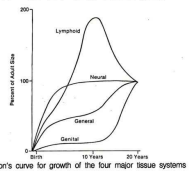
GROWTH AND DEVELOPMENT

Graber 27-128
Langman 297-327
Moyers 1-72
Profitt 18-64
(16-47, in 1st edition)

- Definition by Todd
  - Growth : increase in size
  - Development : progress toward maturity
- Growth and development의 3-fold process
  1. self-multiplication
  2. differentiation
  3. organization
  4. time factor
- 각 organ은 서로 다른 time에 서로 다른 rate로 성장한다.
  그리고 시기마다 그 성장속도가 다르다.(= differential growth)

예)



Scammon's curve for growth of the four major tissue systems

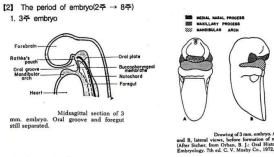
예)	height	weight
prenatal	500배	65억배
postnatal	3배	20배

A. PRENATAL DEVELOPMENT OF CRANIAL, FACIAL AND ORAL STRUCTURES

3 시기
- 1. The period of the ovum (수정 → 2주)
- 2. The period of the embryo (2주 → 8주)
- 3. The period of the fetus (8주 → birth)

[1] The period of the ovum(수정 → 2주)
ovum의 cleavage 기간, uterine wall에 부착
2주후 1.5mm
cephaloid differentiation X

[2] The period of embryo(2주 → 8주)
1. 3주 embryo



Drawing of 3 mm. embryo A, Frontal and B, lateral views, before formation of nasal pits. (After Keibel, from Orban, B.: Oral Histology and Embryology, 7th ed. C. V. Mosby Co., 1972.)

① 3mm in length
② Prosencephalon(= forebrain)
= 추후 head가 될 부위
= 최하방 부위가 추후 frontal eminence(= frontal prominence)될 부위
③ stomodeum
- primitive oral cavity : oral plate(oropharyngeal membrane)에 의해 foregut과 분리
- 2 Maxillary process : oral cavity 측방에 위치
- Mandibular process(1st pharyngeal arch) : oral cavity 밑에 broad 하게 존재

* 3-8주 사이에
- face의 major part 형성
- primitive oral cavity가 깊어져 결국 foregut과 관통

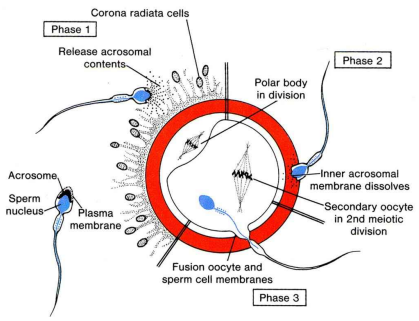


Figure 2-5. Schematic representation of the three phases of oocyte penetration. In phase 1 the spermatozoa break through the corona radiata barrier; in phase 2 one or more spermatozoa penetrate in the zona pellucida; in phase 3 one spermatozoon penetrates through the oocyte membrane, thereby losing its own plasma membrane. Inset shows normal spermatocyte with acrosomic head cap.

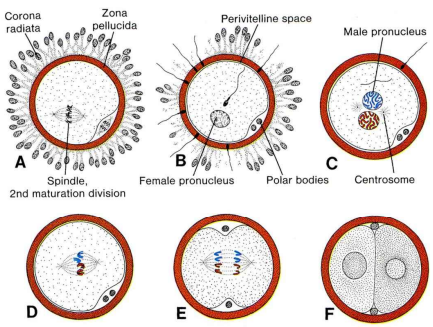


Figure 2-6. **A**, Oocyte immediately after ovulation, showing the spindle of the second meiotic division. **B**, A spermatozoon has penetrated the oocyte, which has finished its second meiotic division. The chromosomes of the oocyte are arranged in a vesicular nucleus, the female pronucleus. The heads of several sperm are stuck in the zona pellucida. **C**, Stage of male and female pronuclei. **D** and **E**, The chromosomes become arranged on the spindle, split longitudinally and move to opposite poles. **F**, The two-cell stage.

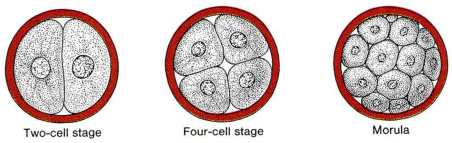


Figure 2-8. Schematic representation of the development of the zygote from the two-cell stage to the late morula stage. The two-cell stage is reached approximately 30 hours after fertilization; the four-cell stage at approximately 40 hours; the 12- and 16-cell stage at approximately 3 days; and the late morula stage at approximately 4 days. During this period the blastomeres are surrounded by the zona pellucida, which disappears at the end of the 4th day.

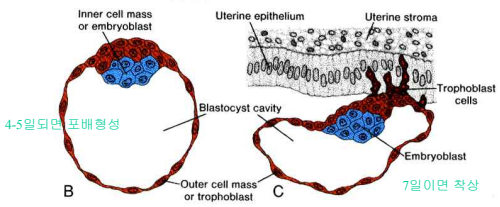
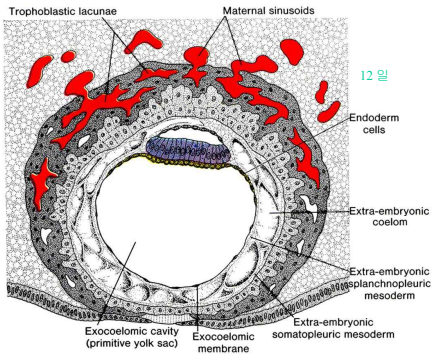
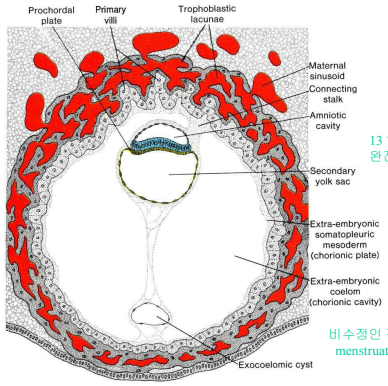


Figure 2.10. **A.** Section of a 107-cell human blastocyst. Note the inner cell mass and trophoblast cells. **B.** Schematic representation of a section through a human blastocyst recovered from the uterine cavity at approximately 4½ days. Blue cells represent the inner cell mass or embryoblast, and brown cells, the trophoblast. **C.** Schematic drawing of a section of a macaque monkey blastocyst at the 9th day of development. Trophoblast cells, located at the embryonic pole of the blastocyst, begin to penetrate the uterine mucosa. The human blastocyst begins to penetrate the uterine mucosa by the 5th or 6th day of development.



