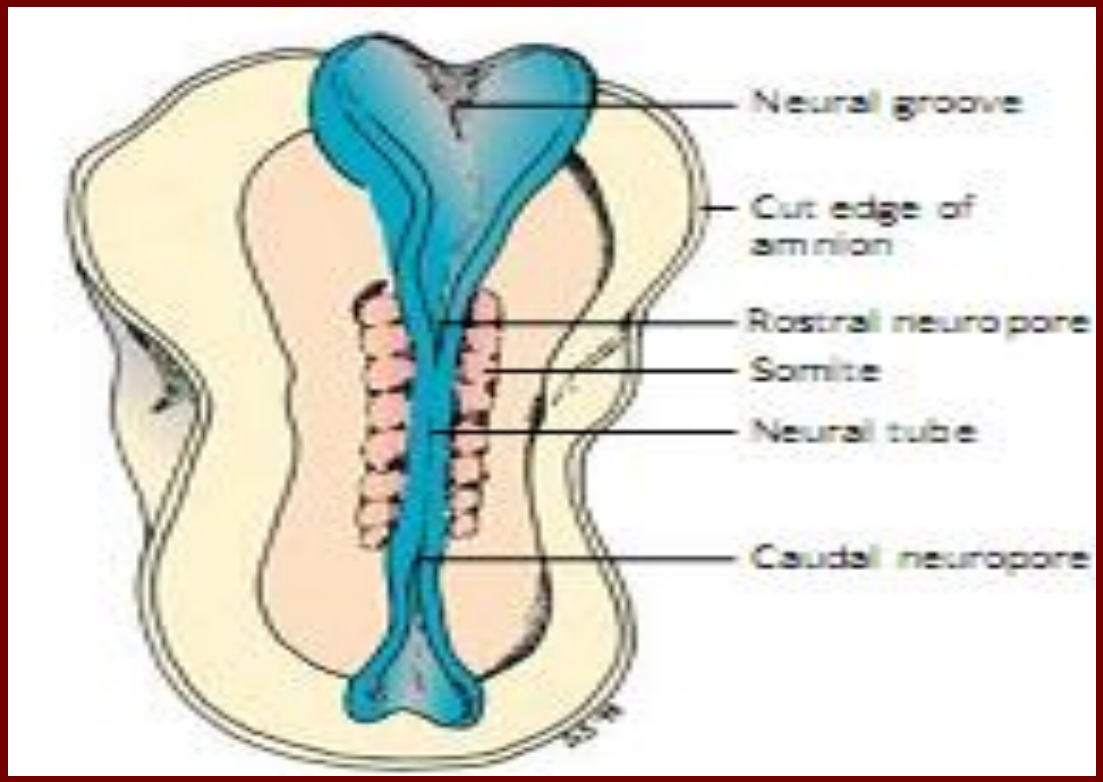
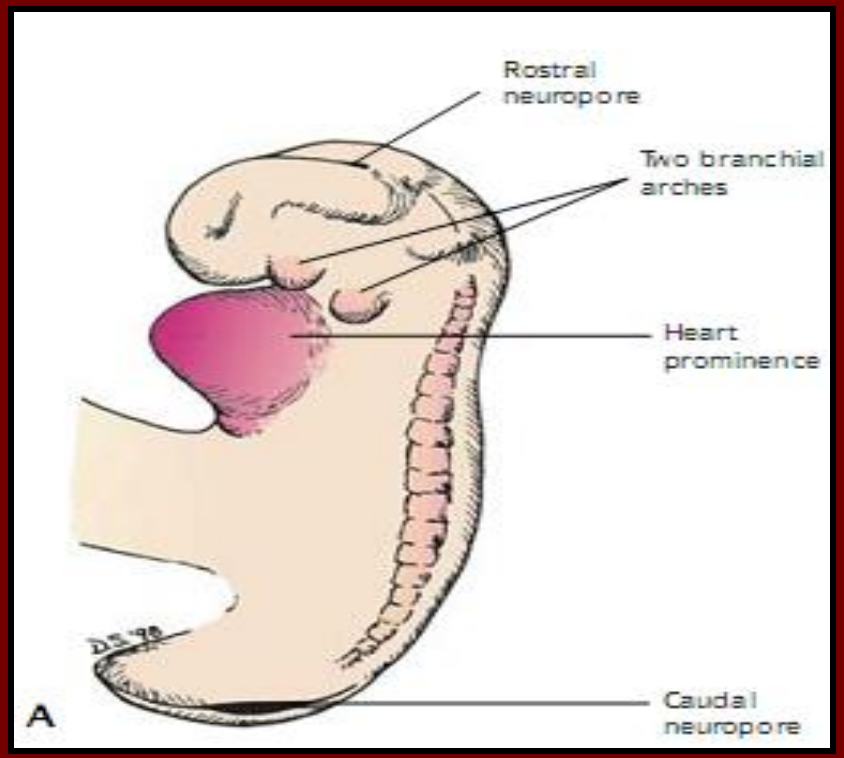
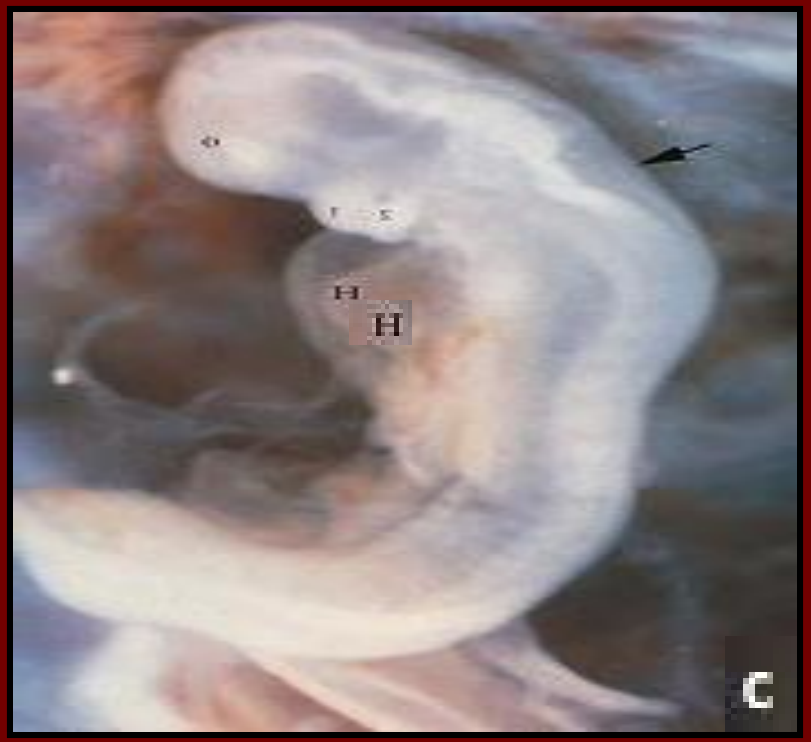


Diagram of human embryo at stage 10. Neural folds are partially fused with the neural tube open at the rostral and caudal neuropore.

STAGES OF EMBRYONIC DEVELOPMENT

(Stages 10–12: Up to Day 28 End of Blastogenesis)
Fourth Week of Development



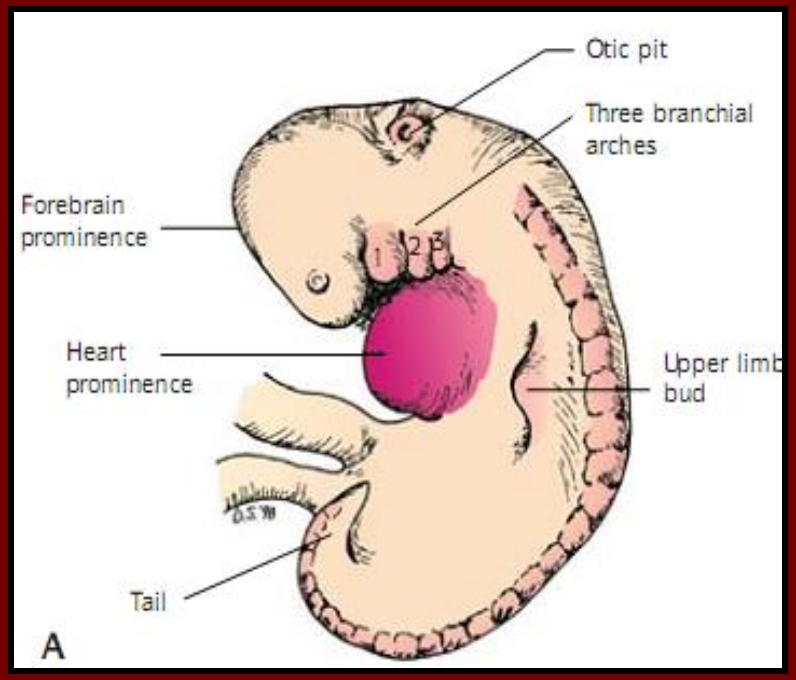


A)Diagram of a human embryo at stage 11. (C) Human embryo at stage 11 with slight curve, two pairs of branchial arches, heart prominence (H), and optic vesicle (O). Rostral neuropore (arrow) continues to close.

B)

STAGES OF EMBRYONIC DEVELOPMENT

(Stages 10–12: Up to Day 28 End of Blastogenesis)
Fourth Week of Development



(A) Drawing of a human embryo at stage 12. (B) Embryo at stage 10–12 (4th week of development) with early vascular development.
A)

STAGES OF EMBRYONIC DEVELOPMENT

(Stages 10–12: Up to Day 28 End of Blastogenesis)
Fourth Week of Development

(B) A human embryo at stage 11 (arrow) showing a slight curve. The size should range from 2 to 5 mm..

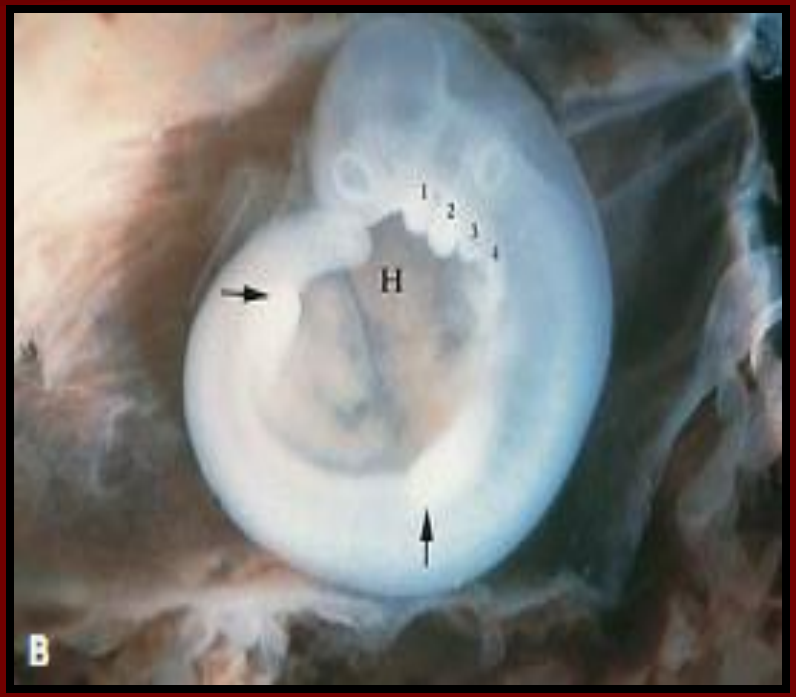
STAGES OF EMBRYONIC DEVELOPMENT

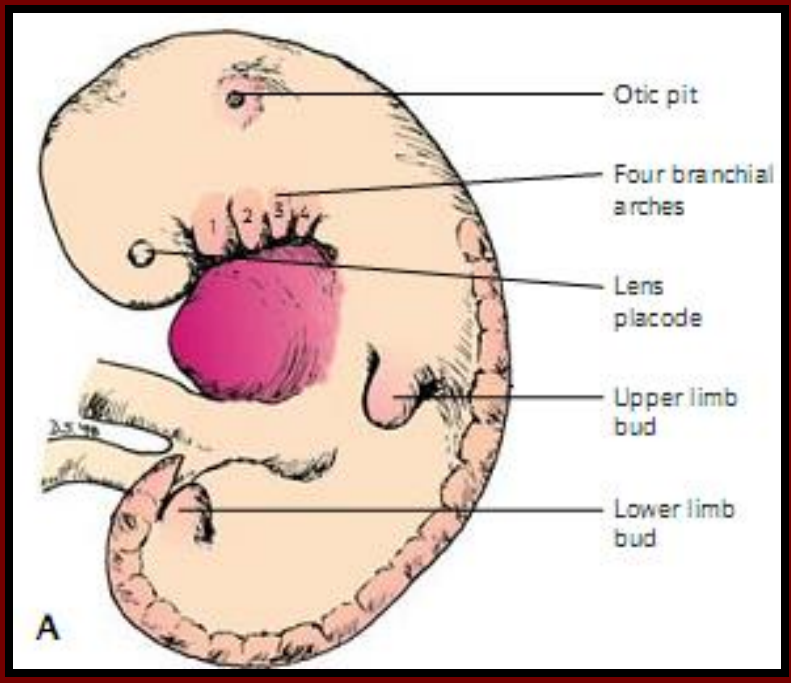
(Stages 13 – 15) Fifth Week of Development

