Pelvis and Perineum Take-Home Worksheet (Do between Pelvis lectures 2 and 3)
Dr. Darren Hoffmann

Objectives:

*After completing this Worksheet, you should be able to:*
- Visualize the pelvis in 3D, displaying knowledge of the relationships of muscles, bones, and neurovasculature.
- Differentiate a male and female pelvis purely based on skeletal anatomy.
- Create a simple line drawing of the vascular tree in the pelvis and attribute distribution areas to each branch.
- Identify the spinal levels of origin for each listed branch of the Sacral plexus and Coccygeal plexus and name the structures/areas supplied by those branches.
- Describe the pathway of the Pudendal nerve from the Sacral plexus to the structures of the Urogenital triangle, making note of key anatomical features along the path.
- Identify the surfaces of the peritoneum within the pelvis and their relationships to the main pelvic organs.
- Apply your understanding of urination and defecation to disease states and explain the pathways verbally.

Worksheet Approach

This worksheet is designed to be a guided exploration through several topics in Pelvic anatomy. These are topics that I think you can learn well on your own, with a little bit of direction from me. The only skills you must have to complete this assignment are the ability to read and use resources to find information.

The exercises in this worksheet are interactive, so I’d recommend printing off a copy of this handout for you to draw/write on or fire up your note-taking app on your computer and save an editable copy. The information that you gather and learn as you complete this worksheet will be used repeatedly in the upcoming Pelvis and Lower Limb lectures, so it is important that you complete this assignment and take it seriously. The information in this handout IS considered testable content.

If you’d like to have answers to any of these questions, feel free to ask me! Or ask each other. Or ask the internet. Whatever gets the job done quicker for you.
I. Pelvis Major Concepts (in case you missed them...)
If you’re a little unsure about the structural concepts of the bony and muscular components of the pelvis or the pathway of the pudendal nerve to the perineum (Pelvis and Perineum Basics Lecture), have a watch-through of these three Gale Interactive Sessions:
   “Bones of the Pelvis”
   “Pelvic Walls and Floor”
   “Perineum and Pudendal Nerve”

If you’re still not sure if you got the gist of this material, have a look at these review and reflection questions. You should be able to answer these based on the Basics lecture and the three Gale Interactive Sessions.

1. Which muscles make up the lateral walls of the pelvis?

2. Which muscles make up the floor of the pelvis?

3. As the Pudendal nerve passes out of the Pelvic cavity through the Greater sciatic foramen, which ligament is posterior to it, and which ligament is anterior to it?

4. Which muscle does the Pudendal nerve pass alongside as it runs from the anal triangle to the urogenital triangle? (This is where bike seat compression can occur.)

5. What are the muscles of the pelvic floor?

6. Which muscle of the pelvis looks like an L, with a muscular portion which turns around a bone and becomes a tendinous portion?
II. Male – Female Bony Pelvis Comparison

Male and Female Pelves are composed of the same bones, but the arrangement is slightly different in order to accommodate childbirth in women. A whole bony pelvis has enough visual information in it to determine whether the skeleton it belongs to is male or female, something that Anthropologists use routinely in examining human remains. Below are representative images of male and female pelves side by side.

There are at least 4 ways to differentiate a male pelvis from a female pelvis. Take a look at the images provided below and use your eyes and a straight-edge of some kind to determine how each criterion applies to the male and female pelves.

1. *Greater Pelvis Depth*
   - The Greater pelvis is deeper and narrower in ________________.
   - The Greater pelvis is shallower and wider in ________________.

2. *The Infrapubic Angle* (angle between pubic bones)
   - The Infrapublic angle is larger in ________________.
   - The Infrapublic angle is smaller in ________________.

3. *The Pelvic Outlet* (Interspinous distance)
   - The Interspinous distance is smaller in ________________.
   - The Interspinous distance is larger in ________________.

4. *Pelvic Inlet Shape*
   - The Pelvic inlet is more heart shaped in ________________.
   - The Pelvic inlet is more rounded in ________________.

Male Pelvis Images

Female Pelvis Images

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III. Defining Territories of Pelvic Arteries and Nerves in **THREE CONCEPTS**

The specific branching patterns of Pelvic arteries and nerves tend to be variable and unreliable, so memorizing a detailed map of the branching tree is not necessary for this course. Instead we will make generalizations about groups of blood vessels, look at typical branching sequences and focus more on the distribution areas as a way to define the identity of an artery or nerve.

