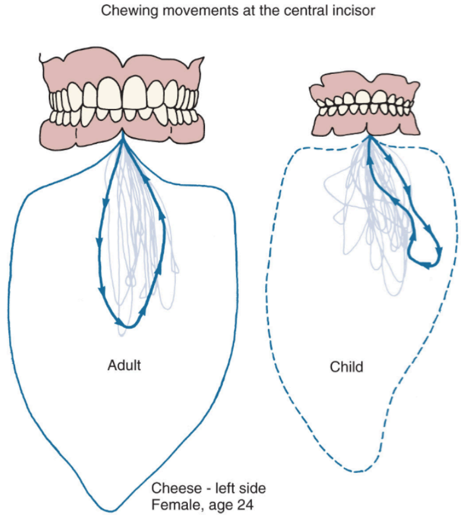
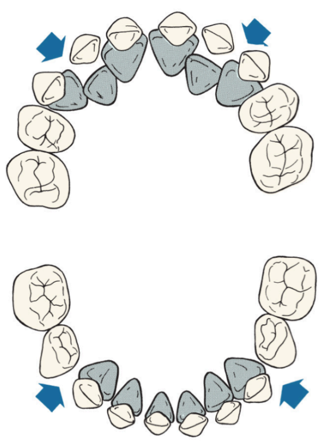
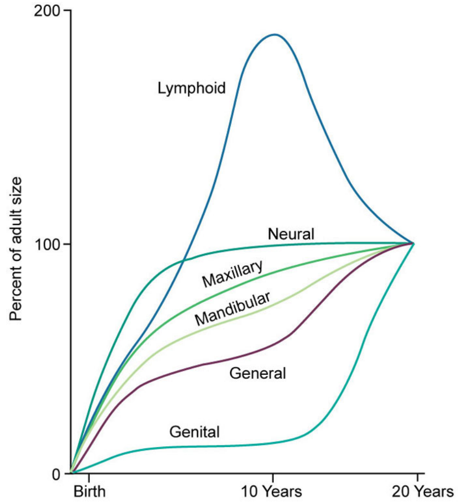
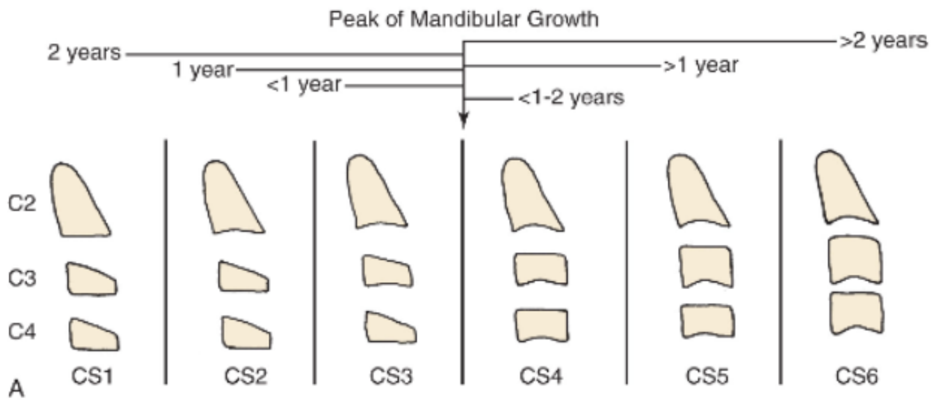
<table>
<tr><td></td><td>
(to short duration of the interposition)
o Tongue trusting is also possible with good anterior occlusion.
o Often tongue trust is necessary to adapt to an open bite.

- <u>Chewing movement:</u>
o The transition develops with eruption of the permanent canines.
o Adults with a severe anterior open bite (no canine function) do not achieve an adult chewing pattern.