At this stage, the embryo measures 5–10 mm in length. Rapid head growth occurs, caused mainly by rapid development of the brain. The upper limbs begin to show differentiation as the hand plates develop toward the end of this week. The fourth pair of branchial arches and the lower-limb buds are present by 28–32 days of development. Lens placodes of the eyes are visible on the sides of the head. The attenuated tail with its somites is a characteristic feature at the beginning of week 5.

STAGES OF EMBRYONIC DEVELOPMENT

(Stages 13 – 15) Fifth Week of Development

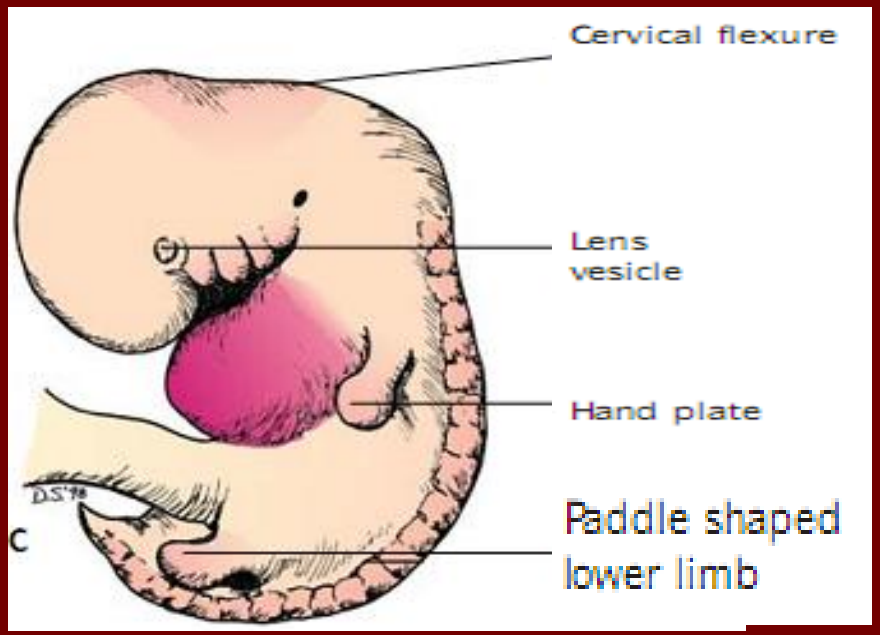




A) Drawing of a human embryo at stage 13. (B) Human embryo at stage 13. Note body curvature, four pairs of branchial arches, heart prominence (H), and upper and lower limb buds (arrows). The lens placode and oticpit are identifiable and the neural tube is closed.

STAGES OF EMBRYONIC DEVELOPMENT

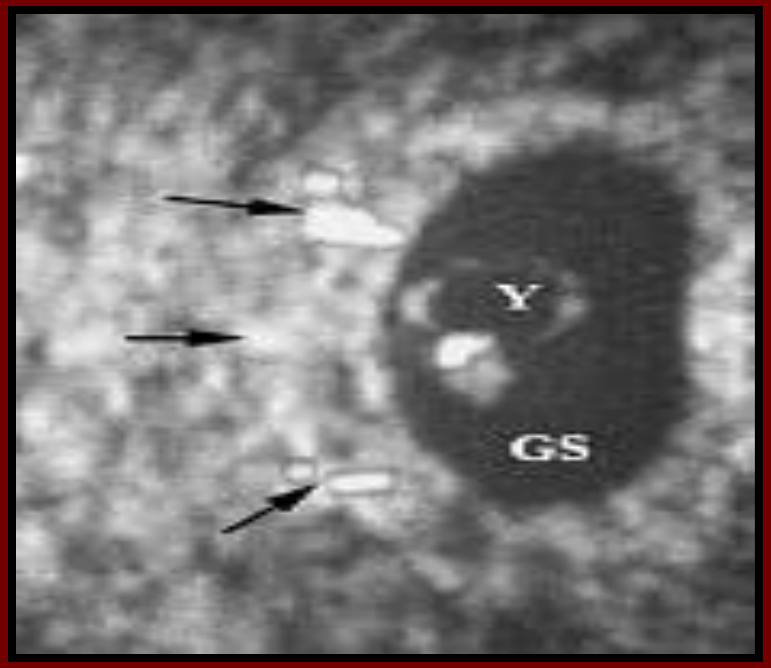
(Stages 13 – 15) Fifth Week of Development



C) Drawing of a human embryo at stage 15. (D) Human embryo at stage 15 with well-defined lens vesicle and an area representing hand plate formation (arrow). The cervical flexure is prominent.

STAGES OF EMBRYONIC DEVELOPMENT

(Stages 13 – 15) Fifth Week of Development



(E) Ultrasound at stages 13–15: (Right) CR length of embryo in the gestational sac. (Left) Doppler imaging showing blood flow (arrows) surrounding the gestational sac (GS) and in the embryo (transverse plane at the level of the heart). Yolk sac (Y) is also indicated.

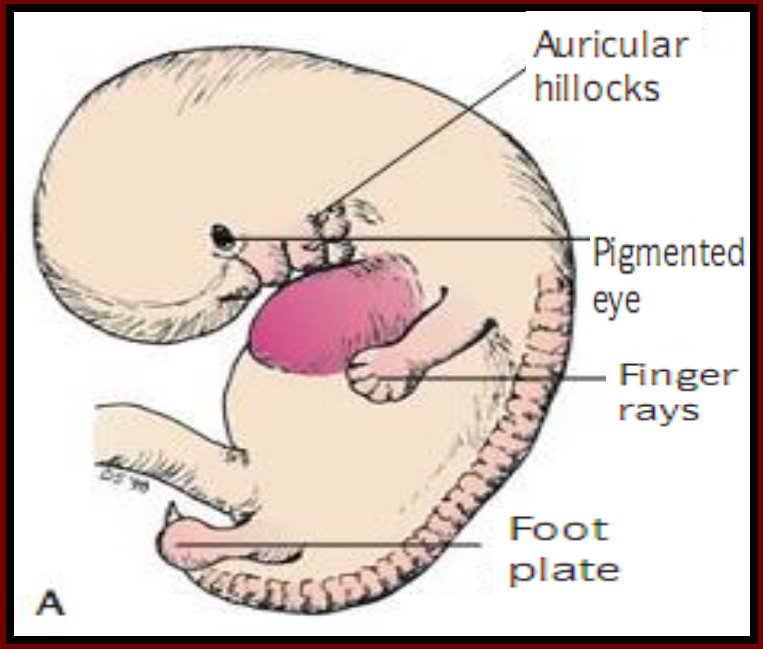
STAGES OF EMBRYONIC DEVELOPMENT

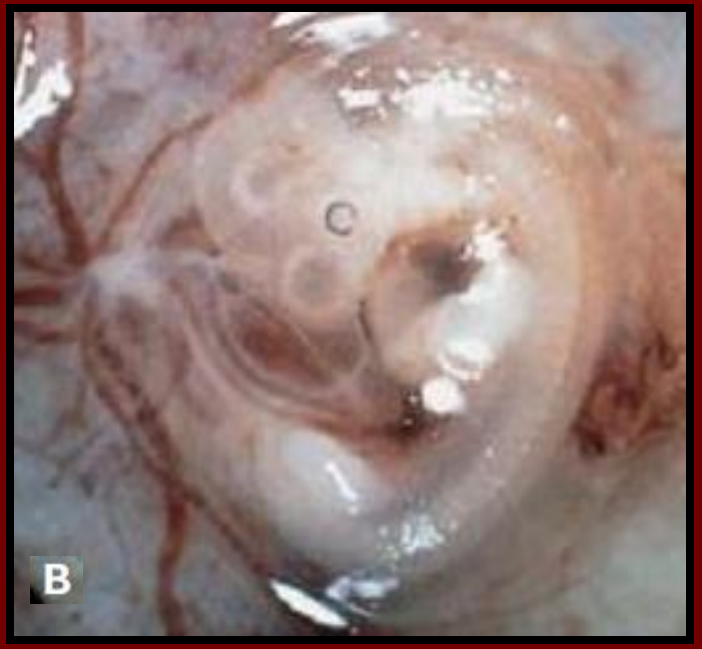
(Stages 16 and 17) Sixth Week of Development

1. The crown–rump (CR) length of the embryo in this time period is 10–14mm.
2. At stage 16:
    1. nasal pits face ventrally.
    2. Retinal pigment becomes visible.
    3. Auricular hillocks appear.
    4. Foot plate is formed.
3. In stage 17:
    1. The C-shape of the embryo is still present.
    2. Development of finger rays and basic facial-structure formation advances.
    3. The upper lip appears when medial nasal prominences and maxillary prominences merge.
    4. The nostrils become clearly defined and the eyes are directed more anteriorly.

STAGES OF EMBRYONIC DEVELOPMENT

(Stages 16 and 17) Sixth Week of Development

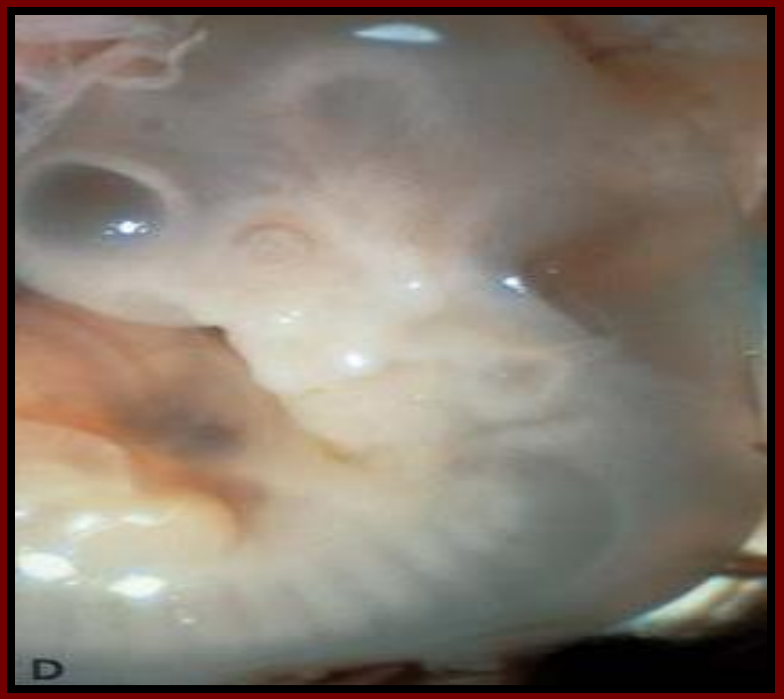




A) Drawing of a human embryo at stage 17, lateral view. (B) Human embryo with early formation of retinal pigment, finger rays and foot plate.