12 일

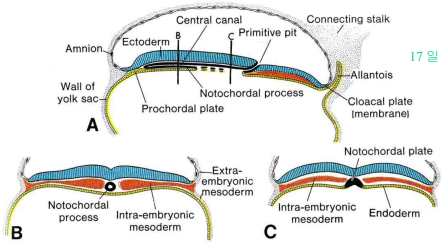
Figure 3-4. Drawing of a human blastocyst of approximately 12 days. The trophoblastic lacunae at the embryonic pole are in open connection with the maternal sinusoids in the endometrial stroma. Extraembryonic mesoderm proliferates and fills the space between the exocoelomic membrane and the inner aspect of the trophoblast.



13 일-자궁내막에 완전히 embedding

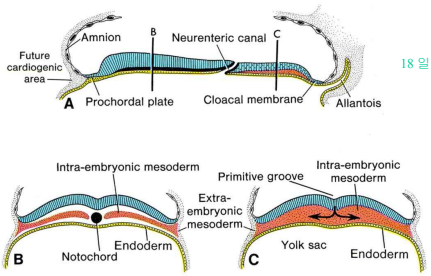
비수정인 경우 menstruation…

Figure 3-6. Drawing of a 13-day human blastocyst. The trophoblastic lacunae are now present at the embryonic as well as the abembryonic pole, and the uteroplacental circulation has begun. Note the primary villi and the extraembryonic coelom **or chorionic cavity**. The secondary yolk sac is entirely lined with endoderm.



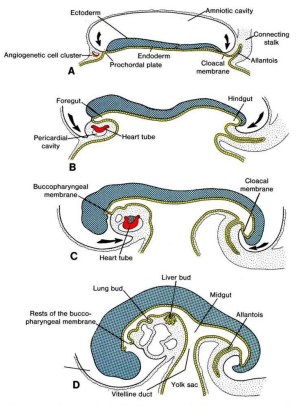
17 일

Figure 4-4. **A**, Drawing of a cephalocaudal midline section through a 17-day embryo. The life span of the notochordal process is short and it frequently breaks down before it is completed. **B**, Transverse section through a region in which the central canal still persists. The intraembryonic mesoderm is in contact with the extraembryonic mesoderm covering the yolk sac and the amnion. **C**, Transverse section through a region where the remaining portion of the notochordal process is temporarily intercalated in the endoderm.



18 일

Figure 4-5. **A**, Drawing of a cephalocaudal midline section through an 18-day embryo. The definitive notochord is established. The neurenteric canal connects the amniotic cavity with the yolk sac. **B**, Transverse section through the cephalic part of the embryo, showing the definitive notochord flanked by intraembryonic mesoderm. **C**, Transverse section through the primitive streak region. Mesoderm formation in the caudal part of the embryo continues into the 4th week.



4 주

Figure 5-14. Drawings of sagittal midline sections of embryos at various stages of development to demonstrate the cephalocaudal flexion and its effect on the position of the endoderm lined cavity. **A**, Presomite embryo; **B**, 7-somite embryo. **C**, 14-somite embryo; **D**, at the end of the 1st month. Note the angiogenetic cell clusters in relation to the prochordal (buccopharyngeal) plate.

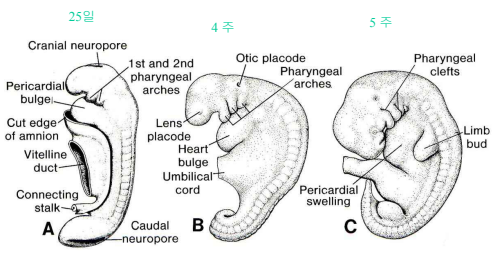


Figure 16-3. Series of human embryos to show the development of the pharyngeal arches. **A**, Approximately 25 days. **B**, 28 days. **C**, 5 weeks.

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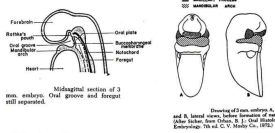
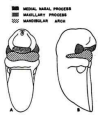


Midsagittal section of 3 mm. embryo. Oral groove and foregut still separated.



Drawing of 5 mm. embryo. A, Frontal and B, lateral views, before formation of nasal pits. (After Sicher, from Orban, B. J.: Oral Histology and Embryology. 7th ed. C. V. Mosby Co., 1972.)

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② Prosencephalon(= forebrain)
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= 최하방 부위가 추뇌 frontal eminence(= frontal prominence)됨 부위
③ stomodeum
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2주후 1.5mm
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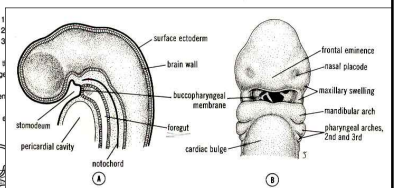

Figure 13-2. *A, Sagittal section through the cephalic end of an embryo of approximately 25 days. The buccopharyngeal membrane is formed by the epithelial entodermal lining of the foregut and the ectodermal lining at the bottom of the stomodeum. B, Frontal view of a slightly older embryo, showing the rupture of the buccopharyngeal membrane.*

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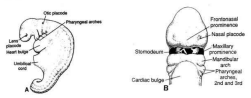
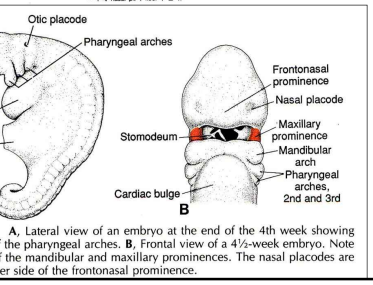
2. 4주



A, Lateral view of an embryo at the end of the 4th week showing the position of the pharyngeal arches. B, Frontal view of a 4½-week embryo. Note the location of the mandibular and maxillary prominences. The nasal placodes are visible on either side of the frontonasal prominence.