<table>
<tr><td>Young child</td><td>Adult</td></tr>
<tr><td>1: Moving the mandible lateral with opening
2: Bring mn back to the midline
3: Close</td><td>1: Open straight down
2: Move the jaw laterally
3: Bring the teeth into contact</td></tr>
</table>
</td></tr>
<tr><td>Eruption of primary teeth</td><td>
- Natal tooth:
Mostly a normal central incisor, not a supernumerary tooth. → Shouldn't be removed.
(natal tooth = present at birth 1:2000-6000)
- Neonatal tooth = Tooth that erupts in the first 30 days of life.
- Eruption sequence is usually preserved.
- Dates / timepoints are variable with a normal range up to 6 m:
o Delay is usual for preterm infants.
o Ethical differences.
- Primary space: Maxilla between 2/3er, mandible between 3/4er.
- Spacing in the anterior part is normal and becomes larger when the child grows and when the alveolar process expands. Spacing is required for proper alignment of the permanent incisors.
Stöckli 1994: 70% children have spaces in the primary dentition.
o Maxilla: 2.5 mm
o Mandible: 1.0 mm.
- The crowns of the permanent incisors lie lingual to the crowns of the primary incisors.

</td></tr>
</table>

<table>
<tr><th colspan="2">Late childhood (5/6 y – puberty): The mixed dentition years</th></tr>
<tr><td>Physical development in late childhood (5/6 y)</td><td>
- Maximum disparity in the development of different tissue systems.


- 7y: Neural growth is essentially completed:
= brain and brain case are as large as they will ever been.
- Lymphoid tissues are beyond adult levels:
= large tonsils and adenoids are common.
- Growth of sex organs has hardly started.
- Rate of general body growth declines from rapid growth at infancy and stabilizes at moderate lower level during late childhood.</td></tr>
<tr><td>Hand x-rays</td><td>
- Ossification of the bones in the wrist, hand and fingers represent accurate a child’s skeletal development status by comparing a patient’s x-ray with a standard x-ray.
- Today used however only in special circumstances.
→ The same information is available in lateral cephs regarding the cervical vertebrae.</td></tr>
<tr><td>Cervical vertebral maturation

(Baccetti, Franchi & McNamara 2005)</td><td>
- Reliability has been questioned, but studies show a good intraobserver & interobserver reliability and applicability. (Bacchetti et al, 2015)
- CVM is a better predictor for timing of the adolescence growth spurt than chronologic age.
- Not valuable to determine if growth has ceased for teenagers with mn prognathisme.

</td></tr>
<tr><td>Behavioral age</td><td>Important for dental tx.</td></tr>
<tr><td>Correlations</td><td>
- Development status with chronologic age 0.8 a.
→ 0.64 prediction reliability
- Dental age with chronologic age 0.7 b.
→ 0.49 prediction reliability
- X^2 to predict one characteristic from another (a.: 0.64, b: 0.49).
- Good correlation of development ages between themselves:
→ If advanced, a child is often advanced in different characteristics (skeletal age, weight, reading…).</td></tr>
</table>

Eruption of permanent teeth	

1. Pre-emergent eruption	- Slow labial or buccal drift of a tooth follicle when the crown is being formed. Minimal extent. Does not contribute to eruption.
	- Eruptive movement starts when crown formation is finished & root formation starts.
	- Tooth erupts when about ¾ of the root is completed.
	
	Two processes are necessary:
	- <u>I. Resorption of bone and primary tooth roots:</u>
	  o Limiting factor for pre-emergent eruption.
	  o Completion of the crown is the start signal = Inhibition removal from:
	    ▪ Layer of osteoclasts cranial of the tooth germ.
	    ▪ Genes necessary for root formation.
	  o Root formation is not necessary for eruption.
	    ▪ If the tooth in a follicle is replaced by a metal piece, an occlusal drift will also occur.
	    ▪ Tooth with an already completed root can still erupt.
	    ▪ Tooth erupts also when the apex area is removed.
	
	- <u>II. Propulsive mechanism to move the tooth occlusal:</u>
	  o Precise mechanism through which the propulsive force is generated remains unknown.
	  Different mechanism for the eruption pre and post-emergence.
	  Theories:
	    ▪ Cross-linking of maturing collagen in the periodontal ligament. (applies only to post-emergence eruption)
	    ▪ Localized variations in blood pressure or blood flow?
	    ▪ Forces from contraction of fibroblasts?
	    ▪ Alterations in the EZM of the periodontal ligament?!
	    ▪ Growth of the pulp and dentin?
	    ▪ Apical bone growth?
	    ▪ Change in relationship of pression of the pulp vs. pression PDL?
	  o At normal speed, the apex always rests at the same level.
	  o If eruption is mechanically blocked, the proliferating apical area will move in the opposite direction → distortion of the root form = root dilacerations.
	