STAGES OF EMBRYONIC DEVELOPMENT

(Stages 16 and 17) Sixth Week of Development



(C) Monochorionic monoamniotic twin embryos with well-developed retinal pigment.
(D) Embryo at 12 weeks fertilization age showing auricular hillocks.

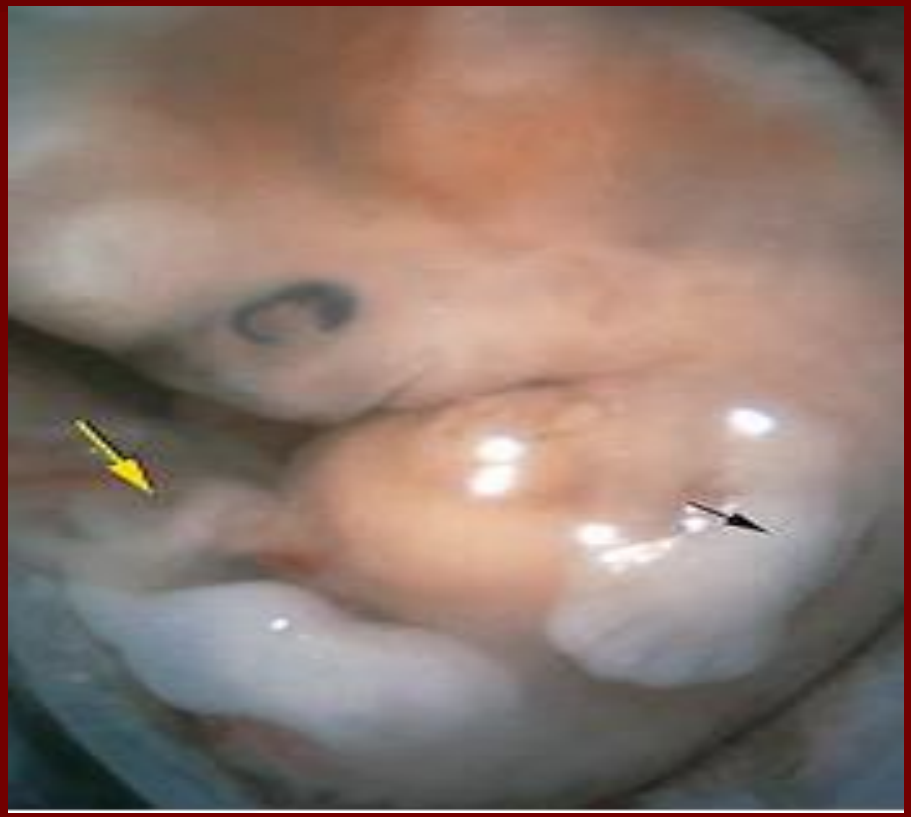
STAGES OF EMBRYONIC DEVELOPMENT

(Stages 18–19) Seventh Week of Development

1. At the end of the 7th week, the embryo attains a CR length of 20 mm. The head continues to enlarge rapidly and the trunk straightens.
2. Elbow regions can be recognized on upper limbs, toe rays appear on the lower limbs, and the nipples become visible.
3. Physiological herniation of the intestinal tract into the umbilical cord occurs.
4. The intestinal loops normally return to the abdomen by the end of the 10th week.

STAGES OF EMBRYONIC DEVELOPMENT

(Stages 18–19) Seventh Week of Development



Human embryo at stage 18 and 19 showing elbow region (black arrow), toe rays, and herniation of intestinal loops into the umbilical cord (yellow arrow).

STAGES OF EMBRYONIC DEVELOPMENT

(Stages 20–23) Eighth Week of Development

1. At this stage, the fingers are distinct but are still webbed. T h e r ea r e notches between the toe rays, and a scalp vascular plexus appears.
2. Toward the end of week 8,
    1. the fingers become free and longer and the development of hands and feet approach each other.
    2. The head becomes more rounded and shows typical human characteristics.

STAGES OF EMBRYONIC DEVELOPMENT

(Stages 20–23) Eighth Week of Development

1.The embryo has

CR length of 20mm at the beginning of the 8th week.

CR is 30 mm in length at the end of the 8th week.

2.

2.All major organ systems are formed by the end of the 8th week the completion of blastogenesis, organogenesis, and embryonic development. Then the fetal period begins.

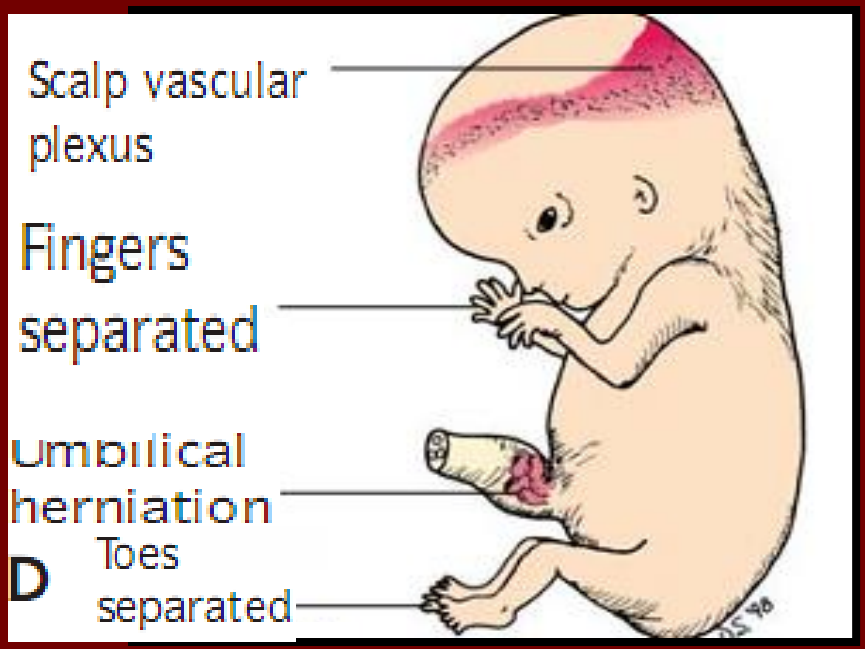
STAGES OF EMBRYONIC DEVELOPMENT

(Stages 20–23) Eighth Week of Development

A) Human embryo at stage 20 showing webbed fingers and notches between the toe rays. The vascular plexus becomes visible (arrows). (B) Human embryo at stage 21 and 22 with free fingers. The hands and feet approach each other. Note the intestine in the umbilical cord (arrow).

STAGES OF EMBRYONIC DEVELOPMENT

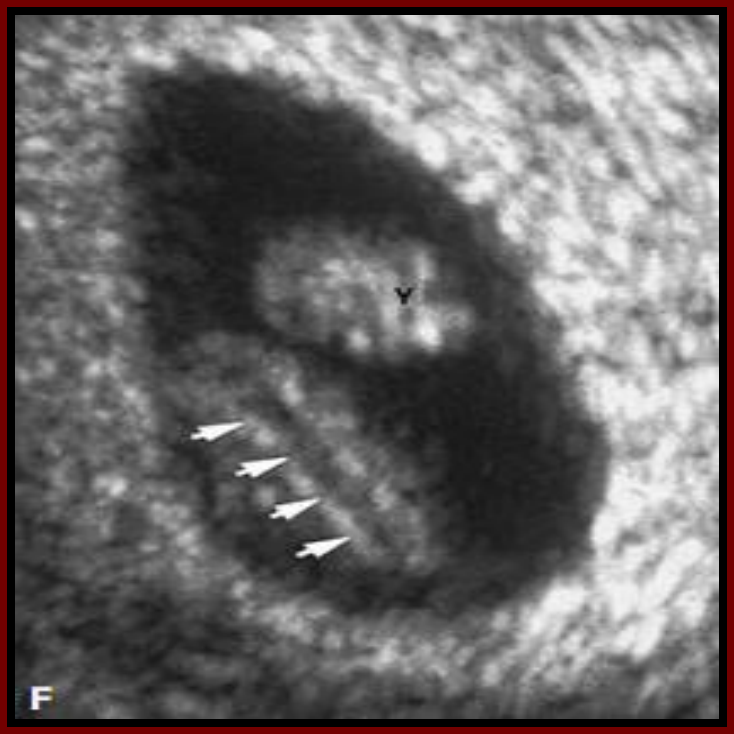
(Stages 20–23) Eighth Week of Development



(C) Human embryo at stage 23 with more typical human characteristics such as a rounder head and completed development of the face, hands and feet.
(D) Drawing of a human embryo at stage 23

STAGES OF EMBRYONIC DEVELOPMENT

(Stages 20–23) Eighth Week of Development



(E) Posterior view of the embryo shown in (C) with an intact neural tube. (F) Ultrasound showing a posterior view of an embryo with the characteristic appearance of an intact neural tube (arrows) (Y, yolk sac).

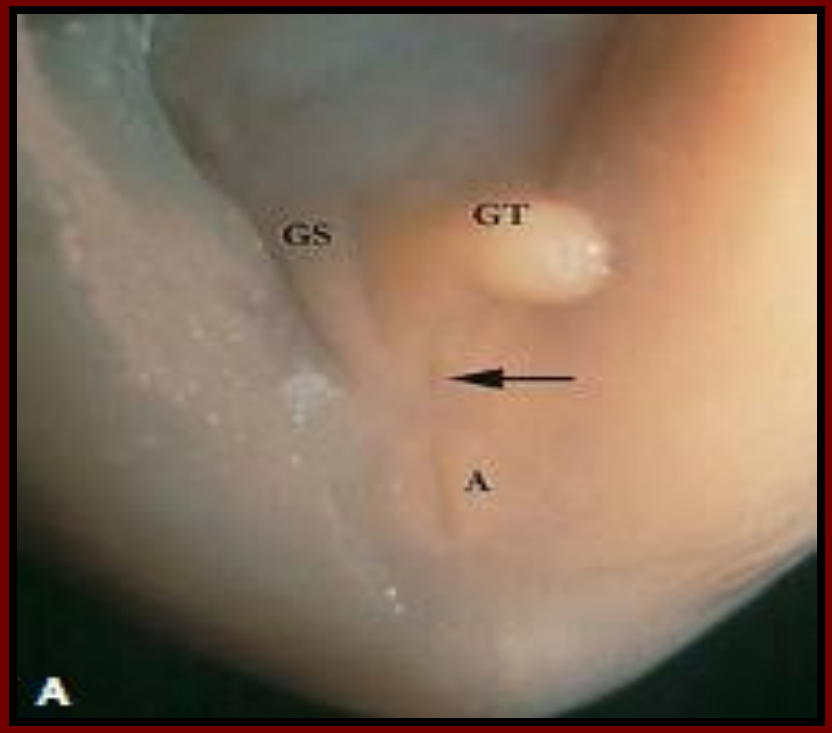
STAGES OF EMBRYONIC DEVELOPMENT

(Stages 20–23) Eighth Week of Development

(G) Fetus at beginning of the fetal period (9 developmental weeks).