**Concept #1: Pelvic Arteries and Nerves originate from the Pelvic walls**

Very few atlas images do justice to the 3D relationships of the Pelvic Arteries and Nerves. You will be exploring them in dissection over the next couple weeks, but at this stage in the game, I want you to understand where the main origins of these structures are situated within the bowl-shape of the pelvis. I’ve prepared a short video demo of these structures and some of their main branches using Cyber-Anatomy.

**Your task** for this concept is to view two Gale Interactive sessions:

“Internal Iliac Artery”
“Sacral Plexus”

and answer the following review questions to make sure you understand some of the key ideas.

**Review and Reflection Questions:**

1. In the pelvis, which is more lateral? Sacral nerve plexus or Internal Iliac arterial system?

2. Which structure lays in direct contact with the Piriformis muscle?
   - a. Coccygeal nerve plexus
   - b. Sacral nerve plexus
   - c. External iliac artery
   - d. Internal iliac artery

3. An artery which exits the pelvis through the greater sciatic foramen ABOVE Piriformis is:
   - a. Obturator artery
   - b. Internal pudendal artery
   - c. Superior vesical artery
   - d. Superior gluteal artery

4. Which of the following are NOT contained within the nerves of the sacral plexus?
   - a. Sensory nerve fibers to the skin of the perineum
   - b. Motor nerve fibers to muscles of the lower limb
   - c. Parasympathetic fibers to pelvic organs
   - d. Sympathetic fibers to the hindgut
**Concept #2: The Pelvic Arteries are divided into two divisions with generalizable territories**

The majority of the Pelvis is supplied by branches of the Internal iliac artery. The Internal iliac artery branches from the Common iliac artery around L4-L5 and then descends into the Lesser (true) pelvis. Once there, it divides into two main divisions:

- **Anterior Division:** The blood supply of Pelvic Viscera and the Perineum
- **Posterior Division:** The blood supply of the muscles of the Pelvic walls, floor and Gluteal region

**Your task** for this concept is to learn the distribution areas of each of the main arteries of the Anterior and Posterior divisions of the Internal iliac arteries. The chart on page 222 of your textbook (Essential Clinical Anatomy) is a great resource for this, but with charts, students routinely miss the point and “over-memorize” the unnecessary details. I’ve listed below a brief, more conceptual way of understanding each artery’s territory. If however, you must memorize every detail, be my guest, that’s what your textbook is for 😊

**Anterior division branches** (listed in typical branching order from superior to inferior):

<table>
<thead>
<tr>
<th>Structures supplied</th>
</tr>
</thead>
<tbody>
<tr>
<td>Umbilical a.</td>
</tr>
<tr>
<td>Placenta during fetal life</td>
</tr>
<tr>
<td>Obturator a.</td>
</tr>
<tr>
<td>Obturator muscles, head of Femur, Ilium bone</td>
</tr>
<tr>
<td>Superior vesical a.</td>
</tr>
<tr>
<td>Superior bladder</td>
</tr>
<tr>
<td>Ductus deferens a.</td>
</tr>
<tr>
<td>Ductus deferens</td>
</tr>
<tr>
<td>Inferior vesical a. (male)</td>
</tr>
<tr>
<td>Inferior bladder/ureter, Seminal vesicle, Prostate</td>
</tr>
<tr>
<td>Uterine a. (female)</td>
</tr>
<tr>
<td>Inferior bladder/ureter, Uterus, Uterine tubes, Vagina</td>
</tr>
<tr>
<td>Middle rectal a.</td>
</tr>
<tr>
<td>Rectum (some anastomoses with other pelvic organs)</td>
</tr>
<tr>
<td>Internal pudendal a.</td>
</tr>
<tr>
<td>Perineum</td>
</tr>
<tr>
<td>(Internal pudendal a. is the end of the road for the Anterior division)</td>
</tr>
</tbody>
</table>

**Posterior division branches** (listed in the typical branching order from superior to inferior):

<table>
<thead>
<tr>
<th>Structures supplied</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iliolumbar a.</td>
</tr>
<tr>
<td>Posterior abdominal wall muscles</td>
</tr>
<tr>
<td>Lateral sacral a.</td>
</tr>
<tr>
<td>Piriformis and vertebral canal</td>
</tr>
<tr>
<td>Superior gluteal a.</td>
</tr>
<tr>
<td>Gluteal muscles</td>
</tr>
<tr>
<td>Inferior gluteal a.</td>
</tr>
<tr>
<td>Piriformis, Levator ani, Coccygeus and Gluteal muscles</td>
</tr>
<tr>
<td>(Inferior gluteal a. is the end of the road for the Posterior division)</td>
</tr>
</tbody>
</table>