	• Normally the 2 processes operate in concert.
	• The 2 processes are not controlled physiologically by the same mechanism. → If a tooth is tied to the mandible the overlying bone resorptions proceeds at the usual rate although the tooth cannot erupt → formation of a cystic cavity.
	
	- <u>Cleidocranial dysplasia</u>:
	  • Abnormal resorption of bone & primary teeth → ø eruption of succedaneous teeth.
	  • Nonsuccedaneous tooth eruption is delayed by fibrotic gingiva.
	  • Multiple supernumerary teeth.
	  • Teeth can sometimes erupt spontaneously when the obstructions are removed. Application of orthodontic force is necessary if not.
	
	- <u>Primary failure of eruption: *(Frazier-Bowers, 2007)*</u> FB says PTH1R, ø PTHR1.
	  • Affected posterior teeth fail to erupt, because of a defect in the propulsive mechanism due to a mutation of the parathyroid hormone receptor gene 1 (**PTH1R**).
	  • **Type 1:**
	  Failure at the same time for all teeth → 2nd molar more affected than 1st molar.
	  • **Type 2:**
	  Gradient of time → central tooth (normally 1st molar) is normally the most severe affected.
	  • *Non-syndromic PFE :*
	  Heterozygote Mutation des PTHR1ens (dieses Gen kodiert den G-Protein-gekoppelten Rezeptor für das Nebenschilddrüsen-hormon PTH). Bei einer Mutation dieses Gens verändert sich die Rezeptorkonfiguration, wobei PTH nicht mehr binden kann. Der PTHR1 ist auf der Oberfläche von Osteoblasten exprimiert → bei Aktivierung durchs PTH werden Osteoklasten via RANKL stimuliert, OPG ↓, Sclerostin ↓ und Knochenresorption findet statt.

2. Post emergent eruption

- **Post-emergent spurt:**
  = Rapid eruption from the time a tooth has penetrated the gingiva until it reaches the occlusal plane.
- Root dilaceration usually occurs, if eruption of the tooth is impeded or due to trauma. The tooth can continue to erupt normally, after dilaceration occurred.
- *Prof. Becker*:
  - Early tx start is indicated for teeth with dilacerations. Root formation is possible as long as the apex is open.
  - May plan apex ectomy + root tx for teeth with severe dilaceration to avoid gingiva perforation.

- **Juvenile occlusal equilibrium:**
  = Slow eruption when the tooth reaches the occlusal level of other teeth and is in complete function.
  - The eruption rate is parallel to the rate of vertical growth of the mandibular ramus.
  - Eruption only between 8 p.m. - 1 a.m. Stop of the tooth eruption during the day or even a small intrusion occurs. Regulated by growth hormone release.
  - Applied pressure / force stops eruption only for 1-3 min, if there is any effect at all. → Contact with food, does not explain the rhythm.
  - Shortening of collagen fibers in the periodontal ligament by cross-linking as eruption mechanism.

- **Adult occlusal equilibrium:**
  - Extremely slow eruption rate, more rapidly if an antagonist is lost.
  - Loss of vertical dimension, if the eruption does not compensate the tooth wear.

Dental Age

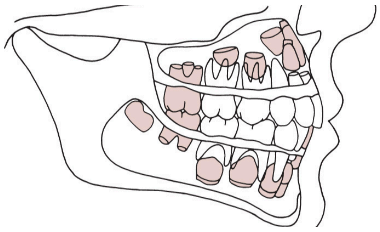
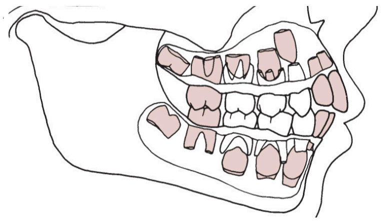
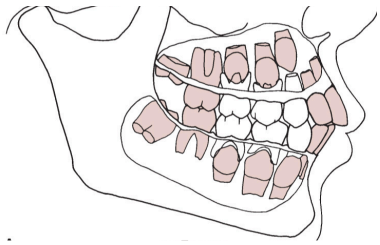
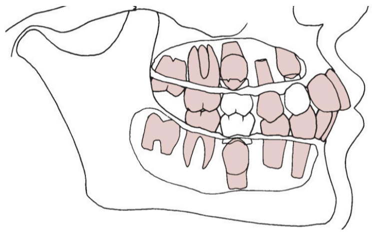
- Defined by:
  - Which teeth have erupted
  - The amount of resorption of the roots of primary teeth
  - The amount of development of the permanent teeth
- Change of sequence is a more reliable sign for disturbances than a generalized delay or acceleration.