STAGES OF EMBRYONIC DEVELOPMENT

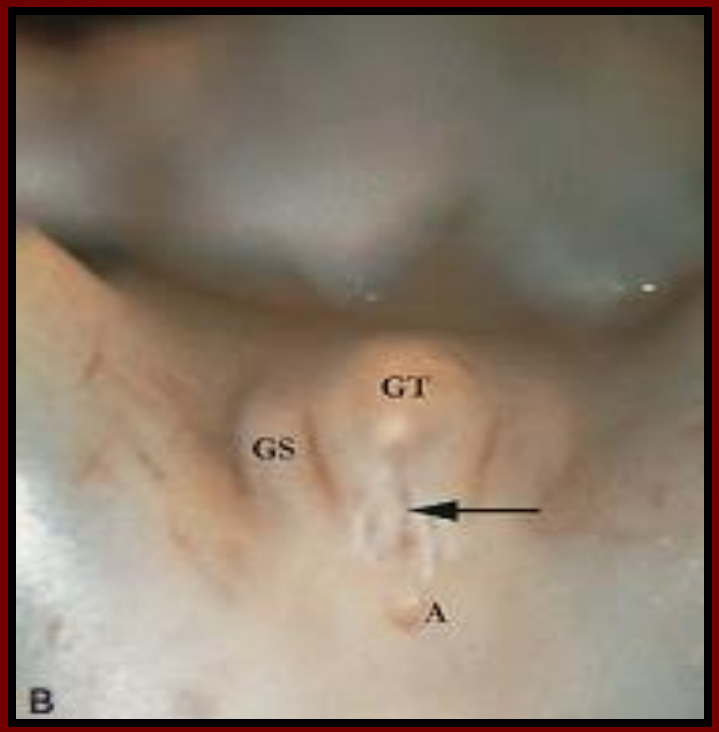
(Stages 20–23) Eighth Week of Development

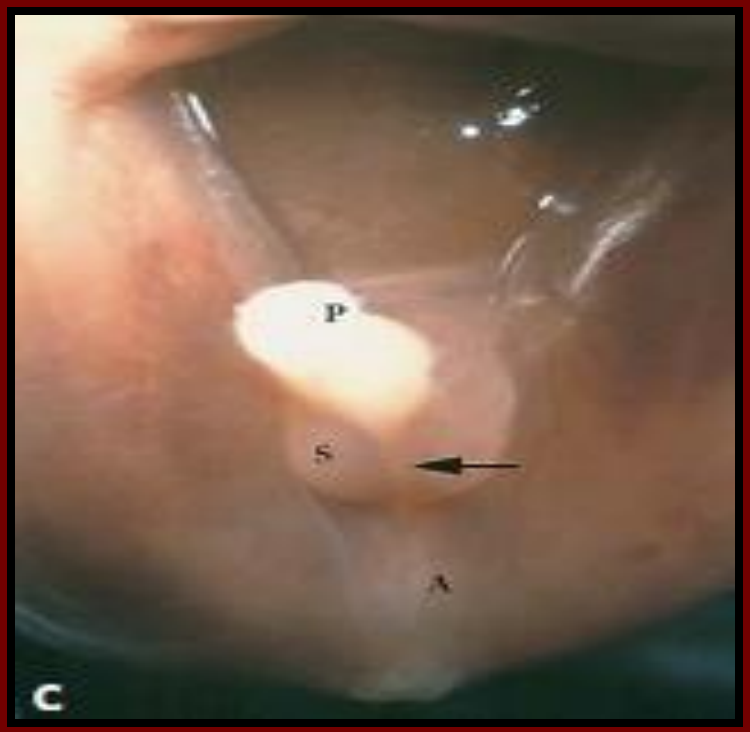


A) Sexual differentiation of male and female cannot be determined until the 12th week of fertilization age. At 9 weeks the genitalia are ambiguous (GT, genital tubercle; urogenital groove, arrow; GS, genital swelling; A, anus).

STAGES OF EMBRYONIC DEVELOPMENT

(Stages 20–23) Eighth Week of Development





(B) Female at 12 weeks fertilization age (GT, genital tubercle; urogenital groove, arrow; GS, genital swelling; A, anus). (C) Male at 12 weeks fertilization age (P, penis; S, scrotum; A, anus; arrow, scrotal raphe).

Prenatal Evaluation of Growth by Ultrasound

- Prenatal evaluation is usually possible 3 weeks after fertilization.

- Embryonic development and growth start with fertilization and progress through 4weeks, blastogenesis (post conception days 0–28), and organogenesis (days 29–56). In humans, fusion of the eyelids (days 56–60) is regarded as an arbitrary end of the embryonic period.

Prenatal Evaluation of Growth by Ultrasound

1.Evaluation by ultrasound is dated from the first day of the last menstrual period, which is termed “gestational age” (2weeks longer than embryonic age).

2.

2.A gestational sac can usually be identified at 5weeks and is an early indication of an intrauterine pregnancy. Ultrasound evaluation of the embryo reveals the following:

Prenatal Evaluation of Growth by Ultrasound

1. **At 6 weeks**, gestational age, embryonic structures and heart activity are almost always visible.
   1.
2. **At 7 weeks**, the embryo is 10 mm at a minimum and fetal heart activity should be visible in 100% of viable pregnancies.

3. **At 8 weeks**, fetal structures are visible and the yolk sac is identified as a circular structure measuring 5 mm in diameter. The detection of a yolk sac excludes the diagnosis of a blighted ovum because a viable embryo is necessary for yolk sac development.

Prenatal Evaluation of Growth by Ultrasound

4. An empty gestational sac with a mean diameter greater than **30mm** with no visible embryonic structures means that a non viable pregnancy **blighted ovum** exists.

5. **At 9–11 weeks,** progressive ossification occurs with major centers in the calvaria and ilium.

Prenatal Evaluation of Growth by Ultrasound

The CR length

1. Measured from the outer edge of the cephalic pole to the outer edge of the fetal rump.
2. This measurement predicts the gestational age with an error of ±3 days (90% confidence limits) after 7–10 weeks. The error increases to ±5 days between 10 and 14 weeks of gestation.
3. Fetal flexion may decrease maximal CR length by 5%.

Prenatal Evaluation of Growth by Ultrasound

The cephalic index

1. The ratio of the biparietal diameter (BPD) divided by the occipital frontal diameter.
2. A normal ratio is 0.75 to 0.85.
3. After 20 weeks of gestation, the BPD is less reliable for gestational dating because of changes in shape, growth disturbances, and individual variation.

Prenatal Evaluation of Growth by Ultrasound

1. **The femur** can be measured as early as 10 weeks gestational age.
2.
2. **Fetal BPD and femur length**
3.

For gestational age dating have a confidence interval of:

1. **±1** week from **12 to 22 weeks.**
2. **±2** weeks from **22 to 32 weeks.**
3. **±3** weeks from **32 to 41 weeks.**

First Trimester Scanning

First Trimester Scanning

Guidelines for First Trimester Ultrasonography

First Trimester Scanning

- The location of the **gestational sac** should be documented.
- The embryo should be identified and the **crown-rump length** recorded.

- Presence or absence of **fetal life** should be reported.
- **Fetal number** should be documented.
- Evaluation of the **uterus** (including cervix) and **adnexal structures** should be performed.

First Trimester Scanning

1. Technique
2. *Gestational Sac*
3. *Yolk Sac*
4. *Fetal Heart Beat*
5. *Fetal Pole*
6. *Crown Rump Length*
7. *Gestational Age*
8. *Twins*
9. *Missed Abortion*
10. *Threatened Abortion*
11. *Incomplete Abortion*
12. *Ectopic Pregnancy*
13. *Corpus Luteum Cyst*
14. *Nuchal Translucency Thickness*

First Trimester Scanning

Technique

- 1.**First trimester scanning** can be performed using either :

  - **1.Abdominal approach:**
    - 1.performed with a full maternal bladder.
    - 2.provides a wider field of view.
    - 3.provides the greatest depth of view.

  - **2.Vaginal approach.**
    - 1.performed with the bladder empty.
    - 2.Gives a much greater resolution with much of fine detail.

First Trimester Scanning

Technique

- In circumstances where both approaches are readily available, the greater detail provided by **transvaginal** scans usually outweighs other considerations, and **is preferred**.

First Trimester Scanning

Technique

- 1.The patient is scanned in the normal examination position (dorsal lithotomy) with her feet secure in stirrups and her perineum even with the end of the examination table.
- 2.
- 2.Place a small amount of ultrasonic coupling gel on the tip of the transvaginal transducer. Then cover the transducer with a condom. After lubricating the vaginal opening, gently insert the transducer into the vagina.

First Trimester Scanning

Technique

- 1. Visualize the longitudinal plane of the uterus (Sagittal section) and evaluate its' size. It can be measured from the cervix to the fundus, AP diameter, and width.
- 2.
- 2. Normal uterine volume :
  - 1. Less than 100 cc (nulliparous patients).
  - 2. Less than 125 cc (multiparous patients).
- 3. Identify (if present), the gestational sac, yolk sac, fetus (or fetuses), presence or absence of fetal movement and fetal heart beat.

First Trimester Scanning

Technique

- 1.After the uterus is evaluated by sweeping up and down and side to side.
- 2.
- 2.The ovaries are identified and evaluated.
  - The ovaries are usually located just anterior to the iliac vessels.
- 3.Document important views and measurements on film or electronically. Then document your findings in some written format.

First Trimester Scanning

Gestational Sac

- 1.The gestational sac is the earliest sonographic finding in pregnancy.
- 2.Appears as an echogenic (bright echoes) ring surrounding a sonolucent (clear) center.
- 3.
- 3. Ectopic pregnancies can also have a gestational sac identified with ultrasound, even though the pregnancy is not within the endometrial cavity.
- 4.

First Trimester Scanning

Gestational Sac

- The gestational sac
  - Appears at about 4 weeks gestational age.
  - Grows at a rate of about 1 mm a day through the 9th week of pregnancy.

- 1.Gestational sac size may be determined by measuring :
  - 1.the largest diameter.
  - 2.The mean of three diameters. These differences rarely effect gestational age dating by more than a day or two.

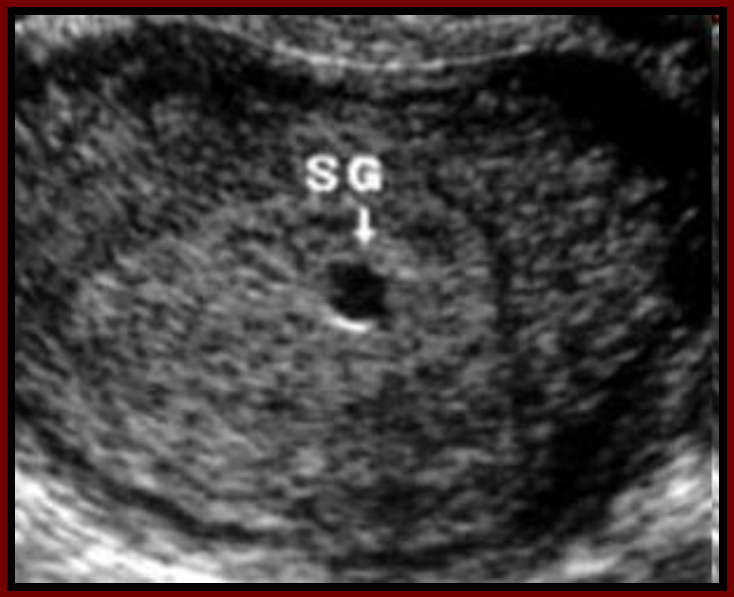
First Trimester Scanning

Gestational Sac

- 1.Your ability to identify an early gestational sac will depend on many factors, including:
  - 1.Capabilities of the ultrasound **equipment**.
  - **2.Approach** (vaginal or abdominal).
  - **3.Experience**.
  - **4.Orientation** of the uterus (generally it is easier to see if the uterus is anteflexed or retroflexed), and the presence of such complicating factors as fibroid tumors of the uterus.
  - 5.
- 2.While a gestational sac is sometimes seen as early as during the 4th week of gestation, it may not be seen until the end of the 5th week, when the serum HCG levels have risen to 1000-1500 mIU.

