The Hebrew University of Jerusalem

Syllabus

Growth and development of the craniofacial complex - 97947

Last update 14-09-2022

HU Credits: *4*

Degree/Cycle: *2nd degree (Master)*

Responsible Department: *Bio-Medical Sciences in Dentistry*

Academic year: *0*

Semester: *1st Semester*

Teaching Languages: *English*

Campus: *Ein Karem*

Course/Module Coordinator: *Dr. Miri Haisraeli-Shalish and Dr. Zvi Muster*

Coordinator Email: *Dr. Miri Haisraeli-Shalish, mshalish@mail.huji.ac.il*

Coordinator Office Hours: *Monday 10:00-11:00 (Dr. Shalish) and Tuesday 10:00-11:00 (Dr. Muster)*

Teaching Staff:
Dr. Miriam Haisraeli-Shalish,
Dr. Marina Faerman

Course/Module description:
This course provides a broad knowledge in general growth, as well as specific fundamentals of craniofacial growth and development.

Course/Module aims:
- Provide the students with up-to-date knowledge relevant to the fields of growth and development with a focus on the craniofacial complex.
- Provide the students with tools to assess normal and abnormal growth.

Learning outcomes - On successful completion of this module, students should be able to:
On successful completion of this course, students should be able to:
• Discuss genetic and molecular aspects of growth as well as embryology concepts.
• Describe growth hypotheses.
• Evaluate skeletal maturation and general growth.
• Describe growth and function of the craniofacial complex, including soft tissues.
• Discuss endocrinology of growth.
• Describe syndromes and clefts.
• Integrate the knowledge of growth and development of the craniofacial system into orthodontic diagnosis and treatment planning.

Attendance requirements(%):
90

Teaching arrangement and method of instruction: : frontal lectures and seminars. Reading assignments for each seminar session is to provide background information for class discussions related to the scheduled topics.

Course/Module Content:
1 Introduction to growth and development Dr. Haisraeli-Shalish
2 Growth of the cranium and the cranial base Dr. Muster
3 Maxillary growth Dr. Katz
4 Genetic and molecular aspects of craniofacial development Dr. Leibovich

5 Mandibular growth Prof. Ben-Bassat
Dr. Grossman
6 Growth hypotheses Dr. I. Barkana
7 Facial growth dynamics Dr. Haisraeli-Shalish
8 Skeletal maturation Dr. S. Ben Sushan
9 General growth Dr. Faerman
10 Soft tissues and function Dr. Friedman
11 Endocrinology and growth Dr. D. Gillis
12 Genetics and Orthodontics Dr. Sheffer
13 Syndromes Dr. Forer
14 Clefts – Development and Etiology Prof. Ben-Bassat
15 Embryology of the craniofacial system Dr. Inbal
16 Exam

<u>Required Reading:</u>
I. Introduction to growth and development
*1. Enlow DH, Hans HG: Essentials of Facial Growth. 1996, Chapters 1-3.**
*2. Bishara SE: Facial and dental changes in adolescents and their clinical implications. AO 70:471-483, 2000.**
*3. Bishara SE et al: Facial and dental changes in adulthood. AJODO 106:175-186, 1994.**
*4. Bjork A & Skieller V: Facial development and tooth eruption. An implant study at the age of puberty. AJO 62:339-383, 1972.**
5. Enlow DH, Hans HG. Essentials of Facial Growth. 1996, Chapter 10.
6. Proffit WR: Contemporary Orthodontics. Mosby, 2007 Ch.2, pp. 27-39.
*7. Mao JJ., Nah HD: Growth and development: hereditary mechnical modulation. Am J Orthod Dentofacial Orthop. 125: 676-689, 2004.**

II. Growth of the cranium and the cranial base
1. Proffit WR et al. Contemporary Orthodontics, 4th edition, Chapter 2, pp. 40-44, 2007.
*2. Scott JH. The cranial base. Am J Phys Anthrop 16:319-348, 1958.**
3. Melsen B. The cranial base. Acta Odontol Scand 32, Suppl 62:108- 111, 1974.
4. Bjork A. Cranial base development. Am J Orthod 41:198-225, 1955.
5. Coben SE. The spheno-occipital synchondrosis: The missing link between the profession's concept of craniofacial growth and orthodontic treatment. Am J Orthod Dentofacial Orthop 114:709-712, 1998.*
*6. Opperman LA, Gakunga PT, Carlson DS. Genetic factors influencing morphogenesis and growth of sutures and synchondroses in the craniofacial complex. Semin Orthod 11:199-208, 2005**

III. Maxillary growth
1. Enlow D.H, Bang S.: Growth and remodeling of the human maxilla. Am J Orthodontics 51:446-463, 1965.