*ERROR IN TEXT: Your text lists Inferior gluteal a. as being part of the Anterior division, but I think it looks like it comes from Posterior division or at least it could go either way, and it makes more sense functionally to group it with the Posterior division.*
Concept #3: The Pelvic Somatic Nerves are a small subset of the Sacral and Coccygeal Plexus nerves

The Somatic nerves of the pelvis originate from two collections of ventral rami called the Sacral Plexus and Coccygeal Plexus. The spinal levels that contribute to these plexuses are not immediately intuitive based on the names alone:

- **The Sacral Plexus** is made of Ventral rami from L4-S4
- **The Coccygeal Plexus** is made of Ventral rami from S4, S5 and the Coccygeal nerves (number of coccygeal nerves is unknown and likely variable)

Since most of these nerves supply lower limb structures, and you will study them in greater detail in Unit 2, you do not need to know the distributions of all the sacral plexus nerves!

Your task is to learn the distributions of only two: the Pudendal nerve and Coccygeal nerves. If you’d like to learn about the other sacral plexus branches now, pages 217 and 218 of your textbook (Essential Clinical Anatomy) have helpful text and a chart that will put it all together.

### Sacral and Coccygeal plexus branches

<table>
<thead>
<tr>
<th>Structure</th>
<th>Spinal Levels</th>
<th>Structures Supplied</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sciatic n.</td>
<td>L4-S3</td>
<td>Motor to muscles of perineum, including External anal/urethral sphincters</td>
</tr>
<tr>
<td>Superior Gluteal n.</td>
<td>L4-S1</td>
<td>Sensation to skin of perineum</td>
</tr>
<tr>
<td>Inferior Gluteal n.</td>
<td>L5-S2</td>
<td></td>
</tr>
<tr>
<td>Nerves to the lateral hip rotators</td>
<td>L5-S2</td>
<td></td>
</tr>
<tr>
<td>(piriformis, QF, IG, OI, SG — consider these as a group)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Posterior femoral cutaneous n.</td>
<td>S2-S3</td>
<td></td>
</tr>
<tr>
<td><strong>Pudendal n.</strong></td>
<td>S2-S4</td>
<td>Motor to Levator ani, coccygeus, Sensory to Bullseye skin area on the dermatome map (between anus and coccyx)</td>
</tr>
</tbody>
</table>

Coccygeal nn. S3-S5, Cx

### Helpful Hint!!!

on Learning Distributions of Nerves and Arteries:

- **Step 1:** Get your facts straight and clearly organized (I’ve done this for you in these charts)
- **Step 2:** Use flashcards for drilling and practice (nerve on one side, distribution on the other)
- **Step 3:** Work forwards and backwards (nerve to distribution, distribution to nerve)
- **Step 4:** Use the cadaver as an integrative test. Every skin surface you can see, you should be able to name the nerve/artery which supplies it. Every muscle you can see, you should be able to name the nerve which supplies it. Tour the cadaver with nerves in mind. You’ll master lecture and lab at the same time!

This method is fool-proof. Use it here. Use it again and again in this course. You can thank me later.
IV. Peritoneal Fossae
Let us not forget the organs of the pelvis and the pelvic nerves and blood vessels are almost all housed within the sub-peritoneal space (see Most Important Drawing of Your Life Figure Below). The peritoneum of the abdominal cavity blankets the organs of the pelvis creating many folds and fossae. In this exercise, you will examine a series of atlas images and attach names to each of the different folds and fossae in the peritoneum.

A. Key vocabulary for peritoneal folds and fossae
In order to understand why these folds are called what they are, it’s important to understand the vocabulary of the root words contained within. Define each of the five root words listed below. If you don’t know them off the top of your head, use the handy List of Medical Roots, Suffixes and Prefixes on Wikipedia. ([http://en.wikipedia.org/wiki/List_of_medical_roots,_suffixes_and_prefixes](http://en.wikipedia.org/wiki/List_of_medical_roots,_suffixes_and_prefixes))

Para:

Supra:

Recto:

Utero:

Vesico:
B. Lateral View
On the male and female mid-sagittal views of pelvic organs shown at right, identify the following spaces:

- Vesicouterine Fossa
- Rectouterine Fossa
- Supravesical Fossa
- Rectovesical fossa

These fossae are important to know because fluid in the peritoneal cavity will often run down into the pelvis and collect in these fossae.