First Trimester Scanning

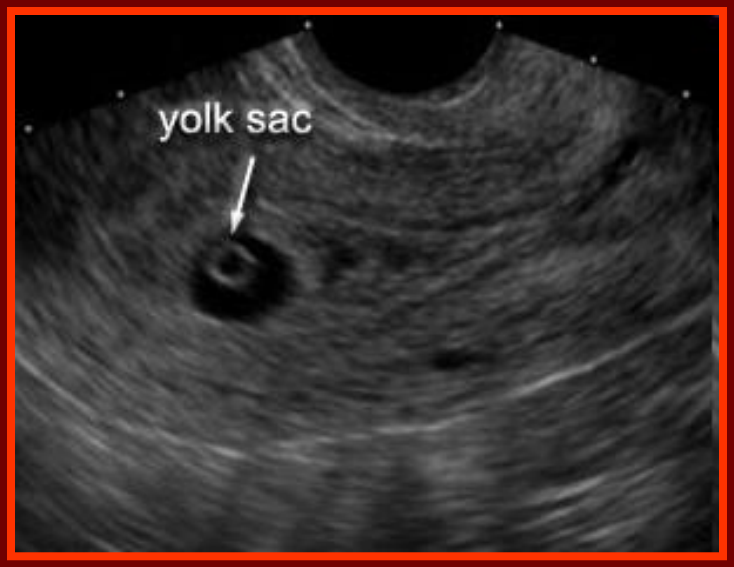
Gestational Sac (4 weeks)



Uterus (transverse view); Gestational Sac (arrow) and the decidual reaction

First Trimester Scanning

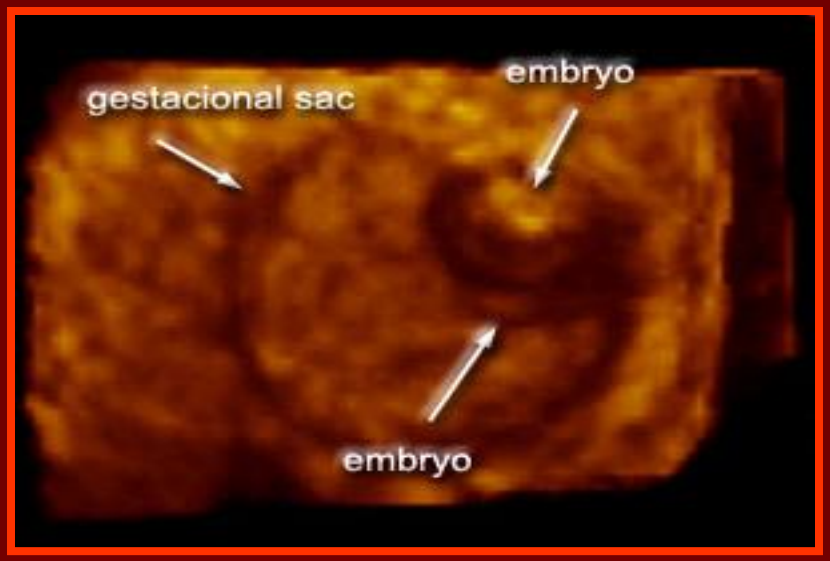
Gestational Sac (5 weeks)



Longitudinal view of the uterus Gestational Sac + Yolk Sac (embryionic pole not visible)

First Trimester Scanning

Gestational Sac (5 weeks)



end of the week 5 and visualization of the embryo

First Trimester Scanning

Gestational Sac (5 weeks)

Coronal section showing the implantation (fundus+left corno), normal decidual reaction

First Trimester Scanning

Gestational Sac 6 weeks (crown–rump length 4–8 mm)

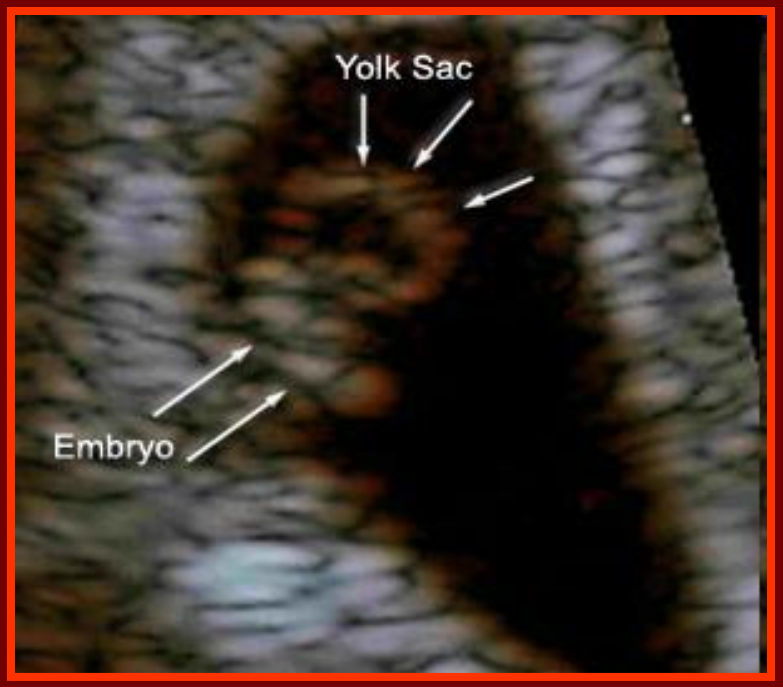


Figure 1a - Embryo at 6 weeks (crown–rump length 5 mm). Coronal section with arrows pointing to the embryo. The yolk sac lies adjacent to the embryo

First Trimester Scanning

Gestational Sac 6 weeks (crown–rump length 4–8 mm)

Figure 1b - Embryo at 6 weeks (crown–rump length 5 mm). 3D reconstruction with arrows pointing to the embryo (CRL). The yolk sac lies adjacent to the embryo

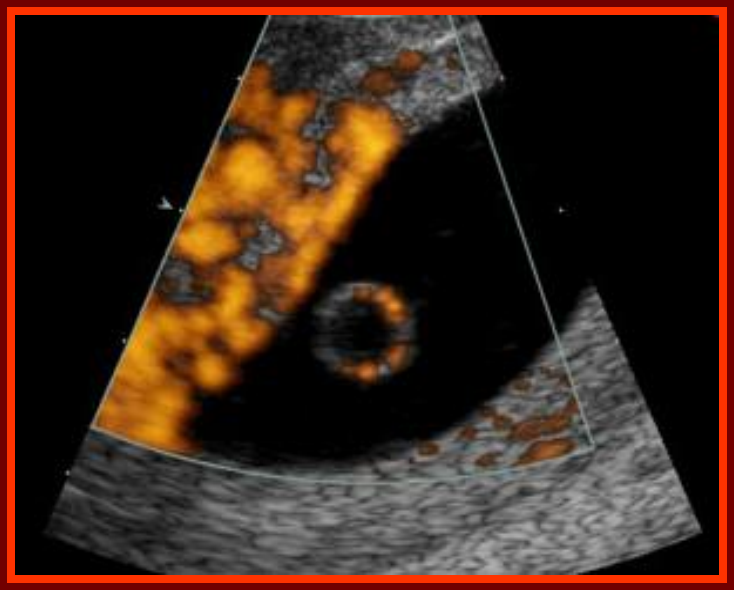
First Trimester Scanning

Gestational Sac 7 weeks (crown–rump length 9–14 mm)

Figure 2 - Embryo at 7+2 weeks (crown–rump length 12 mm). Oblique transverse section through the head demonstrating the rhombencephalon (Rh), diencephalon (Di) and hemispheres (H). The connections between the lateral ventricles and third ventricle (foramina of Monro) are still wide. The echogenic ring to the left is the yolk sac

First Trimester Scanning

Gestational Sac 6 weeks (crown–rump length 4–8 mm)



Identification of the yolk sac and the placenta vascularization and yolk sac

First Trimester Scanning

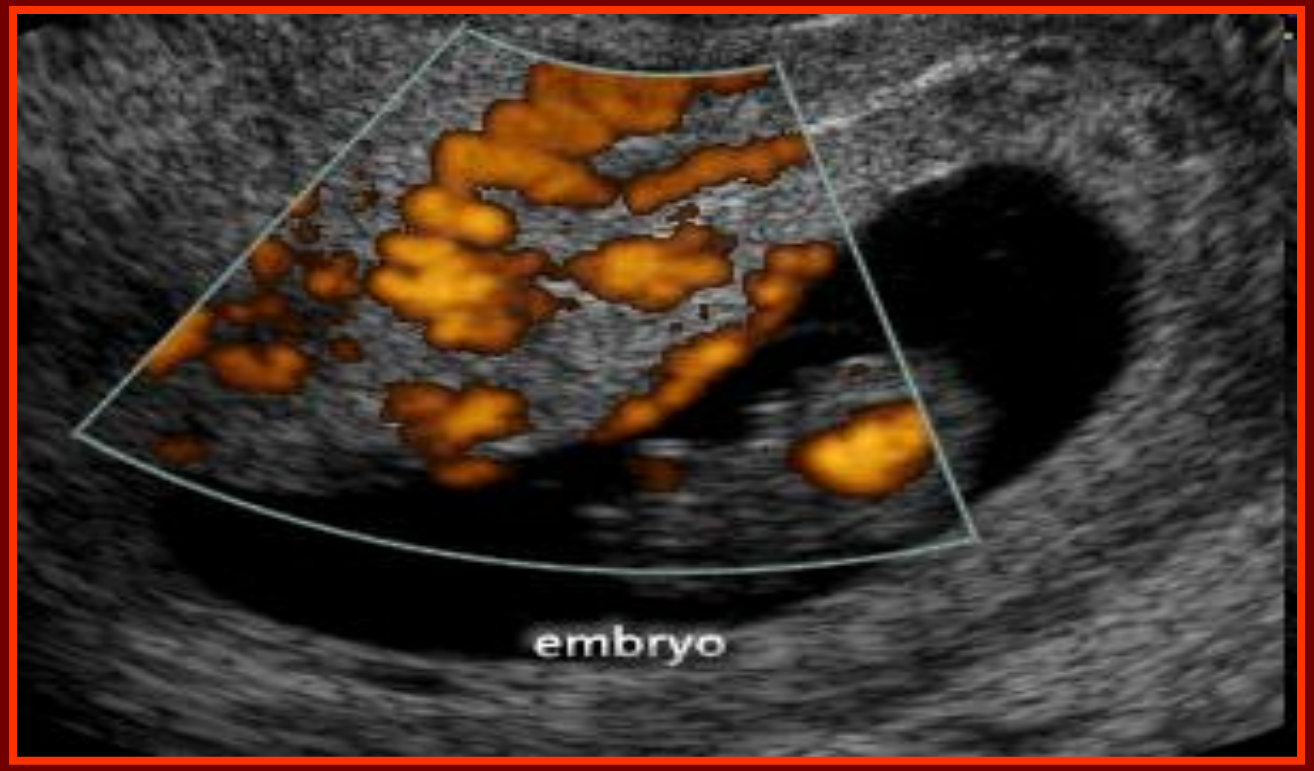
Gestational Sac 8 weeks (crown–rump length 15–22 mm)

First Trimester Scanning

Gestational Sac 8 weeks (crown–rump length 15–22 mm)

