SCRUBS

STUDENT COLLABORATIVE RESOURCES FOR UNDERSTANDING AND BRODY SUCCESS

SCRUBS is a student driven initiative that aims to develop supplemental resources for current and future cohorts that will pass through Brody. Members of **SCRUBS** participate in a variety of sub-committees working to create resources for students, by students. These resources aim to offer unique perspectives from students who have walked in the same shoes and can develop resources that we wish we had been exposed to during our time in the course.

The hope is this organization will become a staple of the Brody student body, exemplifying the unique collaborative community that Brody offers. If this is a mission that aligns with your goals and you have the desire to help those that will come behind you, as well as a goal to leave your mark on Brody as a whole, we invite you to join the team!

Disclaimer:

The resources that are included in this document are made by students and not the faculty. As such, there is the possibility for errors in our development, although this is mitigated via a team approach to development with multiple stages of vetting. If there is a contradiction with the coursework presented within your course, please go by the course documents. Additionally, **SCRUBS** aims to supply ***supplemental resources***, however these are in no way replacements to the instruction of the Brody faculty. Use these resources as a supplement, but not as your primary source for course material.

Coursepack Practice Questions

Embryology Chapter 12 - Genital System

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Quiz Level

1. Which of the following structures is NOT present in the developing ovary?

A) Secondary Follicles
B) Cortical Cords
C) Primordial follicles
D) Oogonia
E) Primary Oocytes

2. Which letter corresponds to the part of the male external genitalia derived from surface ectoderm fusing along the anterior surface of the penis?

A) Penile (spongy) urethra
B) Scrotum
C) Scrotal raphe
D) Prepuce (foreskin)
E) Penile raphe

3. All the following are derivatives of the mesonephric ducts except:

A) Duct of Gartner
B) Efferent Ductules
C) Ductus Deferens
D) Ejaculatory Duct
E) Epididymis
F) Seminal Gland

4. Fill in the blanks: The gonads descend dependent on the formation of the _____, a retroperitoneal ligamentous cord that connects from the gonads to the fascia in the labioscrotal swellings. In the female, this structure has two remnants: superiorly, the _____, and inferiorly, the _____.

A) Inguinal ligament; Inguinal canal; Round Ligament of the Uterus
B) Gubernaculum; Tunica Vaginalis; Tunica Albuginea
C) Gubernaculum; Ovarian Ligament; Round Ligament of the Uterus
D) Inguinal Canal; Processus Vaginalis; Tunica Vaginalis
E) Gubernaculum; Round Ligament of the Uterus; Ovarian Ligament

5. Why do the ovaries differentiate later in development than male testes?

A) Growth inhibition signals from the polar bodies of the cells in the indifferent gonad slow their development
B) The testes must begin to form and then regress before ovaries can form
C) Ovaries form in the absence of testis-differentiation signals, so their development must begin after testes to ensure no such signal is present
D) An adequate number of the primordial germ cells must differentiate into oogonia before the ovary can begin development
E) Estrogen and progesterone are not produced until late in the 8th week of development; these hormones are responsible for ovarian differentiation and so the ovary cannot develop until after this time.

Test Level

6. Correctly match the three sources contributing to the development of indifferent gonads with their derivatives:

A) Endoderm – medulla; Ectoderm – cortex; Neuroectoderm – spermatogonia/oogonia
B) Mesothelium - cortex; Mesenchyme – medulla; Primordial Germ Cells – spermatogonia/oogonia
C) Mesothelium – medulla; Mesenchyme – cortex; Primordial Germ Cells – spermatogonia/oogonia
D) Ectoderm – cortex; Mesoderm – medulla; Endoderm – spermatogonia/oogonia
E) Endoderm – medulla; Mesoderm – cortex; Neuroectoderm – spermatogonia/oogonia

7. Which of the following does NOT occur under the direction of SRY during the embryonic development of testes?

A) Leydig cells develop from mesenchymal cells in the gonadal ridges and begin producing testosterone.
B) Gonadal cords extend into the medulla, branch, and anastomose to form the rete testes.
C) Sertoli cells differentiate within the gonadal cords and help to form seminiferous cords with the spermatogonia.
D) Sertoli cells secrete AMH/MIS, which suppresses further development of the paramesonephric ducts.
E) The seminiferous cords develop lumina and become seminiferous tubules.
F) The tunica albuginea develops between the gonad and the surface epithelium.