① 5mm in length
② frontal eminence 양옆에 ectodermal proliferation이 나타난다
(= nasal placode : local thickening of the surface ectoderm)
* 추뇌 nasal pit의 floor가 된다.



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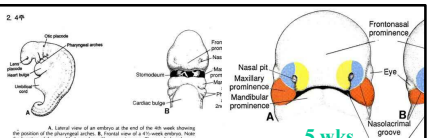
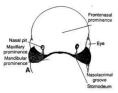


Figure 16-19. Frontal aspect of the face. A, Five-week embryo. The nasal prominences are gradually separated from deep furrows.

3. 5주



① Medial nasal process
Lateral nasal process
→ 가 갑자기 형성
nasal placode를 둘러 싼다.

- 추뇌 medial nasal process
  - a. nose의 middle portion
  - b. upper lip의 middle portion
  - c. maxilla의 middle portion
  - d. primary palate

추뇌 lateral nasal process
→ alae of nose

② maxillary process는 계속 medial로 이동
(lateral nasal process와 nasolacrimal groove 이루고 있음)
③ pharyngeal pouch 형성(→ pharyngeal arch and furrow 형성)

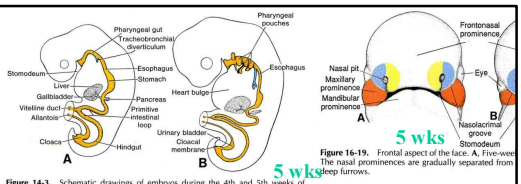


Figure 14-3. Schematic drawings of embryos during the 4th and 5th weeks of development to show the formation of the gastrointestinal tract and the various derivatives originating from the endodermal germ layer.

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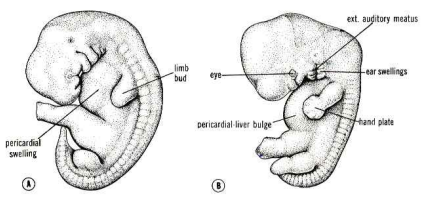
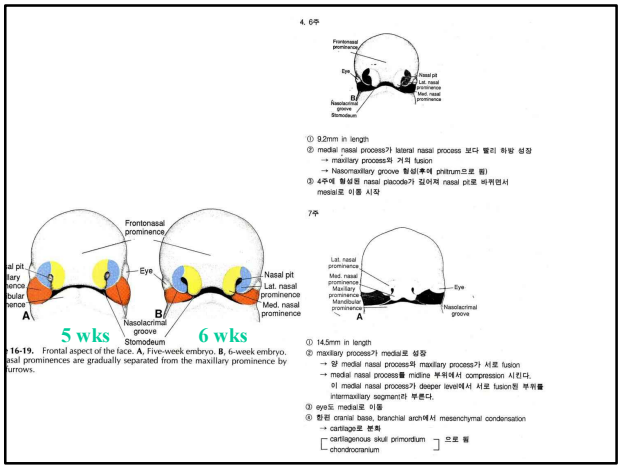


Figure 5-18. *A, Schematic drawing of a human embryo at the beginning of the fifth week seen from the left. Crown-rump length is approximately 7 mm. Note the paddle-shaped limb buds and the pharyngeal arches (modified after Streeter). B, Schematic drawing of a 6-week human embryo seen from the left. Crown-rump length is approximately 13 mm. The upper limb buds show a flattened terminal portion with four radial grooves. Note the formation of the eye and the external auditory meatus flanked on each side by three hillocks derived from the mandibular and hyoid arches (modified after Streeter).*



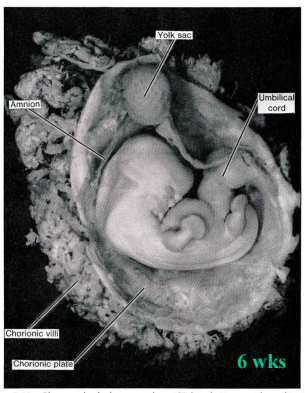
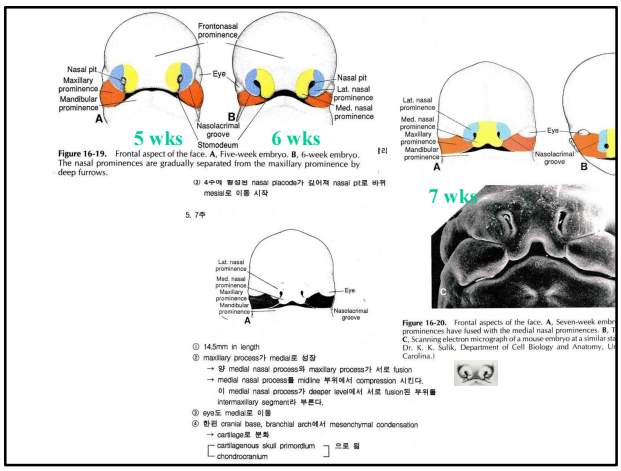
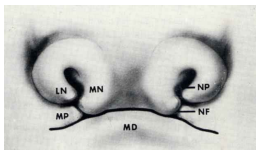
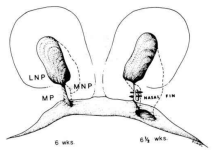
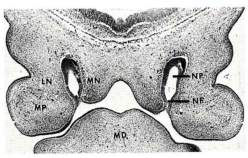


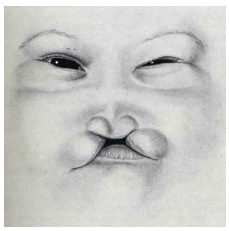
Figure 5-19. Photograph of a human embryo (CR length 13 mm, 6th week). Note that the yolk sac is visible in the chorionic cavity. (From Blechschmidt E: *The Stages of Human Development before Birth*. Philadelphia, WB Saunders, 1961. Courtesy E. Blechschmidt, Professor of Anatomy, University of Göttingen.)