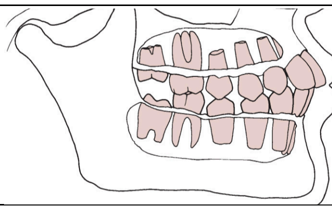
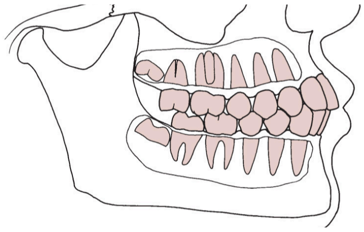
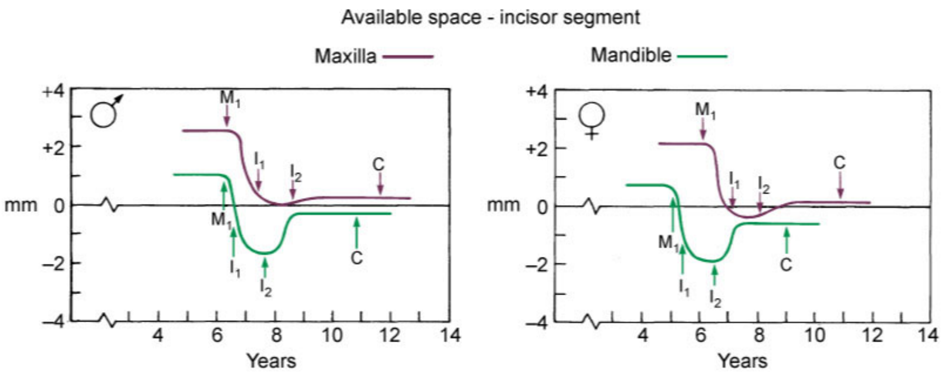
- <u>Variation in sequence with clinical significance:</u>
  - **Eruption of 7-7 before mn premolars:**
    Decrease of space can block out 5-5 outside the arch.
    → Space opening is maybe necessary.
  - **Eruption of 3+3 before maxillary premolars:**
    → Canines are forced labially.
    (also if there would be enough space if they had erupted after 4+4)
  - **Asymmetries in eruption between the right and left side:**
    X-ray if difference >6m.

- Tooth emerges when root formation is about ¾ completed.
- Root formation completed 2-3 y after toot eruption.

TABLE 3.2 Chronology of Tooth Development, Permanent Dentition

Tooth	CALCIFICATION BEGINS		CROWN COMPLETED		ERUPTION		ROOT COMPLETED	
	Maxillary	Mandibular	Maxillary	Mandibular	Maxillary	Mandibular	Maxillary	Mandibular
Central	3mo	3mo	4½ yr	3½ yr	7¼ yr	6¼ yr	10½ yr	9½ yr
Lateral	11mo	3mo	5½ yr	4yr	8¼ yr	7½ yr	11yr	10yr
Canine	4mo	4mo	6yr	5¾ yr	11½ yr	10½ yr	13½ yr	12¾ yr
First premolar	20mo	22mo	7yr	6¾ yr	10¼ yr	10½ yr	13½ yr	13½ yr
Second premolar	27mo	28mo	7¾ yr	7½ yr	11yr	11¼ yr	14½ yr	15yr
First molar	32wk in utero	32wk in utero	4¼ yr	3¾ yr	6¼ yr	6yr	10½ yr	10½ yr
Second molar	27mo	27mo	7¾ yr	7½ yr	12½ yr	12yr	15¾ yr	16yr
Third molar	8yr	9yr	14yr	14yr	20yr	20yr	22yr	22yr

