**Goals:** This series of lectures should enable the resident to:
1. Define the major stations of somatic growth, and the relationship between somatic and craniofacial development.
2. Understand the diversity that governs the association between chronologic, dental and skeletal ages.
3. Understand the concepts of central tendencies and individual variation, and their application in the clinical situation.
4. Understand the role of hormones in somatic growth.

**Objectives:** The resident should know:
1. The central tendencies of major growth events with direct clinical implications on orthodontic treatment: the relationship between growth of the jaws and somatic development; differential growth between the jaws; and direction and pattern of facial growth.
2. Currently used predictors of craniofacial development, such as body height and bone maturation. Research to develop better predictors should be appreciated, including current information and state of research regarding the utilization of hormonal analysis in growth assessment.
3. The opportunities and limitations offered by individual variation from central tendencies, as elaborated, for example, with the variation within the interaction between dental, facial, and somatic growth.
4. Current information regarding the interaction between somatotype, facial configuration and occlusion (or malocclusion).
examination is given at the semi-annual examination that is closest to the end of the course, unless the course director schedules the final examination earlier. During a course, any number of progress tests or assignments may be given. Their cumulative weight in proportion to the final grade may not exceed 50%.

**PANELS OF SOMATIC AND CRANIOFACIAL GROWTH AND DEVELOPMENT**

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**COURSE OUTLINE**

**Panel 1: Relationship between growth of the jaws and somatic development**

*Scammon’s representation of the development of the four major tissues of the body:*

Facial bones undergo an adolescent growth spurt similar in pattern to that of the body: facial growth peaks at the same time or slightly later than the peak of maximum increments in height. Correlations tend to be higher between body height and the mandible than between body height and the maxilla. This discrepancy is probably due to the fact that growth of the sutures, which is closely associated with maxillary growth, ceases before (about two years) the completion of growth in mandibular length. (Result: differential growth between the jaws).

**Panel 2: Differential growth between the jaws**

Growth curves of the maxilla and mandible. This differential pattern applies within planes of space. Specifically, growth of the face is characterized by the descent of the maxilla away from the cranial base, a movement that displaces the mandible as well. Simultaneously, the mandible descends from the maxilla. These displacements represent both translation and rotation in space that require adaptive changes not only in bone, but also in cartilaginous and soft tissues. Differential growth might also be expected between planes of space, as growth tends to cease first in the transverse, sagittal, and finally vertical planes.

**Panel 3: Direction and pattern of facial growth**

Summarized by the finding of *Broadbent (1937)* that an individual pattern of growth has a tendency to remain the same throughout development. A corollary to this premise is that the same pattern holds regardless of facial type, whether brachyfacial, dolichofacial, or normal. Interestingly, however, certain facial types or at least major features of these facial types have been associated with different body types, namely endo, meso, and ectomorph. For example, at the extreme of ectomorphy the features of a dolichocephalic pattern may be expected.

**Panel 4: Predictors of craniofacial development**
Bjork: Growth timing in boys: Facial growth peaks at or slightly later than the maximum change in height. Sutural growth of the face is completed before growth in height and at the mandibular condyles ceases. In girls, peaks occur nearly 1.5 years earlier. In addition to body height, craniofacial development is gauged in relation to skeletal maturation as evaluated with hand-wrist radiographs. Recently, stages of maturation of cervical vertebrae, described as changes in shape on cephalometric x-rays, were related to skeletal development, but much research is still needed in this area. The predictors of timing of skeletal growth, assessed with hand-wrist radiographs, apply both to growth in height and facial development, particularly mandibular growth. The latter is relatively easier to measure on cephalometric radiographs than is maxillary development, because the mandible is a distinct skeletal unit, while the maxilla is not readily separated from adjacent bones and its assessment is usually reduced to that of the size and position of the midline structure, particularly the palate.

Panel 5: Individual variation-
EXAMPLES
- Mandibular length (Woodside DG, 1974)
- Relationship between skeletal and dental development [5.1] (Ghafari J, 1978)

Mean occurrence ± one standard deviation of three growth events: emergence of the mandibular second premolar (PM2), emergence of the permanent maxillary second molar (M2), and peak height velocity (PHV). Dental emergence data are based on the work of Hurme, and PHV on the publications of Tanner and Davies. The shaded area delineated by the arrows (between the ages of 10.5
and 11.5 years) represents a window between the estimated times of loss of the primary mandibular second molars between girls and boys.

SPECIAL FOCUS: ROLE OF HORMES IN SOMATIC GROWTH

THIS LECTURE IS SUPPLEMENTED BY A SPECIAL LECTURE GIVEN BY DR. SAMIR NAJJAR ON THE MORE ENCOMPASSING ROLE OF HORMONES IN SOMATIC GROWTH, WITH EMPHASIS ON NORMAL AND ABNORMAL DEVELOPMENT AND TREATMENT.

Serum and Salivary Steroid Hormones and Growth Factors During Growth: Review and findings from research.

Question: Are hormones useful tools in monitoring somatic growth, and if so, can they be used as predictors of growth to infer conclusions on facial growth (mainly mandibular) and thus on timing orthodontic treatment that seeks to take advantage (Class II) or avoid (Class III) its effects through growth modification?

HORMONES CONSIDERED IN BLOOD AND SALIVA:
Testosterone
Estradiol
Dehydroepiandrosterone sulfate (DHEAS)
Insulin-like growth factor (IGF-1)

Blood samples every 3 months
Whole and parotid saliva every month
Parotid levels of IGF1 gauged because less variable than whole saliva measures in a pilot study

ANTHROPOMETRIC MEASUREMENTS: every month
Body height (BH) (Holtain stadiometer)
Knee height (KH) (Knee Height Measuring Device)

KH: a more sensitive measure of growth than BH $\Rightarrow$ IGF levels correlated with KH

FINDINGS AND DISCUSSION:
1- Variation in adrenal (DHEAS) and gonadal steroids preceding and during adolescence jointly improve prediction of skeletal age.
2- DHEAS + testosterone apparently provide better combination, particularly in boys in mid to late childhood
3- Initial low associations between hormones and skeletal age in girls may reflect increase of levels earlier (in mid-childhood)
4- Near puberty, testosterone in boys, and estradiol and to a lesser extent IGF1 in girls, become more significant contributors to predicting variation in skeletal age
5- Gender differences probably reflect different patterns of hormonal fluctuation, and differences in duration of maturational periods

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<tr>
<th>LEVEL FLUCTUATION</th>
<th>PERIOD OF SECRETION</th>
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<tbody>
<tr>
<td><strong>BOYS</strong></td>
<td>Less</td>
</tr>
<tr>
<td><strong>GIRLS</strong></td>
<td>More</td>
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