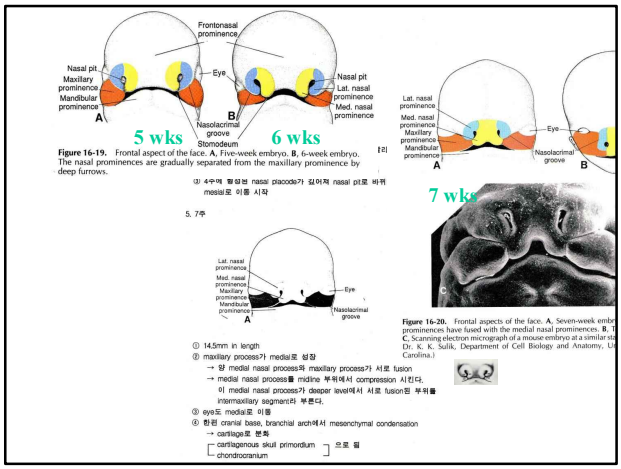


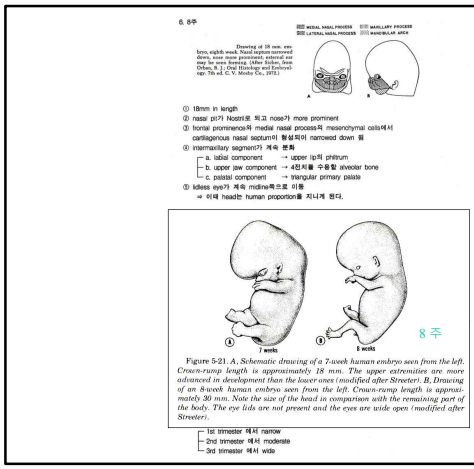


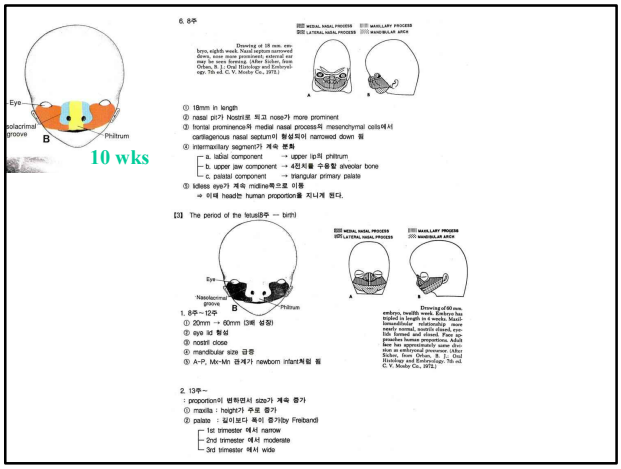


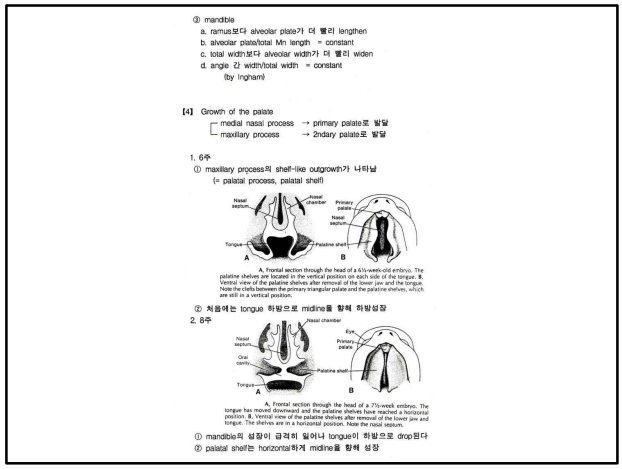


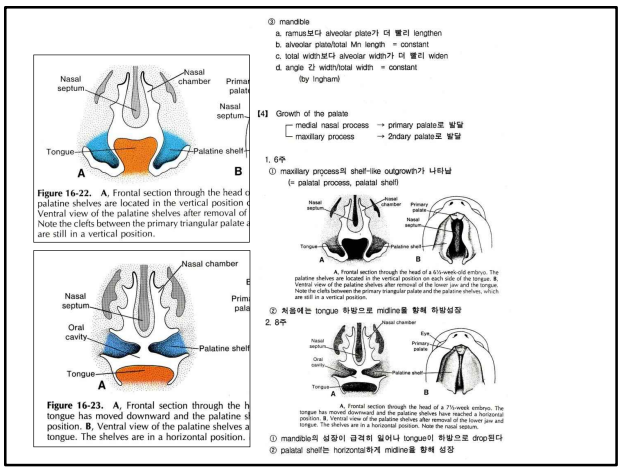







Eye
Philtrum
10 wks
6. 8주
① 18mm in length
② nasal pit가 Nostril로 되고 nose가 more prominent
③ frontal prominence와 medial nasal process의 mesenchymal cells에서 cartilagenous nasal septum이 형성되어 narrowed down 됨
④ intermaxillary segment가 계속 분화
a. labial component → upper lip의 philtrum
b. upper jaw component → 4본치를 구성할 alveolar bone
c. palatal component → triangular primary palate
⑤ lidless eye가 계속 midline쪽으로 이동
⇒ 이때 head는 human proportion을 지니게 된다.
[3] The period of the fetus(8주 ~ birth)
1. 8주~12주
① 20mm → 60mm (3배 성장)
② eye lid 형성
③ nostril close
④ mandibular size 급증
⑤ A-P, Mx-Mn 관계가 newborn infant처럼 됨
2. 13주~
: proportion이 변하면서 size가 계속 증가
① maxilla : height가 주로 증가
② palate : 길이보다 폭이 증가(by Freiband)
1st trimester 에서 narrow
2nd trimester 에서 moderate
3rd trimester 에서 wide