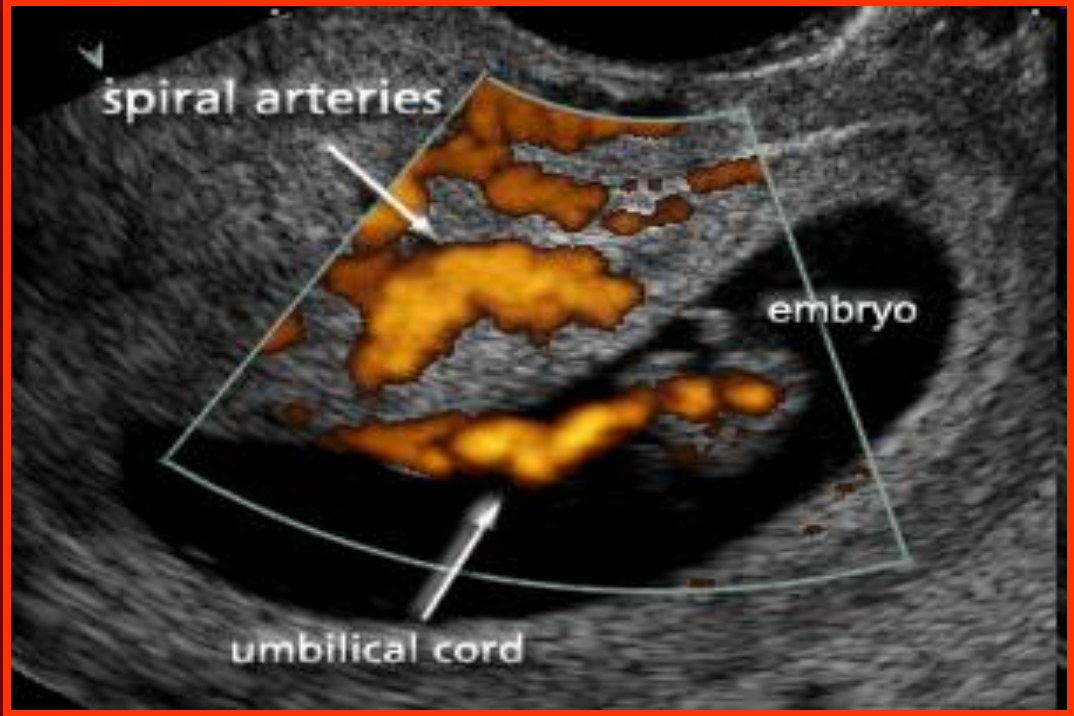
First Trimester Scanning

Gestational Sac 8 weeks (crown–rump length 15–22 mm)



First Trimester Scanning

Gestational Sac 8 weeks (crown–rump length 15–22 mm)



First Trimester Scanning

Gestational Sac 7 weeks (crown–rump length 9–14 mm)

Figure 4 - 3D scan - the body grows, visualization the future upper and lower limbs.

First Trimester Scanning

Gestational Sac 7 weeks (crown–rump length 9–14 mm)

Figure 5 - Embryo at 8+1 weeks (crown–rump length 17 mm). Section through the rhombencephalon (Rh) and mesencephalon (arrow, M)

First Trimester Scanning

Gestational Sac 7 weeks (crown–rump length 9–14 mm)

Figure 6a - Embryo at 8+5 weeks (crown–rump length 20 mm). Sagittal section vascularization and the umbilical cord.

First Trimester Scanning

Gestational Sac 9 weeks (crown–rump length 23–31 mm)

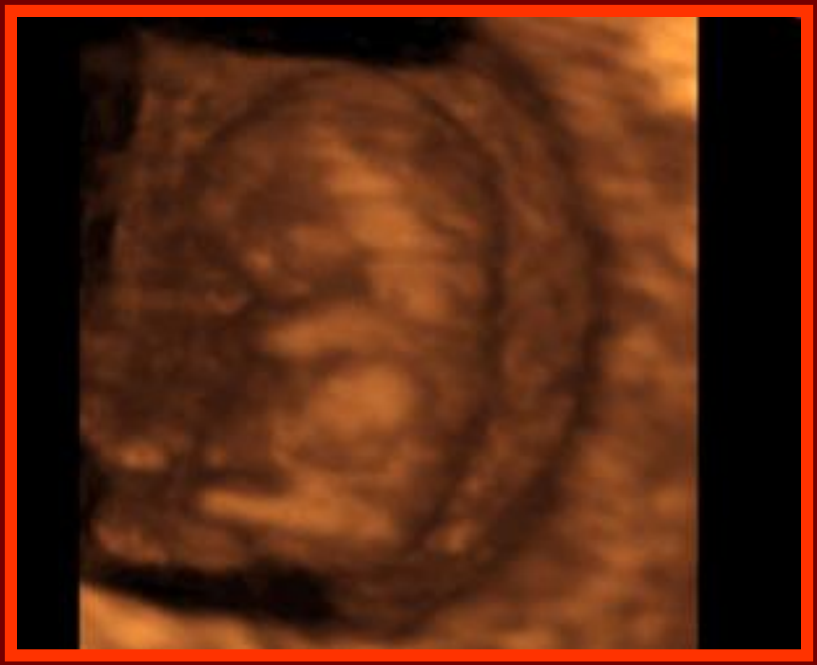


Figure 7 - Embryo at 9-10 weeks (crown–rump length 30 mm). 3D scan showing the external form of the fetal body (upper and lower limbs).

First Trimester Scanning

Gestational Sac 9 weeks (crown–rump length 23–31 mm)

Figure 7c - Embryo at 9+4 weeks (crown–rump length 28 mm). Longitudinal section demonstrating the the physiological midgut herniation present as a large hyperechogenic mass.

First Trimester Scanning

Postembryonic period, weeks 10 and 11 (crown–rump length 32–54 mm)

3D scan at 11-12 weeks

First Trimester Scanning

Postembryonic period, weeks 10 and 11 (crown–rump length 32–54 mm)

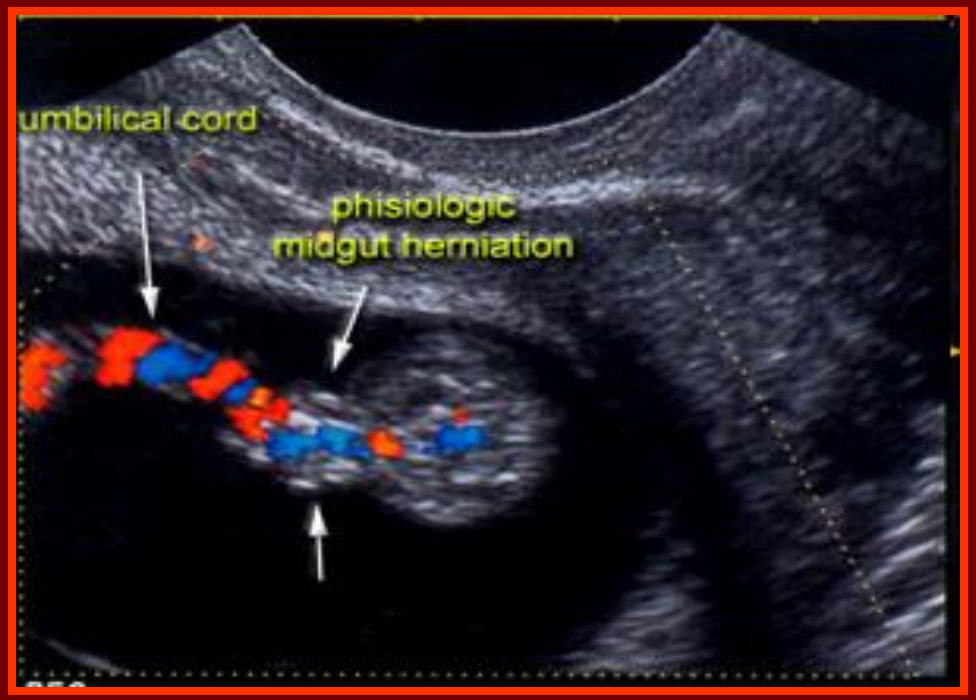


Figure 8a - Embryo at 10 weeks (crown–rump length 32 mm). Horizontal section through the abdomen demonstrating the umbilical cord. The arrows show the extension of the physiological midgut herniation

First Trimester Scanning

Postembryonic period, weeks 10 and 11 (crown–rump length 32–54 mm)

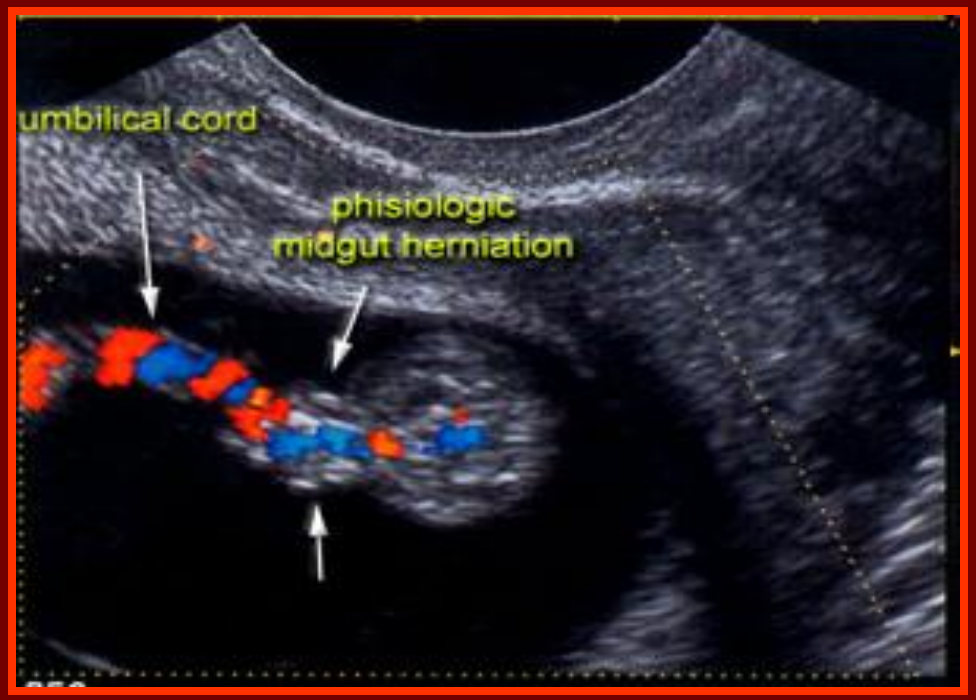


Figure 8a - Embryo at 10 weeks (crown–rump length 32 mm). Horizontal section through the abdomen demonstrating the umbilical cord. The arrows show the extension of the physiological midgut herniation

First Trimester Scanning

Yolk Sac

- As the pregnancy advances, the next structure to become visible to ultrasound is the **yolk sac:**
  - **Round**.
  - **Sonolucent** structure with a bright rim.
  - First appears during the **fifth week** of pregnancy.
  - Grows to be **no larger than 6 mm**.

First Trimester Scanning

Yolk Sac

- 1.
- 1. Yolk sacs **larger than 6 mm** are usually indicative of an abnormal pregnancy.
- 2.
- 2. Failure to identify (with transvaginal ultrasound) a yolk sac when the **gestational sac has grown to 12 mm** is also usually indicative of a failed pregnancy.
- 3.
- 3. Yolk sacs that are **moving** within the gestational sac ("floating"), contain **echogenic** material (rather than sonolucent), are ominous findings for the pregnancy.

First Trimester Scanning

Fetal Heart Beat

- 1. **Using endovaginal scanning:**

  - 1.The fetal cardiac muscle begins its' rhythmic contractions, and that rhythmic motion can be seen along the **edge of the yolk sac**.
  - 2.
  - 2.Initially, the **fetal cardiac motion** has a slower rate (60-90 BPM), but cardiac rate increases as the fetus develops further.