8. The paramesonephric ducts contribute to the development of much of the female genital tract. Which answer choice correctly correlates the portion of the female genital tract with its precursor?

A) The cranial portions of the paramesonephric ducts give rise to the suspensory ligaments of the ovary
B) The fusion of the caudal portion of the paramesonephric ducts creates the lower part of the vagina
C)The broad ligament of the uterus forms from remnants of the mesonephric duct as it regresses/degrades
D) The urethral, paraurethral, and greater vestibular glands form from endodermal outgrowths from the pelvic region of the urogenital sinus
E) The sinus tubercle develops with the fusing paramesonephric ducts to form the cervix – separating the uterus from the vaginal canal

9. A female patient presents to clinic for her first ultrasound appointment after becoming pregnant. During the ultrasound, her physician notices that her uterus does not present normally. The patient's uterus has a more heart-like shape than normal and has two uterine horns. What is the correct diagnosis for the patient's developmental anomaly, and how does it occur?

A) Septate uterus from incomplete degradation of the uterine septum
B) Bicornuate uterus from only one paramesonephric duct developing
C) Unicornuate uterus from anomalous fusion of the paramesonephric ducts
D) Bicornuate uterus from anomalous fusion of the paramesonephric ducts
E) Unicornuate uterus from only one paramesonephric duct developing

10. A family with limited previous access to medical care is attempting to toilet train their young son, but the child seems to have extensive difficulty aiming when trying to urinate. After having a physical exam performed at the pediatrician's office, the physician noted that the child had a penile developmental abnormality correlating with the external urethral orifice opening in an anomalous location along the anterior surface of the penis. What is the name of this abnormality?

A) Hypospadias
B) Cryptorchidism
C) Ectopic Testis
D) Epispadias
E) Androgen Insensitivity Syndrome

Bonus Questions

11. Place the following events in the correct chronological order regarding the development of indifferent external genitalia:

1) The cloacal folds become either urogenital folds or anal folds
2) The genital tubercle develops from mesenchyme at the anterior end of the cloacal membrane
3) The urorectal septum unites with the cloacal membrane, creating an anterior urogenital membrane and a posterior anal membrane
4) Labioscrotal swellings appear, and the genital tubercle enlarges to form a phallus
5) The urogenital and anal membranes rupture, forming the urogenital orifice and the anal orifice.
6) Cloacal folds form on either side of the cloacal membrane

A) 6, 2, 3, 5, 1, 4
B) 5, 3, 6, 1, 4, 2
C) 4, 1, 5, 2, 3, 6
D) 2, 6, 5, 3, 1, 4
E) 6, 2, 3, 1, 5, 4

12. Which answer shows the female external genitalia matched with its primordial structure:

A) The labia minora is derived from unfused labioscrotal folds
B) The anterior labial commissure, mons pubis, and posterior labial commissure are all derived from the urogenital folds
C) The labia majora is derived from the fusion of urogenital folds
D) The clitoris is derived from the phallus
E) The frenulum of the clitoris is derived from the phallus

13. The parents of a newborn infant are surprised when the physician proudly states “Congratulations, you have a baby boy!” while laying the child on the mother’s chest. They had been told after previous screens that they would be having a girl. It was then discovered that the newborn had congenital adrenal hyperplasia, ovarian tissue present, but male appearing genitals. What was the infant’s presentation?