- Dental age 6y	• E 1-1 • E 6-6 • E 6+6 
- Dental age 7y	• E 1+1, 2-2 • Root development 2+2 well advanced • 543+345 stage of crown completion
- Dental age 8y	• E 2+2 • 2-3y delay afterwards before further teeth erupt 
- Dental age 9y	• Root formation of 621±126 nearly complete. • 3-3, 4±4 first third of the root complete • Root formation beginning 3+3, 5±5 
- Dental age 10y	• Resorption of the roots of the primary canines and molars • Root formation completed: 21-12, 2+2 nearly • Root formation: 43-34 $^{1}/_{3}$ 4+4 ½ 5-5, 53+35 sign. development
- Dental age 11y	• E 3-3, 4-4, 4+4 • Root formation 6±6 completed • Remaining primary teeth: V±V 
- Dental age 12y	• E 3+3, 5±5 • E 7±7 nearly Succedaneous teeth normally complete their eruption before the 2nd molars erupt, but not always

<table>
<tr><td></td><td></td></tr>
<tr><td>Dental age 15y</td><td>• Roots of all permanent teeth except 8±8 complete
• 8±8 apparent on the x-ray
</td></tr>
<tr><td>Space relationship in replacement of the incisors</td><td>- Permanent incisors in both jaws lay lingual and apical of the primary teeth.
→ Tendency for mn incisors to erupt lingually in a slightly irregular position.
- If there is not enough room for the teeth, they are usually displaced labial.
- Permanent incisors are larger than the primary → Spacing in the primary dentition is crucial. Normally there is no additional spacing in the posterior region.
o Thilander 2009: Difference in tooth with primary - permanent teeth:
▪ Maxilla:
• 21+12: Δ +7 mm | incl. 3+3 Δ + 9 mm
• IV + IV = 4 + 4
• 5 + 5: Δ - 1 mm per side
▪ Mandible:
• 21-12: Δ +5 mm | incl. 3-3 Δ +7 mm
• IV - IV = 4 - 4
• 5 - 5: Δ -2.7 mm per side
- Mx: Normally enough space for 2+2.
- Mn: On average Δ -1.6 mm space missing for the permanent incisors.
→ Incisor liability = difference between the space available and the space necessary.
- Transitory crowding between 8-9 y of age is normal. Normalization when the canines erupt.


Moorrees, 1965: Space available within the arches: Boys left, girls right.
Mn: space for incisors negative for about 2y after eruptions → small crowding.

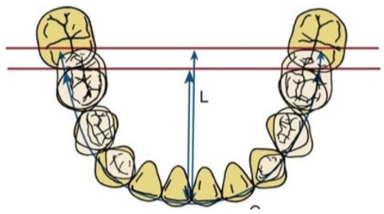
- <u>Sources of extra space:</u>
- Slight increase in arch width across the canines:
o Teeth erupt slightly outward as growth continues.
o 2 mm gain of space: mx > mn; girls < boys
→ girls are more likely to have anterior incisor crowding.
- Slight labial positioning (proclination) of the central and lateral incisors. Primary incisors are straighter.
→ 1-2 mm gain of space due to a larger circle of the arch.
- Distal ship of the primary canines when the permanent incisors erupt in the primate space.
→ Mn: 1 mm gain of space</td></tr>
</table>

<table>
<tr><td></td><td>→ Mx: 0 (primate space lays mesial III+III)
- All changes happen without significant skeletal growth.

- Ugly duckling stage:
= Maxillary diastema & 2+2 flared labially and distally.
Increased risk for impacted 3+3.

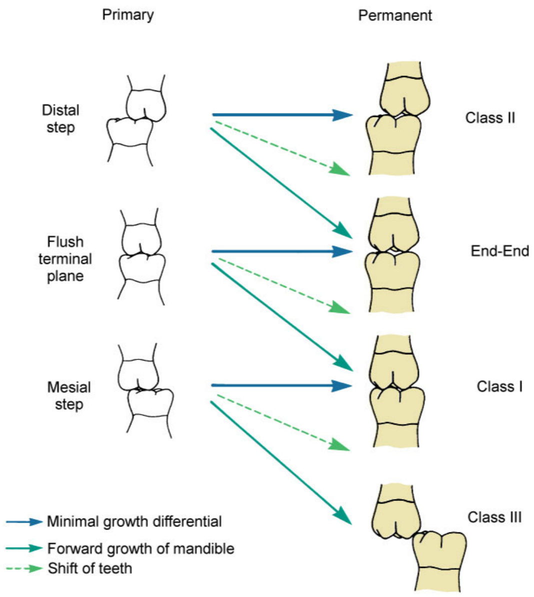
- <u>Central diastema:</u>
o <2 mm normally closes spontaneous when 3+3 erupt.
o >2 mm: spontaneous closure unlikely.</td></tr>
<tr><td>Space relationship in replacement of canine and primary molars</td><td>- Leeway space:
- Mn: 2.5 mm per side (V-V = +2 mm 5-5, IV-IV = +0.5 mm 4-4)
- Mx: 1.5 mm per side (V+V = +1.5 mm 5+5, IV+IV = 4+4)

- 6er move rapidly forward after loss of the premolars:
→ Arch length and arch circumference decrease.