③ mandible
a. ramus보다 alveolar plate가 더 빨리 lengthen
b. alveolar plate/total Mn length = constant
c. total width보다 alveolar width가 더 빨리 widen
d. angle 간 width/total width = constant
(by Ingham)
[4] Growth of the palate
medial nasal process → primary palate로 발달
maxillary process → 2ndary palate로 발달
1. 6주
① maxillary process의 shelf-like outgrowth가 나타남
(= palatal process, palatal shelf)
② 처음에는 tongue 하방으로 midline을 향해 하방성장
2. 8주
① mandible의 성장이 급격히 일어나 tongue이 하방으로 drop된다
② palatal shelf는 horizontal하게 midline을 향해 성장


Nasal septum
Nasal chamber
Nasal septum
Tongue
Palatine shelf
A
B
Figure 16-22. A, Frontal section through the head
palatine shelves are located in the vertical position
Ventral view of the palatine shelves after removal of
Note the clefts between the primary triangular palate
are still in a vertical position.
Nasal chamber
Nasal septum
Oral cavity
Palatine shelf
Tongue
A
Figure 16-23. A, Frontal section through the h
tongue has moved downward and the palatine s
position. B, Ventral view of the palatine shelves
tongue. The shelves are in a horizontal position.

③ mandible
a. ramus보다 alveolar plate가 더 빨리 lengthen
b. alveolar plate/total Mn length = constant
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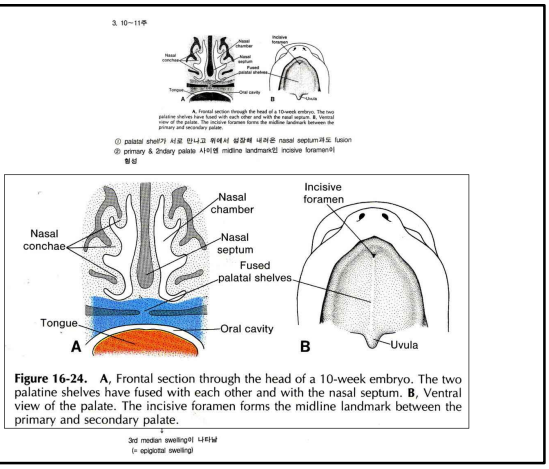
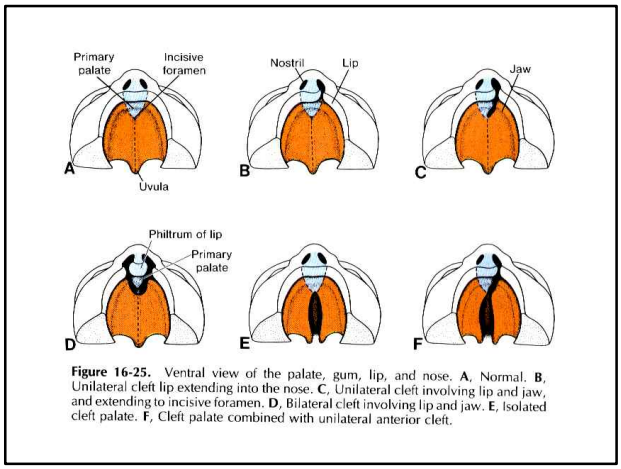
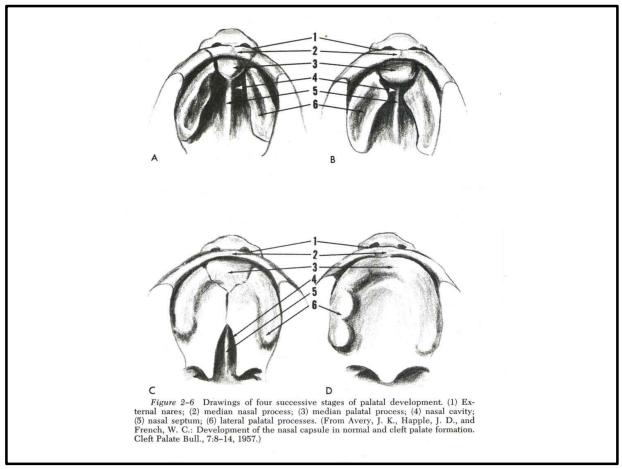

3. 10~11주
① palatal shelf가 서로 만나고 위에서 성장해 내려온 nasal septum과도 fusion
② primary & 2ndary palate 사이엔 midline landmark인 incisive foramen이 형성
Nasal chamber
Incisive foramen
Nasal conchae
Nasal septum
Fused palatal shelves
Tongue
Oral cavity
Uvula
A
B
Figure 16-24. A, Frontal section through the head of a 10-week embryo. The two palatine shelves have fused with each other and with the nasal septum. B, Ventral view of the palate. The incisive foramen forms the midline landmark between the primary and secondary palate.
3rd median swelling이 나타남
(= epigloital swelling)


Primary palate
Incisive foramen
Nostril
Lip
Jaw
A
B
C
Uvula
Philtrum of lip
Primary palate
D
E
F
Figure 16-25. Ventral view of the palate, gum, lip, and nose. A, Normal. B, Unilateral cleft lip extending into the nose. C, Unilateral cleft involving lip and jaw, and extending to incisive foramen. D, Bilateral cleft involving lip and jaw. E, Isolated cleft palate. F, Cleft palate combined with unilateral anterior cleft.


1
2
3
4
5
6
A
B
C
D
Figure 2-6 Drawings of four successive stages of palatal development. (1) External nares; (2) median nasal process; (3) median palatal process; (4) nasal cavity; (5) nasal septum; (6) lateral palatal processes. (From Avery, J. K., Happle, J. D., and French, W. C.: Development of the nasal capsule in normal and cleft palate formation. Cleft Palate Bull., 7:8–14, 1957.)

