

1 **ANAT2300 - Vertebrate Development A Lecture 6**

School of Medical Sciences
The University of New South Wales

Dr Mark Hill

Cell Biology Laboratory
Room G20 Wallace Wurth Building
Email: m.hill@unsw.edu.au

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3 **Lecture Overview**

- Mesoderm Development
 - axial process
 - mesoderm
 - partitioning and segmentation
 - adult mesoderm products
 - paraxial mesoderm form somites
 - products of somites
 - musculoskeletal
 - axes
- Limb and Bone development
 - Will cover in other lectures

4 **Mesoderm Formation**

5 **Trilaminar Embryo- Axial Process**

6 **Cell Sorting**

7 **Mesoderm**

- generated from epiblast cells migrating through the primitive streak
 - epiblast cells expressing FGF2(fibroblast growth factor)
- forms a mesenchymal layer between ectoderm and endoderm with notochord down midline
- present before neural tube formation
- divides initially into 3 components
 - paraxial
 - intermediate
 - lateral

8 **Intermediate Mesoderm**

- lies between paraxial and lateral mesoderm
- generates urogenital system
- Wolffian duct, kidney
 - covered in Vertebrate Development B

9 **Lateral Plate Mesoderm**

- intraembryonic coelom divides into 2 parts
 - at approximately day 18-19
- Intraembryonic coelom
 - forms 3 body cavities- pericardial, pleural, peritoneal
- Splanchnic
 - generates heart and smooth muscle of GIT and blood vessels

- Somatic
 - generates body wall osteogenic, chondrogenic and fibrogenic
 - except ribs and scapula

10 ☐☐☐ Lateral Plate Mesoderm

11 ☐☐☐ Mesoderm

12 ☐☐☐ Paraxial Mesoderm

- lies adjacent to notochord
- forms 2 components
 - Head
 - unsegmented paraxial mesoderm
 - Body
 - segmented paraxial mesoderm
- Generates
 - trunk muscles, skeleton, dermis of skin, blood vessels, connective tissue

13 ☐☐☐ Segmented Paraxial Mesoderm

- segments called somites
 - first pair of somites (day 20)
- segmentation imposes a pattern on
 - nerves, vasculature, vertebra....
- somites appear in ordered sequence cranial to caudal
 - appearance so regular used to stage the embryo
 - Hamburger & Hamilton 1951- chicken
 - thought to be generated by a “clock”
 - 1 pair every 90 minutes
 - neural tube begins to close at 4th somite level
 - 44 pairs of somites

14 ☐☐☐ Somite Formation

15 ☐☐☐ Somitomere to Somite

16 ☐☐☐ Chicken

- Stages
 - regular appearance of somites allowed early experimenters to accurately stage the embryo
- Advantages
 - Accessible
 - easy to manipulate
 - limb grafts/removal
 - Eye, notochord
 - chimeras
 - developmental processes

17 ☐☐☐ Chicken

- taxon-Gallus gallus
 - develops and hatches in 20-21 days
 - Fertilized eggs easily maintained in humidified incubators
- Embryo Staged growth
 - Series of Embryonic Chicken Growth
 - Hamburger & Hamilton J. Morphology, 88 49 - 92, 1951
 - See also UNSW Embryo
 - /OtherEmb/chick1.htm

18 ☐☐☐ Somites

19 ☐☐☐ Somite formation in *Xenopus* ☐

20 ☐☐☐ Paraxial Segmentation

21 ☐ Stage 13/14 Embryo

22 ☐ Somites

- ball forms through epithelialization and
- interactions
 - cell-cell
 - cell-extracellular matrix (ECM)
 - fibronectin, laminin
- has 2 populations of cells
 - peripheral columnar
 - central mesenchymal
- early somite has cavity- somitocoel
 - cavity is lost
 - will contribute to sclerotome
- somite enclosed by ECM connected to nearby tissues

23 ☐ Somite Specification

- Different segmental level somites have to generate different segmental body structures?
- somite has to form different tissues?

24 ☐ Segmental Plate Mesoderm

25 ☐ Somite Differentiation

- Compartmentalization accompanied by altered patterns of expression of Pax genes within the somite
- forms 2 main components
- ventral- sclerotome
 - forms vertebral body and intervertebral disc
- dorsal- dermomyotome
 - forms dermis and skeletal muscle

26 ☐ Somite Axial Specification

- rostral-caudal axis appears regulated by Pax/Hox expression
 - family of DNA binding transcription factors

27 ☐ Sclerotome

- sclerotome later becomes subdivided
- rostral and caudal halves separated laterally by von Ebner's fissure
 - half somites contribute to a single vertebral level body
 - other half intervertebral disc
 - therefore final vertebral segmentation "shifts"

28 ☐ Muscle

- MyoD is first expressed in the dorsomedial quadrant of the still epithelial somite whose cells are not yet definitely committed
 - MyoD myoblast determining transcription factor
 - basic Helix Loop Helix
- form myotome

29 Myotome

- epaxial myotome
 - dorsomedial quarter
 - dorsal epimere (erector spinae)
- hypaxial myotome
 - dorsolateral quarter
 - ventral hypomere
 - 3 primary muscle layers
 - different at neck, thorax and abdomen

30 Chick Embryo Mesoderm

31 Body Musculature

32 Myotome derivatives-mouse embryo

33 Lateral Plate Mesoderm

34 Limb Musculature

35 Dermomyotome- Muscle (MyoD)

36 MyoD Pax 3

37 Somite Differentiation

- migrating neural crest cells enter cranial half
 - Will form DRG
- sclerotome bulges ventro-medially towards notochord
- then surround and engulf notochord
 - not movement of sclerotome
 - growth of surrounding tissues
- notochord forming nucleus pulposus of IVD

38 Dermomyotome


- lateral myotome edge migrates at level of limbs
 - upper limb first then lower
 - mixes with somatic mesoderm
 - dermatome continues to contribute cells to myotome

39 Muscle Development Abnormalities

- Duchenne Muscular Dystrophy
 - Embryonic muscle development normal
 - Changes occur postnatally
 - X-linked dystrophy
 - large gene encoding cytoskeletal protein
 - Dystrophin
 - progressive wasting of muscle
 - die late teens
- Becker Muscular Dystrophy
 - milder form
 - adult onset

40 Axial Segmentation

41  Somite Specification Signals

42  UNSW Embryology pages

- Week 3 Development
 - <http://anatomy.med.unsw.edu.au/cbl/embryo/Notes/week3.htm>
- Week 4 Development
 - <http://anatomy.med.unsw.edu.au/cbl/embryo/Notes/week3.htm>
- Week 4 Movies
 - <http://anatomy.med.unsw.edu.au/cbl/embryo/Movies/week4.htm>
- Skeletal Muscle Development
 - <http://anatomy.med.unsw.edu.au/cbl/embryo/Notes/skmus.htm>
- Abnormalities
 - <http://anatomy.med.unsw.edu.au/cbl/embryo/Notes/skmus2.htm#abnormal>

43  Mesoderm induction in *Xenopus* 