*2. Bjork A, Skieller V: Growth of the maxilla in three dimensions as revealed radiographically by the implant method. Am J Orthodontics 4: 53-64, 1975. *
3. Melsen B: Palatal growth studied on human autopsy material: A histological micro-radiographical study. Am J Orthodontics 68: 42-54, 1975. *
4. Iseri H, Solow B: Average surface remodeling of the maxillary base and the orbital floor in female subjects from 8 to 25 years. An implant study. Am J Orthod Dentofacial Orthopedics 107: 48-57, 1995 *
5. Melsen B et. al.: Postnatal development of the nasal septum studied on human autopsy material. Craniofacial growth series, No.10: 127-143, 1981.*
6. Persson M, Thilander B: Palatal suture closure in man from 15 to 35 years of age. Am J Orthod 72: 42-52, 1977.*

IV. Genetic and molecular aspects of craniofacial development
1. Gehring WJ: The molecular basis of development. Scientific American 253:137-146, 1985.
2. Wagner EF and Karsenty G: Genetic control of skeletal development. Curr Opin Genet Dev. 2001 Oct; 11(5): 527-532.
3. Goldspink G: Gene expression in skeletal muscle. Biochem Soc Trans. 2002 30 (2): 285-290.
4. Hoffman A and Gross G: BMP signaling pathways in cartilage and bone formation. Crit Rev Eukaryot Gene Expr. 2001
5. Lewis MP, Machell JR, Hunt NP, Sinanan AC and Tippett HL: The extracellular matrix of muscle-implications for manipulation of the craniofacial musculature. Eur J Oral Sci. 2001; 109(4): 209-221.
6. Meikle MC: Craniofacial Development, Growth and Evolution. Bateson Publishing Bressingham, Norfolk, England, 2002: The Biology of Skeletal Tissues, pp. 77-124.
7. Opperman L.A: Cranial Sutures as Intramembranus Bone Growth Sites. Developmental Dynamics 219:472-485, 2000.
8. Mukhopadhyay P, Greene RM, Pisano MM. Expression profiling of transforming growth factor beta superfamily genes in developing orofacial tissue. Birth Defects Res A Clin Mol Teratol. 2006;76(7):528-43.
9. Nie X, Luukko K, Kettunen P. BMP signalling in craniofacial development. Int J Dev Biol. 2006;50(6):511-21.
10. Chai Y, Maxson RE Jr. Recent advances in craniofacial morphogenesis. Dev Dyn. 2006;235(9):2353-75.
11. Opperman LA, Rawlins JT. The extracellular matrix environment in suture morphogenesis and growth. Cells Tissues Organs. 2005;181(3-4):127-35.
12. Nie X, Luukko K, Kettunen P. FGF signalling in craniofacial development and developmental disorders. Oral Dis. 2006;12(2):102-11.
13. Radlanski RJ, Renz H. Genes, forces, and forms: mechanical aspects of prenatal craniofacial development. Dev Dyn. 2006; 235(5):1219-29.
14. Holmbeck K. Collagenase in cranial morphogenesis. Cells Tissues Organs. 2005;181(3-4):154-65.