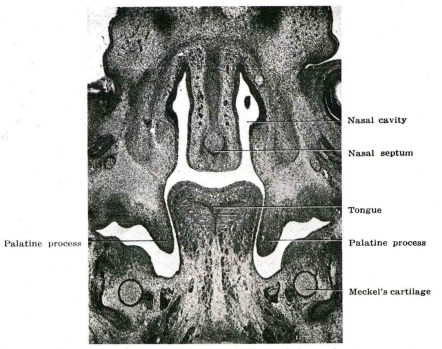


Figure 2–7 Frontal section, 24 mm. embryo, eighth week. Tongue interposed between vertical palatine processes. (From Orban, B. J.: Oral Histology and Embryology. 7th ed. C. V. Mosby Co., 1972.)

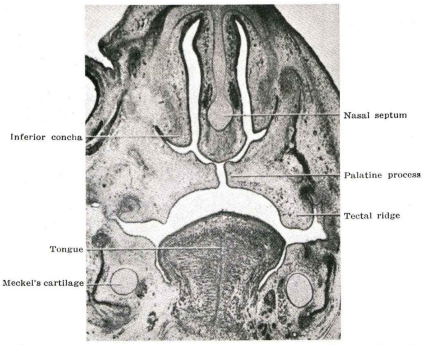


Figure 2–8 Frontal section, 30 mm. embryo, eleventh week. Through differential growth, palatine processes have become horizontal and approach each other and the nasal septum. Large mandibular growth increments have allowed the tongue to drop below the level of the palate. (From Orban, B. J.: Oral Histology and Embryology. 7th ed. C. V. Mosby Co., 1972.)

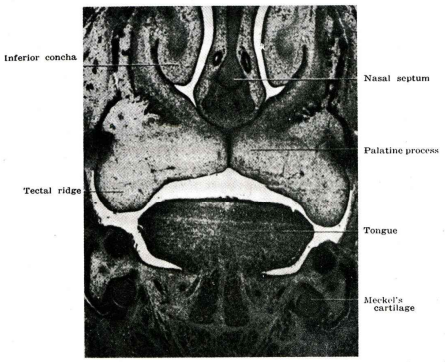
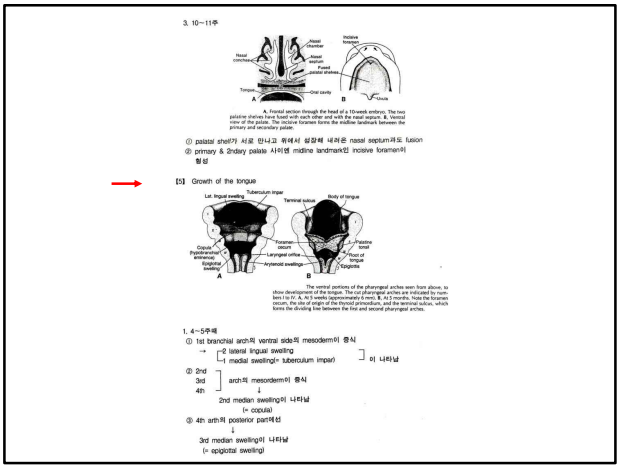


Figure 2–9 Frontal section, slightly older than Fig. 2–8. Fusion taking place between palatine processes and nasal septum. (From Orban, B. J.: Oral Histology and Embryology. 7th ed. C. V. Mosby Co., 1972.)



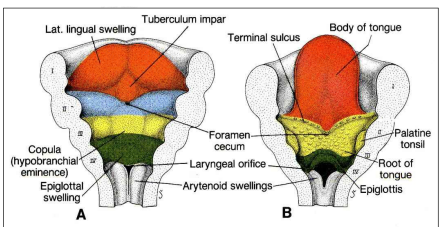
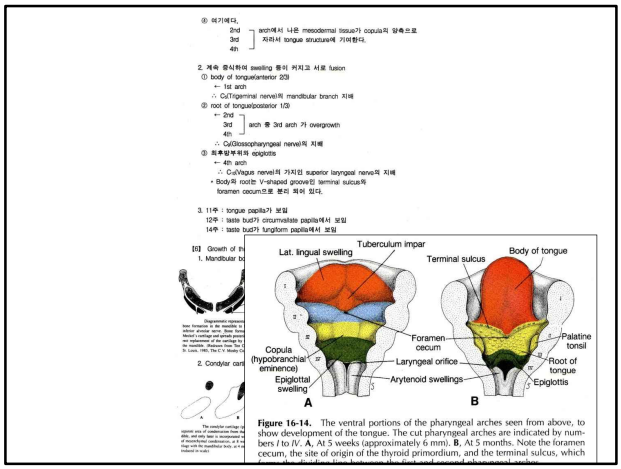


Figure 16-14. The ventral portions of the pharyngeal arches seen from above, to show development of the tongue. The cut pharyngeal arches are indicated by numbers *I* to *IV*. **A**, At 5 weeks (approximately 6 mm). **B**, At 5 months. Note the foramen cecum, the site of origin of the thyroid primordium, and the terminal sulcus, which forms the dividing line between the first and second pharyngeal arches.

1. 4~5주째
① 1st branchial arch의 ventral side의 mesoderm이 증식
→ 2 lateral lingual swelling
1 medial swelling(= tuberculum impar)
이 나타남
② 2nd
3rd
4th
arch의 mesoderm이 증식
2nd median swelling이 나타남
(= copula)
③ 4th arch의 posterior part에선
3rd median swelling이 나타남
(= epiglottal swelling)



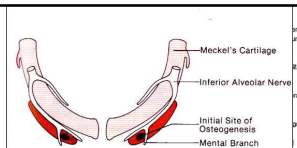


FIGURE 2-21 Diagrammatic representation of the relation of initial bone formation in the mandible to Meckel's cartilage and the inferior alveolar nerve. Bone formation begins just lateral to Meckel's cartilage and spreads posteriorly along it without any direct replacement of the cartilage by the newly forming bone of the mandible. (Redrawn from Ten Cate AR: *Oral histology*, St. Louis, 1985, Mosby.)

rmal tissue가 copula의 양측으로
ula에 기여한다.

fusion

anch 지배

growth

or laryngeal nerve의 지배
rminal sulcus의

서 보임
보임

[6] Growth of the mandible

1. Mandibular body

7주 embryo 시 Meckel's cartilage 측방에서
mesenchyme의 condensation 시작
↓
intramembraneous bone formation
↓
mandibular body 형성
(반면 Meckel's cartilage는 퇴화)

2. Condylar cartilage

8주 embryo 시 mandibular body와는 별개로
당근 모양의 cartilage가 독립적으로 발생
↓
4 month경에 mandibular body와 fusion
↓
body/축의 cartilage는 bone으로 transform되고
태생시엔 조금만 남는다.
(dense fibrous C-T가 위에 있음)

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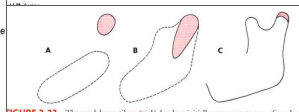

FIGURE 2-22 The condylar cartilage (*joint*) develops initially as a separate area of condensation from that of the body of the mandible, and only later is incorporated within it. **A**, Separate areas of mesenchymal condensation, at 8 weeks; **B**, fusion of the cartilage with the mandibular body, at 4 months, **C**, situation at birth (reduced to scale).