- Stöckli 1994: Molar migration is normally smaller than the LWS.
o Mx: 1 mm
o Mn: 2 mm

- Relationship of primary molars:



• Distal step (10%)
> Cl.II
> End to end

• Flush terminal plane/normal relationship (30%)
> Cl.1
> end to end

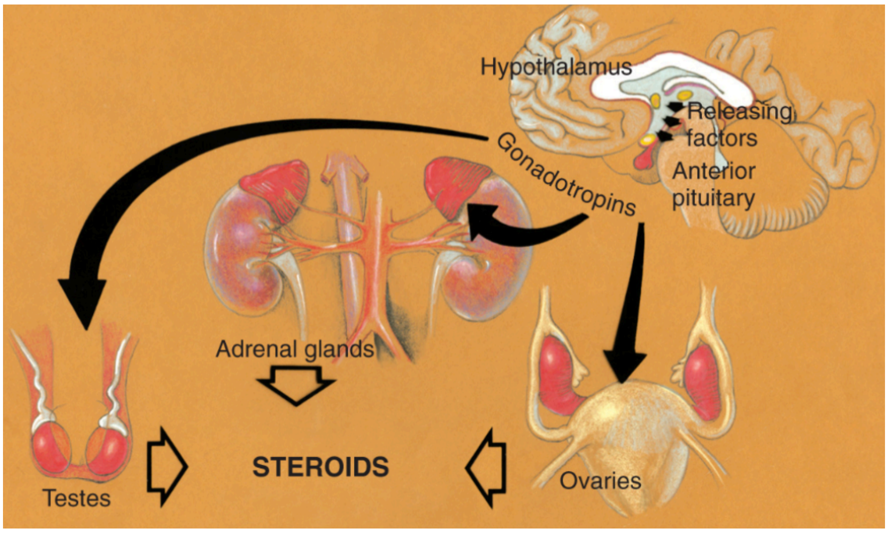
• Mesial step (60%)
> Cl.1
> Cl.III

k

- The amount of differential mn growth and molar shift into the leeway space determines the molar relationship.
- Flush terminal plane = normal relationship of the primary molar teeth.
(or mesial terminal plane with no mn primate spaces)
- Class III is almost never seen in the primary dentition, as the mn lies behind the maxilla due to the growth pattern.
- Forward movement mn molars > mx molars.
- The transition is usually done by one-half cusp (3-4 mm) relative forward movement of the lower molar accomplished by a combination of differential growth and tooth movements.
Key variable = amount and direction of mn growth.</td></tr>
</table>

Proffit Chapter 4:

Later Stages of Development

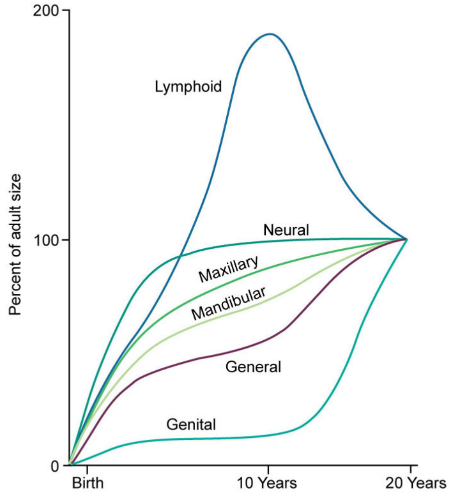
<table>
<tr><td colspan="2">Adolescence: The early permanent dentition years</td></tr>
<tr><td>Adolescence</td><td>= Transitional period between the juvenile stage and adulthood when sexual maturation is attained. Adolescent growth spurt, secondary sexual characteristics, physiological changes, fertility, change from the mixed in the permanent dentition.</td></tr>
<tr><td>Initiation of adolescence</td><td>