V. Mandibular growth
1. Enlow D.H. and Hans M.G.: Essentials of Facial Growth.WB Saunders Co., 1996.*

Developmental Sequence. Chapter 3, pp. 42-45, 46-49, 53-55.
2. Bjork A: Variations in the growth pattern of the human mandible: Longitudinal radiographic study by the implant method. J D Res 42: 400-411, 1963.
3. Bjork A: Normal and abnormal growth of the mandible. A synthesis of longitudinal cephalometric implant studies over a period of 25 years. EJO 5: 1-46, 1983.
4. Baumrind S, Ben-Bassat Y, Korn E.L, Bravo L.A and Curry S: Mandibular remodeling measured on cephalograms. 1. Osseous changes relative to superimposition on metallic implants. Am J Orthod Dentofac Orthop 102:134-142, 1992.
5. Graber L.W: The alterability of mandibular growth of the human face and cranium. In: Determinants of mandibular form and growth: Monograph no. 4. Craniofacial Growth Series. Edited by A.J. McNamara Jr: 1975, pp. 229-241.
6. Petrovic A: Control of postnatal growth of secondary cartilages of the mandible by mechanisms regulating occlusion. Trans Eur Orthod Soc 69-75, 1974.
7. Bjork: Prediction of mandibular growth and rotation. AJO 55:585-599, 1969.
8. Baumrind S and Korn E.L.. Postnatal width changes in the internal structures of the human mandible: a longitudinal three-dimensional cephalometric study using implants. EJO 14:417-426, 1992.
*9. You ZH, Fishman LS, Rosenblum RE, Subtelny JD: Dentoalveolar changes related to mandibular forward growth in untreated Class II persons. Am J Orthod Dentofac Orthop 120: 598-607, 2001.**

VI. Growth hypotheses
*1. Thilander B: Basic mechanisms in craniofacial growth. Acta Odont. Scand. 53:144-151, 1995.**
*2. Van Limborgh J: Morphogenetic control of craniofacial growth. Craniofacial growth series. No. 14:1-15, 1980.**
*3. Moss M, Salentiijn L: The primary role of functional matrices in facial growth. AJO 55:566-577, 1969.**
4. Enlow DH and Hans MG: Essentials of Facial Growth, 1996, chapter 12.
5. Miekle MC: Craniofacial development growth and evolution. 2002, pp. 261-267.
6. Proffit WR: Contemporary orthodontics. Mosby, 2007. Ch. 2 pp. 47-58.

VII. Facial growth dynamics
*1. Solow B. The dento-alveolar compensatory mechanism: background and clinical implications. Br J Orthod 1980;7:145-161**
2. Lewis A.B. et al Pubertal spurts in cranial base and mandible. AO 1985;55:16-30.
3. Ursi W.J., Trotman C.A., McNamara J.A. Jr., Behrens R.G. Sexual dimorphism in normal craniofacial growth. AO 1993;63:47- 56.
4. Meikle M.C. Craniofacial Development, Growth and Evolution. 2002 pp. 100-113.
5. Proffit W.R. Contemporary Orthodontics. Mosby, 2007, Ch. 4, pp.127-129.

VIII. Skeletal maturation
1. Enlow: Facial growth 3rd Edition, pp. 418-420, 1990.
*2. Demijian, Buschang, Ta: Interrelationships among measures of somatic, skeletal, dental and sexual maturity. AJO 1985; 88(5): 433-438.**

*3. Baccetti T, Franchi L, McNamara JA: The cervical vertebral maturation (CVM) method for assessment of optimal treatment timing in dentofacial orthopedics. Seminars in Orthodontics, Sept. 2005:119-130.**
4. Coutinho, Buschang, Miranda: Relationships between mandibular canine calcification stages and skeletal maturity. AJO 1993; 104(3): 262-268.
5. Sierra: Assessment of dental and skeletal Maturity. AO 1987 (3): 194-208.
6. Leite, O'Reilly, Close: Skeletal age assessment with first, second and third fingers. AJO 1987; December 492-498.
*7. Moore, Moyer, DuBois: Skeletal maturation and craniofacial growth. AJO 1990; 98(1): 33-40.**
8. Hagg V: Maturation indicators and the pubertal growth spurt. AJO 1982; 82 (4): 299-309.
9. Ruf S and Pancherz H: Frontal sinus development as an indicator for somatic maturity at puberty? AJO 1996; 110: 476-482.
*10. Smith R. Misuse of hand wrist radiographs. Am J Orthod 77: 75-78, 1980.**

IX. General growth
1. Enlow: Facial growth 3rd Edition, Chapter 15, 1990.
2. Ranly D.M. Synopsis of craniofacial growth. 1988. Chapter 3.
3. Greulich W.W. and Pyle S.I. Radiographic atlas of skeletal development of the hand and wrist. 1959, Stanford, CA: Stanford University Press.
4. Tanner J.M., Whitehouse R.H., Marshall W.A., Healy M.J.R., Goldstein H. Assessment of skeletal maturity and prediction of adult height (TW2 method). 1983. London: Academic Press.