A) True Gonadal Intersex
B) 46 XX Intersex
C) 46 XY Intersex
D) Androgen Insensitivity Syndrome
E) Male Pseudohermaphroditism

Answers

1. The correct answer is A: Secondary Follicles.
Secondary follicles develop during puberty when a primary follicle undergoes further meiotic division; therefore, they would not be present in a developing ovary. Ovarian development begins with the development of cortical cords (B). Oogonia (D) go through mitosis, they then enter meiosis and become primary oocytes (E), which are then surrounded by epithelial cells from the cortical cords and called primordial follicles (C). Meiosis is arrested in prophase of meiosis 1 until puberty.

2. The correct answer is E: Penile Raphe.
This is derived from surface ectoderm which fuses along the anterior surface of the penis (remember your anatomical position!). The penis itself is a derivative of the phallus. The penile (spongy) urethra (A) is formed from the fusion of the urogenital folds around the phallic urogenital sinus. The scrotum (B) is derived from the labioscrotal swellings, which grow medially and fuse. This line of fusion is the scrotal raphe (C). The prepuce (foreskin) (D), while an ectoderm derivative, is an ingrowth at the periphery of the glans penis – it is not considered a fusion along the anterior surface of the penis.

3. The correct answer is B: Efferent Ductules.
The efferent ductules are derivatives of the remaining mesonephric **tubules** (derivatives of the degrading mesonephric kidney – they connected the renal corpuscles to the mesonephric duct prior to the development of the metanephrogenic kidney). The epididymis (E), ductus deferens (C), seminal gland (F), and ejaculatory duct (D) are all male derivatives of the mesonephric duct. The Duct of Gartner (A) is an uncommon vestigial remnant of the mesonephric duct that can occur in females (see the chart on page 229 in the coursepack).

4. The correct answer is C: Gubernaculum; Ovarian Ligament; Round Ligament of the Uterus.
In both sexes, the gubernaculum develops and spans from the indifferent gonad superiorly to the fascia of the labioscrotal swellings inferiorly. In males, the gonad is pulled down by this ligament and the processus vaginalis descends anteriorly (crossing anterior to ureter and carrying vas deferens/testicular vessels with it). In females, the ovaries become attached to the broad ligament during descent. Therefore, the superior portion of the gubernaculum remains as the ovarian ligament (connecting the superior gonad with the uterus) and the inferior gubernaculum remains as the round ligament of the uterus (connecting the uterus with the fascia of the labioscrotal swelling – labia majora).

5. The correct answer is C: Ovaries form in the absence of testis-differentiation signals, so their development must begin after testes to ensure no such signal is present.
Female genital development is the “default” for every embryo except in the presence of SRY/TDF, which is only present in male development. A, B, and D are all false statements and do not occur during development. E is false because, while estrogen and progesterone are eventually produced by cells in the ovary, they do not play a role in the development of the ovary itself. They may play a role in the development of female external genitalia, but this is not confirmed.

6. The Correct answer is B: Mesothelium - cortex; Mesenchyme – medulla; Primordial Germ Cells – spermatogonia/oogonia.
The three sources that contribute to the gonadal ridge (mesothelium, mesenchyme, and primordial germ cells) are what then contribute to the development of the indifferent gonad. Mesothelium and Mesenchyme are both intermediate mesoderm derivatives, so any answer choices that list either the cortex or medulla of the gonad as being from a different germ layer are incorrect (A, D, and E). C incorrectly swapped the derivatives of Mesothelium and Mesenchyme in the indifferent gonad.

7. The correct answer is E: The seminiferous cords develop lumina and become seminiferous tubules.
While the seminiferous tubules are the direct derivative of the seminiferous cords, this is incorrect as this process is not directed by SRY and does not occur during embryonic development. This process is triggered by puberty. All other answer choices are correct processes that are directed by SRY/TDF in the developing fetus.