Occurs in the brain:
1. Brain cells in the hypothalamus secrete releasing factors in the cell body. (epigenetic regulation)
2. Cytoplasmic transportation of the releasing factors along the axon to a richly vascular area at the base of the hypothalamus near the pituitary gland.
3. Passage into capillaries, carried by blood to the pituitary.
Pituitary portal system = special network of vessels analogue to the liver.
4. Releasing factors stimulate in the anterior part of the pituitary gland the cells to produce the pituitary gonadotropin hormones.
5. Gonadotropin hormones stimulate endocrine cells in the adrenal glands and the developing sex organs to produce sex hormones.
In both genders, male and female sex hormones are produced.
6. Sex hormones cause the development of the secondary sexual characteristics, accelerate growth of the genitals and general body growth, shrinkage of lymphoid tissues.
The control signal is amplified in each step.

- <u>Boys:</u>
Production of male & female sex hormones in the testes + some female hormones in the adrenal cortex.

- <u>Girls:</u>
Ovaries produce estrogen and later progesterone.
The adrenal cortex produces male sex hormones.

- The earlier the onset of puberty, the smaller the adult size:
(and the more intense the growth spurt)
Sex hormones stimulate the cartilage in the long bone to grow faster, but increase even more the skeletal maturation → cartilage transform into bone, the epiphyseal plates close.
- Obese children: Puberty starts earlier → body length ↓</td></tr>
</table>

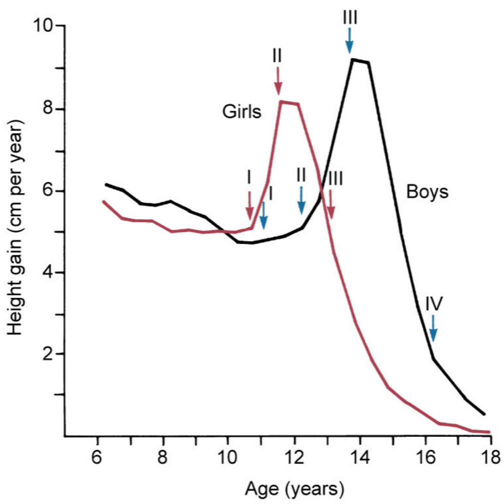


Growth curves for the maxilla and the mandible shown against the background of Scammon's curves. Growth of the jaws is intermediate between the neural and general body curves, with the mandible following the general body curve more closely than the maxilla. The acceleration in general body growth at puberty, which affects the jaws, parallels the dramatic increase in development of the sexual organs. Lymphoid involution also occurs at this time.

Timing of Puberty

- Girls 2 y earlier than boys → Orthodontic tx must be done earlier for girls than for boys.
- Stage of development of secondary sexual characteristics is a good indicator for the stage of adolescence that correlates well with physical growth status.

Girls: Adolescent Growth total 3.5 y, 3 stages	
Stage 1 *Beginning of adolescence growth*	Appearance of breast buds Initial pubic hair
Step 2 (12m later) *Peak velocity in height*	Breast development Axillary hair Darker/more abundant pubic hair
Stage 3 (12-18m later) *Growth spurt ending*	Menstruation Broadening of the hips with adult fat distribution Breasts completed
Boys: Adolescent Growth total 5 y, 4 stages	
Stage 1 *Beginning of adolescent growth*	Fat spurt weight gain Feminine fat distribution
Stage 2 (12m later) *Height spurt is beginning*	Redistribution / reductions in fat Pubic hair Growth of penis
Stage 3 (8-12m later) *Peak velocity in height gain*	Facial hair appears on the upper lip only Axillary hair Muscular growth with hardener / more angular body form
Stage 4 (15-24m later) *Growth spurt ending*	Facial hair on chin and lip Adult distribution / color of pubic and axillary hair Adult body form



Girls:

- Pubertal growth spurt **10.8 -13.3 y**
- Peak of growth: **12.0 y**
- Menarche **13.3 y** (CH **13.7 y**, *Mullis 2009*)
- Maximum growth per year: **8.2 cm**
- **10.7 y** = Start of puberty = breast development *(Mullis, 2009*)

Boys:

- Pubertal growth spurt **12.4 - 15.2 y**
- Peak of growth: **14.0 y**
- Maximum growth per year: **9.2 cm**
- **11.7y** = Start of puberty = testis size **> 4ml** *(Mullis, 2009)*