X. Function and Malocclusion
1. Burstone CJ: Lip posture – its significance in treatment planning. AJO 1967; 53:262-284.
*2. Solow B, Siersbaek-Nielsen S: Cervical and craniocervical posture as predictors of craniofacial growth. Am J Orthod Dentofacial Orthop 449-458, 1992.**
*3. Vig PS: Respiratory mode and morphologic types. Craniofacial Growth Series no.9:238-250, 1979.**
*4. Fricke B et al: Nasal airway, lip competence and craniofacial morphology, EJO 15:297-304, 1993.**
5. Franklin DL et al: The prevalence of malocclusion in children with cerebral palsy. EJO 18:637-643, 1996.
*6. Tarvonen, Koski: Craniofacial skeleton of children with enlarged adenoids. AJODO 91:300-304, 1987.**
*7. Zettergren-Wijk CM, Forsberg S, Linder-Aronson S: Changes in dentofacial morphology after adeno-/tonsillectomy in young children with obstructive sleep apnoea-- a 5-year follow-up study. Eur J Orthod. 28: 319-326, 2006.**
*8. Vig KW. Nasal obstruction and facial growth: The strength of evidence for clinical assumptions. Am J Orthod Dentofacial Orthop 113: 603-11, 1998.**
*9. El H, Palomo JM: Airway for different dentofacial skeletal patterns. Am J Orthod Dentofacial Orthop. 139: e511-e521, 2011.**
10. Pirila-Parkkinen K, Lopponen J, Nieminen P, Tolonen U, Paakko E, Pirittiniemi P:

*Validity of upper airway assessment in children: A clinical, cephalometric and MRI study. Angle Orthod 81: 433-439, 2011.**

Growth of soft tissues
1. Bishara SE, Jacobsen JR, Hession TJ, Treder JE: Soft tissue profile changes from 5 to 45 years of age. Am J Orthod Dentofacial Orthop 114: 698-706, 1998.
2. Subtelny J.D. A longitudinal study of soft tissue facial structures and their profile characteristic, defined in relation to underlying skeletal structures. AJO 1959; 45: 481-507.
*3. Mamandras AH: Linear changes of maxillary and mandibular lips. AJODO 94:405-410. 1988.**
*4. Vig PC and Cohen AM: Vertical growth of the lips: a serial cephalometric study. AJO 75: 405-415, 1979.**
5. Cohen AM, Vig PS: A serial growth study of the tongue and intermaxillary space. AJO 46:332-337, 1976.
6. Vig PC and Cohen AM: The size of the tongue and the intermaxillary space. AO 25-28, 1974.
*7. Nanda RS, Meng H, Kapila S, Goorhuis J: Growth changes in soft tissue facial profile. Angle Orthod 60: 177-190, 1990.**

XI. Endocrinology and growth
1. Westphal O: Normal growth and growth disorders in children. Acta Odontol Scand1995;53:174-8.
2. Pirinen S: Endocrine regulation of craniofacial growth. Acta Odontol Scand 1995;53:179-85.
3. Thilander B: Basic mechanisms in craniofacial growth. Acta Odontol Scand 1995;53:144-51.
4. Van Erum R, Mulier G, Carels C, de-Zegher F: Craniofacial growth and dental maturation in short children born small for gestational age: effect of growth hormone treatment. Horm Res 1998;50:141-6.
5. Verdonck A, Gaethofs M, Carels C, de-Zegher F: Effect of low-dose testosterone on craniofacial growth in boys with delayed puberty. Eur J Orthodontics 1999;21:137-43.
6. Hass AD, Simmons K, Davenport ML, Proffit WR: The effect of growth hormone on craniofacial growth and dental maturation in Turner's syndrome. Angle Orthodontist 2001; 71:50-9.