8. The correct answer is D: The urethral, paraurethral, and greater vestibular glands form from endodermal outgrowths from the pelvic region of the urogenital sinus.
A is incorrect as the cranial portions of the paramesonephric ducts form the uterine tubes. B is incorrect because the fusing paramesonephric ducts form the uterus and upper part of the vagina; the lower part of the vagina forms when the fused paramesonephric duct contacts the sinus tubercle, which induces sinovaginal bulb and vaginal plate formation. The vaginal plate is what canalizes and directly becomes the lower vagina. This is also why E is incorrect, as the cervix is a paramesonephric duct derivative – it is not from the sinus tubercle. Finally, C is incorrect because the broad ligament of the uterus is also formed from the fusion of the paramesonephric ducts; it separates the lower peritoneal cavity into vesicouterine and rectouterine pouches.

9. The correct answer is D: Bicornuate uterus from anomalous fusion of the paramesonephric ducts.
This anomaly presents with a heart-shaped uterus with two uterine horns. A is a correct statement but does not apply to this patient as her uterus does not have a persistent septum dividing it in half. B and C are both incorrect statements. E is a correct statement but does not apply to this patient as she has both sides of her uterus present. A unicornuate uterus is where only one paramesonephric duct forms, corresponding to only half the uterus being able to form. This condition is also commonly associated with unilateral renal agenesis due to failure of the mesonephric duct to develop on the same side.

10. The correct answer isvA: Hypospadias.
The most common penile anomaly is hypospadias, where the external urethral orifice opens anteriorly on the penis due to failure of urogenital fold fusion. Cryptorchism (B) is incorrect as this condition is related to the failure of the testes to descend – they remain in the abdominal cavity along the line they would descend. Ectopic testis (C) is incorrect as it is again related to the testis being located in an anomalous location, not the location of the external urethral orifice. Epispadias is incorrect as it is the condition where the external urethral orifice opens on the posterior surface of the penis. Androgen Insensitivity Syndrome is incorrect because it relates to the development of a biological male (XY) individual's external presentation to appear more feminine (not just the external genitalia) and is caused by a defect in the androgen receptors. While hypospadias is correlated with inadequate production of androgens/mutated androgen receptors, it is specifically caused by mutation only in the receptors of the urogenital folds. Androgen Insensitivity Syndrome impacts the entire body.

11. The correct answer is A: 6, 2, 3, 5, 1, 4.
First, cloacal folds form on either side of the cloacal membrane. Then, the genital tubercle forms from proliferating mesenchyme anteriorly. The urorectal septum will then join with the cloacal membrane, making the urogenital and anal membranes. These membranes will then rupture about a week later. At this point, the former cloacal folds around the urogenital orifice are called the urogenital folds, and the former cloacal folds around the anal orifice are called the anal folds. Finally, labioscrotal swellings appear lateral to the urogenital folds and the genital tubercle will also enlarge to form the phallus. All other choices depicted an incorrect order of events.

12. The correct answer is D: The clitoris is derived from the phallus.
The labia minora (A) is derived from unfused urogenital folds, the labia majora (C) is derived from unfused labioscrotal folds, the frenulum of the clitoris (E) is from the anterior fusion of the urogenital folds, and the posterior/anterior commissures and mons pubis (B) are all derivatives of the fused portions of the labioscrotal folds.

13. The correct answer is B: 46 XX Intersex.
This condition is most commonly caused by congenital adrenal hyperplasia (adrenal glands produce excessive androgens leading to clitoral hypertrophy, partial fusion of the labia majora, and other anomalies that give the external genitalia a male appearance). The infant is not true gonadal intersex (A) because only ovaries were present; true gonadal intersex individuals are very rare and have both ovarian and testicular tissues present. 46 XY Intersex (C), Androgen Insensitivity Syndrome (D), and Male Pseudohermaphroditism (E) all describe individuals that have XY chromosomes, testicles, but externally female-appearing genitalia.