서 보임
보임

[6] Growth of the mandible

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(dense fibrous C-T가 위에 있음)

3. Mandibular symphysis
독립적으로 C-T에서 발생한 fibrocartilage
출생시 fibrocartilage로 있으나 1세경에 골화 된다.

→ Bone formation의 2 types

1) Endochondral bone formation
cartilage에 혈관이 침투하여 ossification center가 발생하고 이를 중심으로 계속적으로 cartilage가 bone으로 바뀜으로서 bone이 형성
예) cranial base, long bone, condyle head
→ interstitial growth → 모두 가능
→ appositional growth →

2) Intramembranous bone formation
cartilage에서 bone이 생기는 것이 아니라 C-T내로 bone matrix가 직접 secretion되어 bone이 형성
예) cranial vault, maxilla, mandible
→ 오직 appositional growth 가능

[7] Growth of the cranium

1. cranial base : endochondral bone formation (chondrocranium)

① 8주 embryo 시
nasal capsule로 부터 occipital area까지 cartilage가 bar 형태로 존재

② 4개월 fetus 시
영양 공급을 위해 chondrocranium 내로 혈관이 침투
→ ossification center가 발생
→ 이곳에서 cartilage가 bone으로 바뀌고 이 bone은 cartilage에 둘러싸인 실로양이 된다.
→ 계속 cartilage가 bone으로 대치되어 결국 cartilage로서는
sphenooccipital
intersphenoid
sphenoethmoidal
→ synchondrosis란 남고

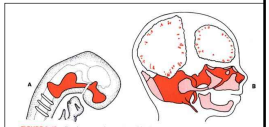

FIGURE 2-18 Development and maturation of the chondrocranium (cartilage: pink; bone: stippled red). **A**, Diagrammatic representation at about 8 weeks. Note that an essentially solid bar of cartilage extends from the nasal capsule anteriorly to the occipital area posteriorly. **B**, Skeletal development at 12 weeks. Ossification centers have appeared in the midline cartilage structures, and in addition, intramembranous bone formation of the pons and brain case has begun. From this point on, bone replaces cartilage of the original chondrocranium rapidly, so that only the small cartilaginous synchondroses connecting the bones of the cranial base remain.

Bone 사이에 있는 cartilagenous joint

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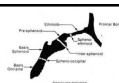
Bone 사이에 있는 cartilagenous joint

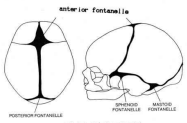


Ethmoid
Sphenoid
Basiocciptal
] bone이 형성된다.

SYNCHONDROSES OF THE CRANIAL BASE
Diagrammatic representation of the synchondroses of the cranial base, showing the location of these important growth sites.

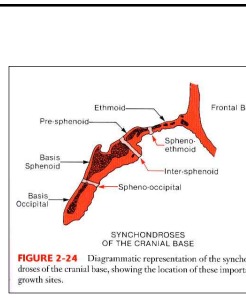
2. Cranial vault : Intramembraneous bone formation
(Desmocranium)
① intramembraneous bone formation에 의해 일련의 flat bone이 형성된다.
② 이후 appositional growth에 의해 성장
← inner & outer surface 모두에서
③ "suture"(skull bone 사이 사이의 periosteum-lined contact area)에서 remodeling과 growth가 왕성하게 일어난다.
— 출생시까지 완전히 fuse X
— fontanelle에 의해 서로 분리

anterior fontanelle



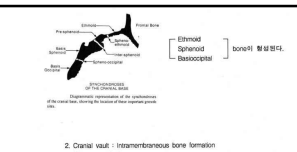
■ The fontanelles of the newborn skull.

[8] Growth of the pharynx
- 최초에 pharynx는 oro-pharyngeal membrane에 의해 primitive oral cavity와 분리 되어 있다가 4주경 membrane이 rupture되고 구강과 개통된다.
- 4-5주경 pharynx에선 pharyngeal gut의 lateral wall를 따라 pharyngeal pouch가 형성(= outer pocketing)
- 5주말 embryo 표면에선 groove 형태가 4개 나타나는데 이를 pharyngeal cleft라 한다.



SYNCHONDROSES OF THE CRANIAL BASE

FIGURE 2-24 Diagrammatic representation of the synchondroses of the cranial base, showing the location of these important growth sites.



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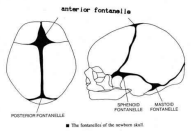

■ The fontanelles of the newborn skull.

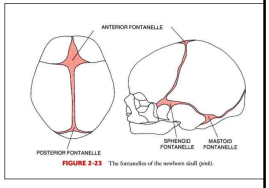

FIGURE 2-23 The fontanelles of the newborn skull (*pink*).

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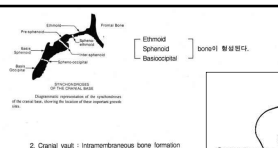

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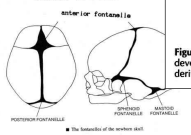


■ The fontanelles of the newborn skull.