*Which of the fossae is the “lowest” or most inferior location in the peritoneal cavity in the female?*

*How about the lowest location in the male?*

C. Superior View
These views are oriented as though you are inside the peritoneal cavity looking down into the pelvis. In addition to the four Fossae listed above, you should be able to identify the peritoneal surfaces alongside the pelvic organs (Paravesical fossa, Pararectal fossa) and the broad curved peritoneal folds (Sacrogenital fold (male) and Rectouterine fold (female)).
V. Urination/Defecation Take Home Assignment Part 1

Read this information about bladder control problems and reflect on how the anatomy you learned in class is related to these conditions.

Damage to the Parasympathetic, Sympathetic or Somatic nerves can cause defects in bladder function

Possible causes of pelvic nerve damage:
- Vaginal childbirth, Meningitis, Diabetes, Stroke, Spinal Cord Injury, Trauma

3 Major Types of Bladder Control Problems

1. **Overactive Bladder**
   - Definition: Bladder contracts suddenly or unexpectedly without warning

   Overactivation of what type of nerves could be involved in this condition?__________________

   Treatment options:
   - Bladder Training
   - Urination journal
   - Electrical Stimulation
   - Botox – paralyze Detrussor muscle
   - Drug therapy
     - Detrol LA, Ditropan XL (patch)
   - Surgery
     - Augmentation cytoplasty

2. **Stress Incontinence**
   - Definition: Uncontrolled leakage of urine during any physical exertion

   Caused by weakness of pelvic floor musculature (lack of support for external urethral sphincter)
   - HUGE medical issue that affects millions of women following childbirth

   Treatment options:
   - Pelvic Floor Muscle retraining - Kegel exercises
     - What muscles and nerves are being strengthened in Kegel Exercises?________________________

   Overactive bladder medications - Reduce bladder outflow

   Structural support
   - Pessary
   - Collagen injections
   - Retropubic suspension of bladder

3. **Urine Retention**
   - Outflow from the bladder is restricted
     - Detrussor cannot contract or urethral sphincters cannot relax

   What nerves could be damaged to cause this condition? ________________________________

   Can lead to ureteric reflux and kidney damage (Urinary tract infection)

   Treatment options:
   - Drug therapies- relax external sphincter - Botox
   - Catheterization- better short term than long term – why?
   - Surgery- resection of part of the urethral sphincter
   - Urinary Diversion- reroute urine to a stoma or reservoir

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Urination/Defecation Take Home Assignment Part 2

Urination Reflex: The Details – A Fill-in-the-blank Review Activity
To make sure you’ve got all of your pathway facts straight, walk through this outline and fill in the blanks with the appropriate responses.

Innervation to the Bladder and the Urination Process

Step 1: Filling of the Bladder
The ureters enter the bladder on the ____________________ surface of the bladder.
Filling of the bladder triggers activation of neurons which sense ____________________.
These neurons return to the CNS by following ____________________.
In this case, the pathway returns to the CNS at these spinal levels ________________.

Step 2: Autonomic Spinal Reflex
In the spinal cord (______ spinal levels), distension afferents cause a spinal reflex which activates ____________________ neurons.
These neurons branch off of the sacral plexus as ____________________ splanchnic nerves.
These branches enter the ____________________ plexus.
These neurons then reach the bladder, synapse and the post-synaptic neuron triggers the ____________________ muscle to contract, squeezing the bladder.
These neurons also constantly inhibit the Internal Urethral Sphincter.
When is the only time the Internal Urethral Sphincter constricts? ________________

Step 3: Somatic Nerves
In addition to activating the reflex, distension afferents also tell the brain that the bladder is full. This activates the “holding it” response that we all learned as part of potty-training.
The primary muscle which “holds it” is the: ____________________
This muscle is innervated by ____________________, which comes from spinal levels ________.
The urethra also has somatic sensation at the distal end. The nerve which confers somatic sensation to the lining of the urethra is ____________________. This nerve is responsible for the burning sensation associated with STI’s.

Defecation Reflex – You’re on your own now
Now that you’ve done the urination process with training wheels on, see if you can create your own narrative describing the sequence of events, both muscular and neurological, that leads to normal defecation.