First Trimester Scanning

Fetal Heart Beat

- 1.Sometimes, with normal pregnancies, the fetal heartbeat is not visible until a **fetal pole of up to 4 mm** in length is seen.
- 2.
- 2. Failure to identify fetal cardiac activity in a fetus whose overall length is **greater than 4 mm** is an ominous sign.
- 3.

First Trimester Scanning

Fetal Heart Beat

- 1.It can sometimes be difficult identifying a fetal heartbeat from the background movement and maternal pulsations. You may find it useful in these cases to scan with one hand while taking the maternal pulse with the other. This makes it easier to identify sonographic movements that are dyssynchronous with the maternal pulse.

First Trimester Scanning

Fetal Pole

- 1.Apparent on transvaginal ultrasound just after the 6th week of gestation. This mass of cells is known as the fetal pole.
- 2.
- 2. Usually you can identify rhythmic fetal cardiac movement within the fetal pole, although it may need to grow several mm before this is apparent.
- 3.

First Trimester Scanning

Fetal Pole

- 1.Grows at a rate of about 1 mm a day, starting at the 6th week of gestational age.
- 2.
- 2.Thus, a simple way to "date" an early pregnancy is to add the length of the fetus (in mm) to 6 weeks.
- 3.
- 3.Using this method, a fetal pole measuring 5 mm would have a gestational age of 6 weeks and 5 days.

First Trimester Scanning

Crown Rump Length

- 1. This term is borrowed from the early 20th century embryologists who found that preserved specimens of early miscarriages assumed a "sitting in the chair" posture in both formalin and alcohol. This posture made the measurement of head-to-toe length impossible. Instead, they subsituted the head-to-butt length (crown rump length) as a reproducible method of measuring the fetus.

First Trimester Scanning

Crown Rump Length

- 1.Today, the crown rump length is a universally recognized term, very useful for measuring early pregnancies.
- 2.
- 2.The CRL is highly reproducible and is the **single most accurate measure of gestational age.**
- **3.**
- 3.After 12 weeks, the accuracy of CRL in predicting gestational age diminishes and is replaced by measurement of the fetal biparietal diameter

First Trimester Scanning

Crown Rump Length

- 1.Only after 53 days is the **fetal rump** the most caudal portion of the fetus.
- 2.
- 2.After 60 days, the **fetal head** becomes the most cephalad portion of the fetal cell mass.
- 3.
- 3.What is really measured during this early development of the fetus is the longest fetal diameter.

First Trimester Scanning

Determination of Gestational Age

- 1.
- 1.
- 1. **Gestational sac diameter.**
- 2. **Length of the fetal pole (CRL).**

First Trimester Scanning

Determination of Gestational Age

Gestational Sac:

- 1.Gestational age = 4 weeks plus (mean sac diameter in mm x days).
- 2.This relies on the growth of the normal gestational sac of 1 mm per day after the 4th week of gestation.
- 3.
- 3.For example, a gestational sac measuring 11 mm would be approximately 5 weeks and 4 days gestational age. (4 weeks plus 11 days = 5 weeks and 4 days).

First Trimester Scanning

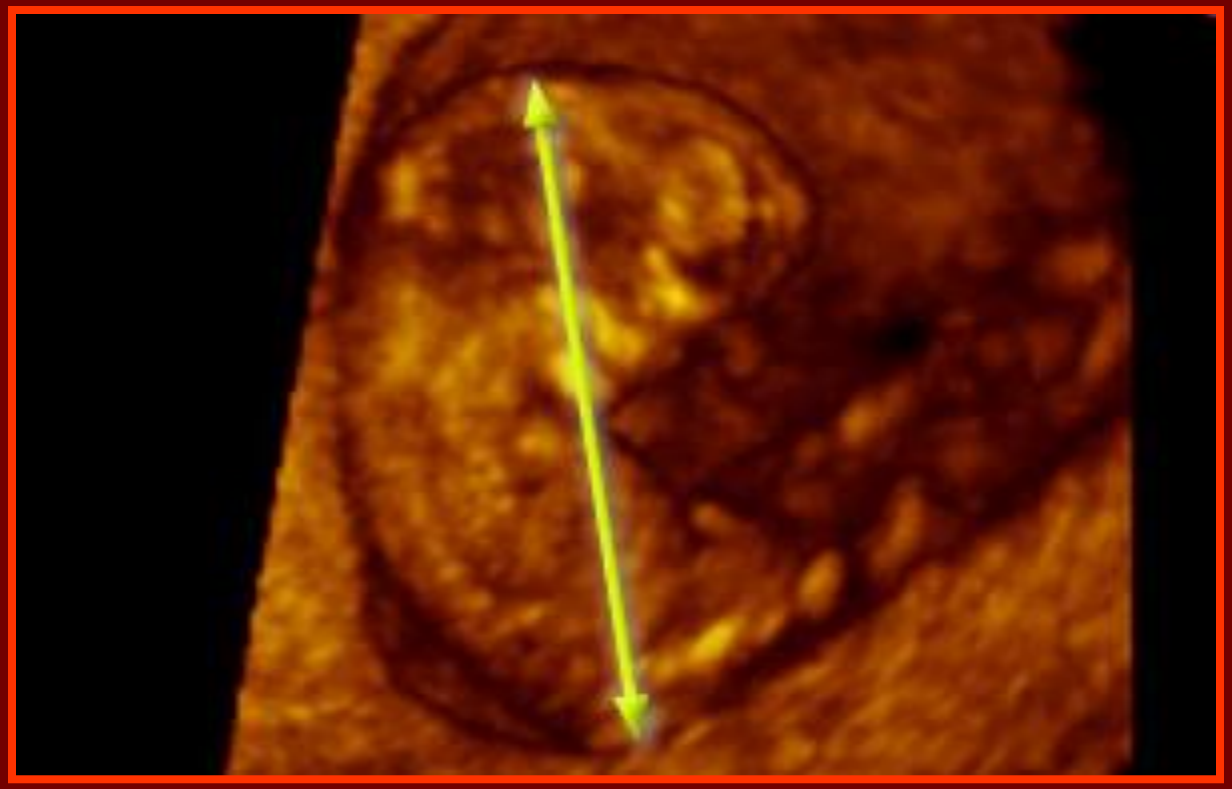
Determination of Gestational Age

Crown Rump Length:

1. Gestational age = 6 weeks plus (CRL x days).
2.
2. This relies on the growth of the normal fetus of 1 mm per day after the 6th week of gestation.
3.
3. For example, a CRL of 16 mm would correspond to a gestational age of 8 weeks and two days (6 weeks plus 16 days = 8 weeks and 2 days).

First Trimester Scanning

Determination of Gestational Age



CRL :measurement of Crown-Rump-Length .

First Trimester Scanning

Twins

- 1.It is useful to identify twins early as the prognosis varies, depending on the **chorionicity and amnionicity** of the twins.
- 2.They may be seen with two separate gestational sacs (**diamniotic, dichorionic twins).**
- 3.They may be seen as two fetal poles occupying the same gestational sac (**monochorionic twins**).

First Trimester Scanning

Twins

- 1.A "**vanishing twin**" occurs in about 20% of twin pregnancies.
- 2.In these cases, one of the twins fails to grow and thrive. Instead, its development arrests and it is reabsorbed, with no evidence at delivery of the twin pregnancy.

First Trimester Scanning

Twins

Number of Amnios and chorions

First Trimester Scanning

Twins

12 week duplicata incompleta

First Trimester Scanning

Missed Abortion

- 1.A missed abortion is an abnormal pregnancy that is destined to miscarry.
- 2.About one in five early pregnancies will not survive. These will grow for a while, with HCG in the urine and serum, but eventually will stop growing normally, and then will stop growing at all. Most of these (two-thirds) will have abnormal chromosomes.
- 3.Evidence of a missed abortion using high-resolution transvaginal scanning includes:

First Trimester Scanning

Missed Abortion

- 1. Absence of any growth of the gestational sac or fetal pole over a 5-day period of observation.
- 2. Absence of a visible fetal heartbeat when the CRL is greater than 5 mm.
- 3. Gestational sac larger than 12 mm mean diameter without visual evidence of a yolk sac.
- 4. Yolk sac larger than 6 mm diameter
- 5. Yolk sac that is abnormally shaped or echogenic (sono dense rather than the normal sono lucent).
- 6. Loss of fetal cardiac activity that was previously seen.
- 7.

First Trimester Scanning

Threatened Abortion

- 1.A threatened abortion is any 1st trimester pregnancy that demonstrates uterine bleeding and/or cramping.
- 2.
- 2.Such patients are frequently evaluated with ultrasound. Bleeding in early pregnancy is a common event and is seen in 25 to 40% of pregnancies.
- 3.
- 3.About half of these will go on to miscarry while the other half will be normal.

First Trimester Scanning

Threatened Abortion

The **benefits** to ultrasound evaluation include:

- 1.Detection of abnormal pregnancies that are destined to miscarry.
- 2.Enabling scheduled intervention, if desired by the patient.
- 3.Reassurance to the patients with normal ultrasound scans.

First Trimester Scanning

Incomplete Abortion

- 1.Ultrasound is sometimes used after passage of pregnancy tissue to determine whether any pregnancy tissue remains inside the uterus.
- 2.
- 2.Sometimes, it is obvious that there is nothing left inside the uterus, as evidenced by a thin, complete endometrial stripe.
- 3.
- 3. In other cases, there will be obvious pregnancy tissue.

First Trimester Scanning

Ectopic Pregnancy

- 1.The appearance of the ectopic pregnancy itself is the same as for intrauterine pregnancies.
- 2.
- 2.Depending of the gestational age and normalcy of development, you may see a gestational sac, a yolk sac, a fetal pole, and a fetal heartbeat.
- 3.
- 3.

First Trimester Scanning

Ectopic Pregnancy

Using transvaginal scanning:

- 1.About half of the ectopic pregnancies can be **directly visualized**.
- 2.Other half of cases, only **indirect evidence** of an ectopic pregnancy will be found.

First Trimester Scanning

Ectopic Pregnancy

Indirect evidence includes:

- **Absence of an identifiable intrauterine pregnancy** with maternal serum HCG levels of more than 1500 (this number varies and may be lower in some labs).

- **Presence of an intrauterine gestational "pseudosac."**
  - These thin-walled structures represent some fluid (sometimes blood)
  - within a decidualized endometrium that bears a superficial resemblence to a gestational sac.
  - Lacks the bright echogenic ring of a true gestational sac.
  - Never contain a yolk sac.

First Trimester Scanning

Ectopic Pregnancy

- **Large amounts of free fluid** (blood) inside the abdominal cavity. Small amounts of free fluid are non-diagnostic, as this is commonly seen in cases of spontaneous abortion, ruptured ovarian cysts, and ovulation.

First Trimester Scanning

Corpus Luteum Cyst

- 1.The observation of these small (usually less than 5 cm) ovarian cysts during early pregnancy is essentially a normal finding.
- 2.
- 2.Should the cyst be large (5 cm or more), or have suspicious characteristics, they may be followed as most corpus luteum cysts will resolve spontaneously sometime during the first trimester.

First Trimester Scanning

Ultrasound Detection Of Chromosomal Anomalies

First Trimester Scanning

Ultrasound Detection Of Chromosomal Anomalies

1.Nuchal edema.
2.Tight amnion.
3.2 vessel cord.
4.Yolk sac anomalies.
5.Major structural anomalies.
6.Shapeless embryo.

First Trimester Scanning

Nuchal edema

Nuchal edema

1.

1.A small black space under the skin of the fetus behind the neck, is called a **nuchal lucency** between 10 and 14weeks and a **nuchal fold** between 15 and 22 weeks.

1.This is different from **cystic hygroma** in which a major amount of fluid accumulates under the skin behind the neck.

2.