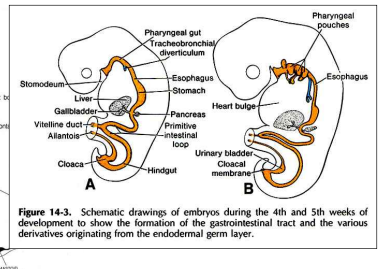


Figure 14-3. Schematic drawings of embryos during the 4th and 5th weeks of development to show the formation of the gastrointestinal tract and the various derivatives originating from the endodermal germ layer.

[8] Growth of the pharynx
- 최초에 pharynx는 oro-pharyngeal membrane에 의해 primitive oral cavity와 분리 되어 있다가 4주경 membrane이 rupture되고 구강과 개통된다.
- 4-5주경 pharynx에선 pharyngeal gut의 lateral wall를 따라 pharyngeal pouch가 형성(= outer pocketing)
- 5주말 embryo 표면에선 groove 형태가 4개 나타나는데 이를 pharyngeal cleft라 한다.

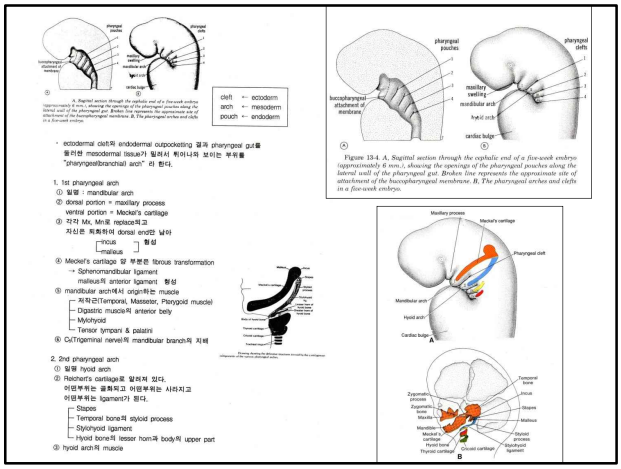


Figure 13-4. *A, Sagittal section through the cephalic end of a five-week embryo (approximately 6 mm.), showing the openings of the pharyngeal pouches along the lateral wall of the pharyngeal gut. Broken line represents the approximate site of attachment of the bucopharyngeal membrane. B, The pharyngeal arches and clefts in a five-week embryo.*

- ectodermal cleft와 endodermal outpocketing 결과 pharyngeal gut를 둘러싼 mesodermal tissue가 발피시 튀어나와 보이는 부위를 "pharyngeal(branchial) arch" 라 한다.

1. 1st pharyngeal arch
   ① 일명 : mandibular arch
   ② dorsal portion = maxillary process
   ventral portion = Meckel's cartilage
   ③ 각각 Mx, Mn로 replace되고
   자신은 퇴화하여 dorsal end만 남아
   - incus
   - malleus] 형성
   ④ Meckel's cartilage 양 부분은 fibrous transformation
   → Sphenomandibular ligament
   malleus의 anterior ligament 형성
   ⑤ mandibular arch에서 origin하는 muscle
   저작근(Temporal, Masseter, Pterygoid muscle)
   Digastric muscle의 anterior belly
   Mylohyoid
   Tensor tympani & palatini
   ⑥ C_N(trigeminal nerve)의 mandibular branch의 지배

2. 2nd pharyngeal arch
   ① 일명 hyoid arch
   ② Reichert's cartilage로 알려져 있다.
   어떤부위는 골화되고 어떤부위는 사라지고
   어떤부위는 ligament가 된다.
   - Stapes
   - Temporal bone의 styloid process
   - Stylohyoid ligament
   - Hyoid bone의 lesser horn과 body의 upper part

   ③ hyoid arch의 muscle

Figure 16-9. Drawing showing the definitive structures formed by the cartilaginous components of the various pharyngeal arches.

- Stapedius
- Stylohyoid muscle
- Digastric muscle의 posterior belly
- Auricular muscle
- Muscle of facial expression

④ C_N(Facial nerve)의 지배

3. 3rd pharyngeal arch
   ① hyoid bone의 greater horn, lower part of the body
   ② muscle : Stylopharyngeal muscle
   Upper pharyngeal constrictor
   ③ C_N(Glossopharyngeal nerve)의 지배

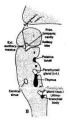
4. 4th pharyngeal arch
   ① thyroid cartilage
   ② muscle : Cricothyroid muscle
   Levator palatini muscle
   Constrictors of the pharynx
   ③ C_N(Vagus nerve)의 superior pharyngeal branch 지배

5. 1st pharyngeal pouch
   - distal → middle ear cavity(넓어져서)
   - proximal → Eustachian tube (그대로 좁아)

   2nd pharyngeal pouch → palatine tonsil
   3rd pharyngeal pouch
   - dorsal → parathyroid gland
   - ventral → thymus

   4th pharyngeal pouch
   - dorsal → superior parathyroid gland
   - ventral → uncertain

6. 1st pharyngeal cleft → E.A.M.
   2nd
   3rd
   4th] pharyngeal cleft → cervical sinus → 결국에 disappear
   (2nd Ph. arch가 아래로 overgrowth)



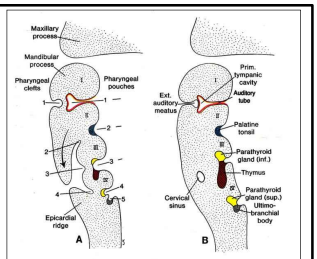


Figure 16-10. A, Schematic representation of the development of the pharyngeal clefts and pouches. Note that the second arch grows over the third and fourth arches, thereby burying the second, third, and fourth pharyngeal clefts. B, The remnants of the second, third, and fourth pharyngeal clefts form the cervical sinus. Note the structures formed by the various pharyngeal pouches.

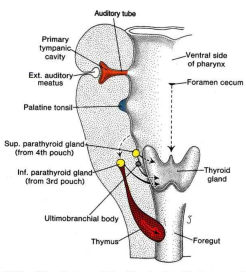


Figure 16-11. Schematic representation of the migration of the thymus, parathyroid glands, and ultimobranchial body. The thyroid gland originates at the level of the foramen cecum and descends to the level of the first tracheal rings.