XII. Genetics and Orthodontics
1. Rice DP. Craniofacial anomalies: from development to molecular pathogenesis. Curr Mol Med 2005;5(7):699-722.
2. Lidral AC, Moreno LM. Progress toward discerning the genetics of cleft lip. Curr Opin Pediatr 2005; 17(6):731-739.
3. Shprintzen RJ, Higgins AM, Antshel K, Fremont W, Roizen N, Kates W. Velo-cardio-facial syndrome. Curr Opin Pediatr 2005; 17(6):725-730.

XIII. Syndromes
1. R.J. Gorlin, L.S. Leviv, M.M. Cohen: Syndromes of the head and neck. 4th ed. Oxford University Press 2001; pp. 33-37, 54-58, 249-252, 641-646, 649-651, 654-659, 700-705, 709.
2. J. Spranger, K. Benirscchke, J.G. Hall, W. Lenz, R.B. Lowry, J.M. Opitz et al: Errors of morphogenesis: concepts and terms. J Paediatr 100: 160-165, 1982.
3. G.H. Sperber: Craniofacial Embryology. Dental practitioner handbook, 4th ed., 1989.

XIV. Clefts – Development and Etiology
*1. *Gorlin RJ, Cohen MM, Hennekam RCM. Syndromes of The Head and Neck, 4th ed. Oxford. 2001. Orofacial clefting syndromes: general aspects: Chap. 20, pp.850-860, 860-864.*
*2. *W.Proffit and H.W.Fields: Contemporary Orthodontics. Mosby Co., 3rd ed, 2000. Ch.3: Early stages of development pp.63-69.*
3. R.T. Gorlin, R.C.M. Henneken and M.M. Cohen: Syndromes of the head and neck. Oxford University Press 4th ed, 2001, Chapter 2: Teratogenic Agents: Folate antagonists, Hydantoin embryopathy, Hyperthermic embryopathy, pp. 20-22, Retinoid embryopathy, pp.24-25, 33.
4. R.J.Gorlin, J.Cervenka and S.Pruzansky: Facial clefting and its syndromes. Birth Defects: Original Article Series. Vol. VII, No.7, pp.3-14; June 1971.
*5. *Wantia N, Rettinger G: The current understanding of cleft lip malformation. Facial Plast Surg. 18: 147-153, 2002.*
6. J.B.Thornton, S.Nimer,S.P.Howard: The incidence, classification, etiology and embryology of oral clefts. Seminars Orthod 2:162-168, 1996.
7. Heidbuchel KLWM, Kuijpers-Jagtman AM and Freihofer HPM. Facial growth in patients with bilateral cleft lip and palate: a cephalometric study. Cleft Palate-Craniofacial J 31:210-216, 1994.
8. da Silva Filho OG, Carvalho Lauris R, Capelozza Filho L, Semb G. Craniofacial morphology in adult patients with unoperated complete bilateral cleft lip and palate. Cleft Palate-Craniofac J 35:111-119, 1998.
9. da Silva Filho OG, de Castro Machado FM, de Andrade AC, de Souza Freitas JA, Bishara SE. Upper dental arch morphology of adult unoperated complete bilateral cleft lip and palate. AJODO 114:154-161, 1998.
10. McCance AM, Roberts-Harry D, Sherrif M, Mars M, Houston WJ. A study model analysis of adult unoperated Sri Lankans with cleft lip and palate. Cleft Palate J 27:146-154, 1990.

XV. Embryology of the craniofacial system
1. Brugman SA et al. The molecular origins of species-specific facial pattern. Current Topics in Developmental Biology 2006;73:1-46.
2. Suri M. Craniofacial syndromes. Seminars in Fetal and Neonatal Medicine 2005;10:243-257.
3. Ferguson MW. Palate development. Development 1988; suppl. 103:41-60.
4. The craniofacial complex in any Human Embryology book.

**Included in the mandatory reading list of the Israeli Scientific Council*

Additional Reading Material:
None

Course/Module evaluation:
End of year written/oral examination 100 %
Presentation 0 %
Participation in Tutorials 0 %
Project work 0 %
Assignments 0 %
Reports 0 %
Research project 0 %
Quizzes 0 %
Other 0 %

Additional information:
None