2.Usually considered abnormal :

1.Greater than 2.5 mm between 10 and 14 weeks.
2.2 mm for embryos with a crown rump length of 35 mm.
3.2.5 mm for embryos with a crown rump length of 85 mm.
4.In practice, however it does not make much difference and 3 mm is a good cut off.

First Trimester Scanning

Nuchal edema

1.

1.The easiest way to obtain the measurement is to do a transvaginal examination, and try to get a view of the back of the neck of the baby.

2.

2.The calipers should be placed on the white lines surrounding the nuchal lucency.

3.

3.The suspicion is that the nuchal lucency is due to over perfusion of the cephalic end of the fetus due to narrowing of the isthmus, which creates an increase of the size of the aorta over the ductus, and increases the perfusion of the cephalic end .

First Trimester Scanning

Nuchal edema

1.

1.Further it appears that those embryos present with some early cardiac failure which is manifested by an abnormal ductus venosus tracing .

2.

2.Overall about 30 percent of fetuses that have a nuchal lucency

1.Have an aneuploidy, and the most common aneuploidies will be trisomy 21, trisomy 18, and monosomy X.

2.Several studies have also demonstrated that the risk of aneuploidy increases with the thickness of the nuchal lucency.

1.

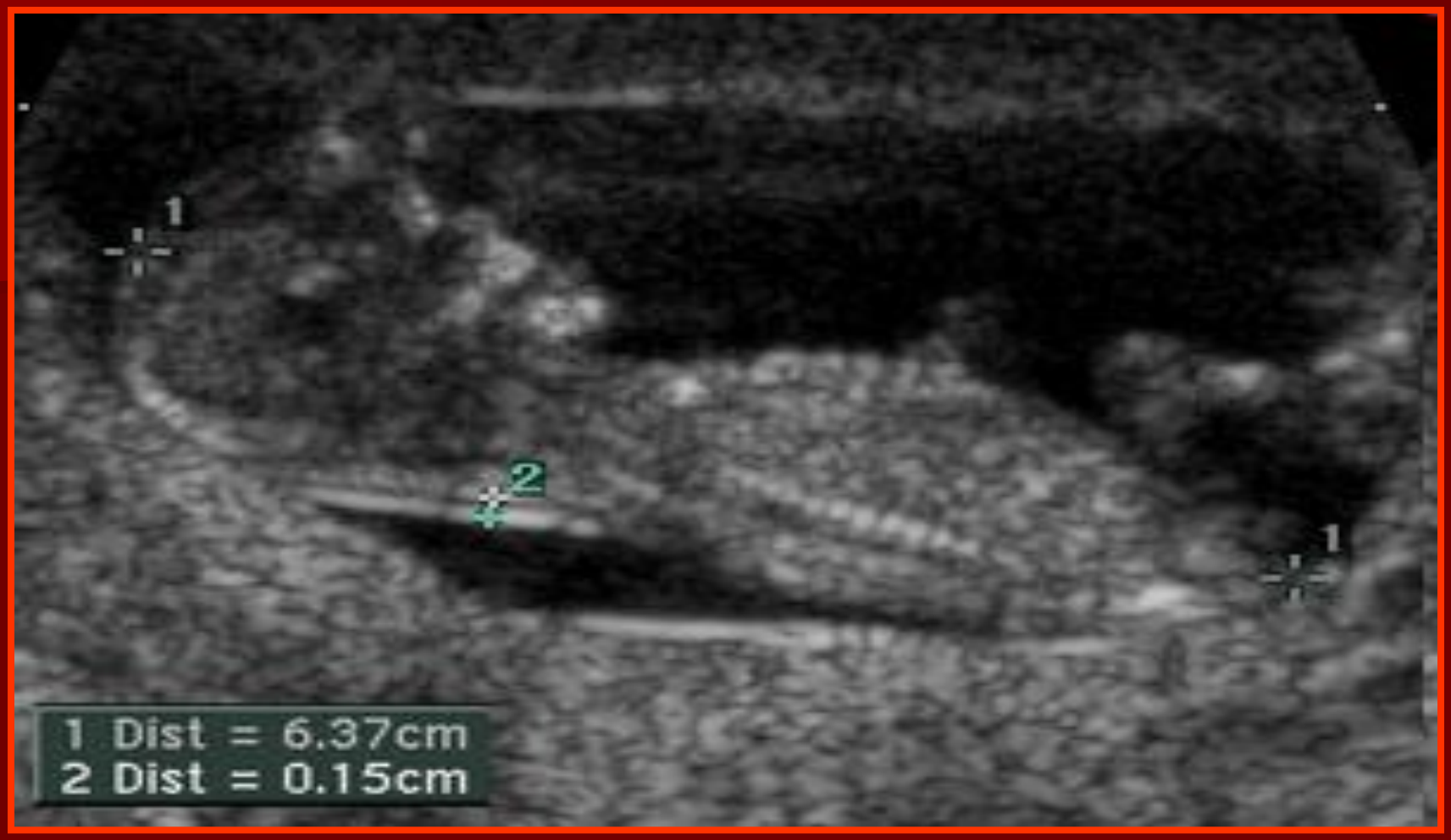
1.

1.

Figure 1 A small nuchal lucency. The measurement is obtained from one white line to the other.

Ultrasound scan at 11 weeks of gestation demonstrating 6-mm nuchal translucency. Chorionic villus sampling revealed trisomy 18.

fetus after termination of pregnancy, demonstrating loose edematous skin over the neck, accounting for the nuchal translucency on ultrasound scanning.



Nuchal Translucency : measurement of the Nuchal Translucency .

First Trimester Scanning

Nuchal edema

1.In fetuses in which the **karyotype is normal** in spite of the nuchal lucency, the nuchal lucency
    1.can also be a marker for non- chromosomal disorder in about four percent of the time.
    2.This will include Noonan syndrome, cystic hygroma, hydrops, omphalocele, obstructive uropathy, genetic syndromes and many others are constantly being described.
2.
2.Have a **poor outcome** and decreased survival rate, compared to those that have a thin nuchal fold.
3.
3.Finally it is well known that nuchal lucency
    1.spontaneously regress.
    2.Rarely seen after 20 weeks.

Tight amnion

- When the amnion is too close to the fetus in which the gestational sac is predominantly occupied by the extra-amniotic coelom,
- and the amniotic cavity is tightly wrapped around the fetus.

Those fetuses are often at risk of trisomy 16 or triploidy.

Figure 2: The amnion is very tightly apposed around this embryo. The embryo later miscarried and was identified as a trisomy 16.

2 vessel cord

- The presence of a two-vessel cord can be a marker for aneuploidy.
- This is not typically searched for in the first trimester., but this finding can be recognized in a 10 weeks fetus.
- One would look for a 2-vessel cord if the fetus has other findings such as a thick nuchal lucency for instance.

2 vessel cord

- 0.2 to 1 percent of pregnancies present with a two vessel cord.
- Among these, about 1 to 10 percent have an aneuploidy, including trisomy 18, 13, triploidy and monosomy X.

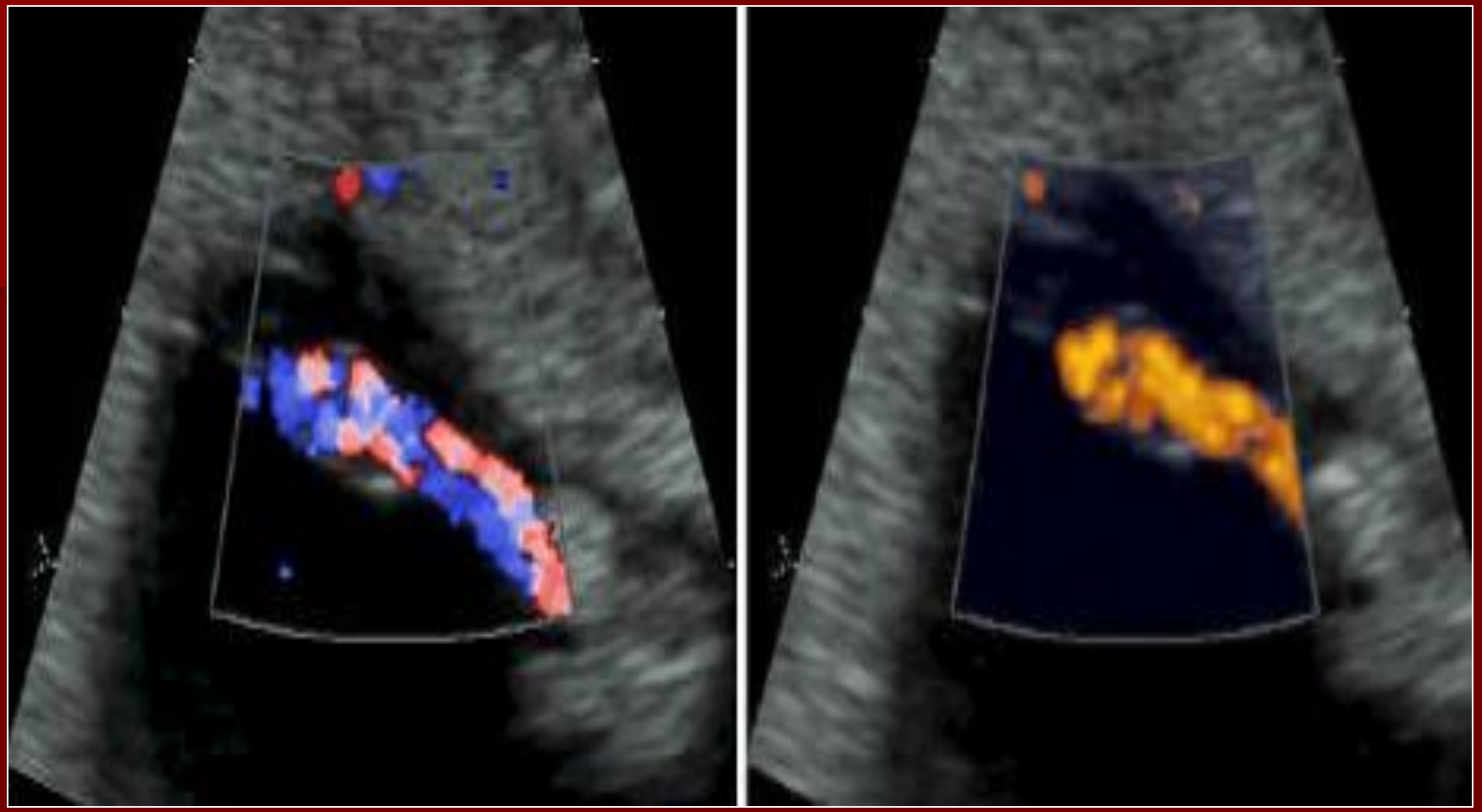


Figure 3: Color Doppler, and energy Doppler demonstrate a 2 vessel cord in a 10 week fetus.

Yolk sac anomalies

Several papers demonstrate that :

- An irregular yolk sac.
- Too large yolk sacs.

are factors that are predictors of pregnancies that will end up as miscarriage in the first trimester

Major structural anomalies

- The presence of certain major anomalies should also prompt a karyotype.

- at nine and ten weeks.
  - One appeared to have an **omphalocele** (greater than the normal physiological herniation of the guts) and had trisomy 18.
  - The other one had a **large obstructed bladder** and a small omphalocele and indeed had trisomy 13.
  - Last had alobar **holoprosencephaly** also within trisomy 18.

Figure 4: Omphalocele at 9 weeks. Trisomy 18

Figure 5: Posterior urethral valves in trisomy 13

Figure 6: Alobar holoprosencephaly at 10 weeks. Trisomy 18.

Shapeless embryo

A shapeless embryo: is an embryo with no distinctive head and body at a time when these findings should be recognized.

- This can be a sign of various trisomies, usually very lethal trisomies such as trisomy 8, 16, and triploidy.


THANK YOU