

What's Included?

Unit Planning

- State & NGSS Standards document
- Unit Pacing Guide for 50 min classes
- Vocabulary terms for prefix/suffix work
- Differentiation ideas for honors students and virtual students ***Digital links for virtual learning found here**
- Honors assignment list

Notes

- Urinary System PPT (18 slides)
- Cornell Note pages (3 pgs)
- Doodle Note pages (3 pgs)
- Answer keys and student examples
- Guide to Using Doodle Notes

Student Pages

- This folder contains duplicate copies of every student page. They are in order according to the pacing guide for QUICK PHOTOCOPYING if you are using the pacing guide as is.

Activities

- Kidney Dissection Lab (5 pgs)
- Microscopy of the Kidney Lab (1 pg)
- Answer keys for all labs

Extensions

- Data Analysis: Fluid Compartments* (1 pg)
- Urinary Homeostasis (2 pgs)
- Digging Deeper: Urinalysis (7 pgs)
- Answer Keys for all Extensions

*Honors Options

Review and Assessment

- Editable Task Card Review (20 cards) with answer sheet
- 3 diagrams- urinary system overview, kidney anatomy, nephron anatomy
- Urinary System Test (paper)- both Honors and Regular versions with answer sheets and keys

Unit Planning:

NGSS and State Standards Document

If your state isn't listed, contact me by email (support@suburbanscience.com) and I'll help you figure out which ones are covered!

| What's Included? | | Urinary |
|-------------------------------|---|--|
| Included Resources by Folder: | Unit Planning <ul style="list-style-type: none"> State & NGSS Standards document Unit Pacing Guide for 50 min classes Vocabulary terms for prefix/suffix work Differentiation ideas for honors students and virtual students *Digital links for virtual learning found here Honors assignment list | |
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| Not included: | Supplementary Resources <ul style="list-style-type: none"> Learn how Dialysis works Learn more details on a urinalysis including gross inspection and how to use a dipstick on a urinalysis sample. Have a medical lab technician as a guest speaker on urinalysis Case Study on Polycystic Kidney Disease | |
| | Materials Needed <ul style="list-style-type: none"> General classroom use: colored pencils, markers, and crayons, index cards for prefixes and suffixes Kidney Dissection Lab: Dissecting tools, trays, gloves, aprons, pig kidneys Kidney Microscopy: Microscope & kidney cross-section slide | |

Unit Overview Page

plus

Supplementary Resource Ideas and Materials Lists

| Standards: | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|--|--------|---|--------|--------|------------|---------------|----|--|----|--|----|---|----|---|----|---|----------------------------------|----|--|----|--|----|--|----|---|----|---|
| Topic: | State: | Standards: | | | | | | | | | | | | | | | | | | | | | | | | | |
| | OH | AP.AE.3 Urine is normally a clear, yellow, sterile solution but the composition can vary slightly between individuals. Urinalysis is a diagnostic tool for detecting substances and conditions in the body. Antidiuretic hormone (ADH) and aldosterone hormones influence the volume and concentration of urine. Caffeine and alcohol act as diuretics and can lead to short or long-term kidney issues. | | | | | | | | | | | | | | | | | | | | | | | | | |
| <p>Choosing Standards: Although many states use NGSS, there are some states that do not. I worked hard to find other state standards, but if yours are not addressed, please send me an email at support@suburbanscience.com and I can help you determine which of your state standards are covered in this unit. Thank you!</p> <p>NGSS for the Unit:</p> <ul style="list-style-type: none"> HS-LS1-2: Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. HS-LS1-3: Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis. | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <p>Topic: State: Standards:</p> <table border="1"> <thead> <tr> <th>Topic:</th> <th>State:</th> <th>Standards:</th> </tr> </thead> <tbody> <tr> <td rowspan="5">Gross Anatomy</td> <td>OH</td> <td>AP.AE.3 The urinary system is a regulatory system that helps maintain homeostasis. The structures of the urinary system include the kidneys, ureters, bladder and urethra. Each kidney consists of the renal cortex, medulla and renal pyramids. The renal pelvis is a funnel-shaped chamber that is connected to the ureter.</td> </tr> <tr> <td>CO</td> <td>Standard XIII, Objectives 1-2 -Examine organs and the general functions of the urinary system. -Identify the gross and microscopic anatomy of the kidneys.</td> </tr> <tr> <td>IN</td> <td>AP.14.3 -Identify and locate major organs of the urinary system and discuss their functions.</td> </tr> <tr> <td>UT</td> <td>Strand 14, Standards 1-3 -Identify the general functions of the urinary system. -Identify the four major organs of the urinary system: kidneys, bladder, ureters, urethra. -Identify the gross anatomy of the kidney: renal cortex, renal medulla, renal pyramids, renal pelvis, renal capsule, calyces.</td> </tr> <tr> <td>FL</td> <td>SC.912.L.14.47 Describe the physiology of urine formation by the kidney.</td> </tr> <tr> <td rowspan="5">Microscopic Anatomy & Physiology</td> <td>OH</td> <td>AP.AE.3 The primary functions of the urinary system are excretion, elimination and regulation of blood volume and pressure. Processes of the urinary system include filtration, reabsorption and secretion, which occurs in the nephrons.</td> </tr> <tr> <td>CO</td> <td>Standard XIII, Objectives 3 -Describe the process of urine formation.</td> </tr> <tr> <td>IN</td> <td>AP.14.2-3 -Understand the function of the kidneys in relation to homeostatic control of bodily fluids, blood pressure, and erythrocyte production. -Develop a model of the nephron which explores its structural components and the functional processes of filtration, secretion, and reabsorption, which are essential to maintaining homeostasis.</td> </tr> <tr> <td>UT</td> <td>Strand 14, Standards 4-5 -Identify the microscopic structures of the nephron: renal corpuscle, glomerulus, glomerular capsule, afferent arteriole, efferent arteriole, renal tubule, peritubular capillaries. -Describe the three basic physiological processes and the structures involved in urine formation.</td> </tr> <tr> <td>FL</td> <td>SC.912.L.14.47 Describe the physiology of urine formation by the kidney.</td> </tr> </tbody> </table> | | | Topic: | State: | Standards: | Gross Anatomy | OH | AP.AE.3 The urinary system is a regulatory system that helps maintain homeostasis. The structures of the urinary system include the kidneys, ureters, bladder and urethra. Each kidney consists of the renal cortex, medulla and renal pyramids. The renal pelvis is a funnel-shaped chamber that is connected to the ureter. | CO | Standard XIII, Objectives 1-2 -Examine organs and the general functions of the urinary system. -Identify the gross and microscopic anatomy of the kidneys. | IN | AP.14.3 -Identify and locate major organs of the urinary system and discuss their functions. | UT | Strand 14, Standards 1-3 -Identify the general functions of the urinary system. -Identify the four major organs of the urinary system: kidneys, bladder, ureters, urethra. -Identify the gross anatomy of the kidney: renal cortex, renal medulla, renal pyramids, renal pelvis, renal capsule, calyces. | FL | SC.912.L.14.47 Describe the physiology of urine formation by the kidney. | Microscopic Anatomy & Physiology | OH | AP.AE.3 The primary functions of the urinary system are excretion, elimination and regulation of blood volume and pressure. Processes of the urinary system include filtration, reabsorption and secretion, which occurs in the nephrons. | CO | Standard XIII, Objectives 3 -Describe the process of urine formation. | IN | AP.14.2-3 -Understand the function of the kidneys in relation to homeostatic control of bodily fluids, blood pressure, and erythrocyte production. -Develop a model of the nephron which explores its structural components and the functional processes of filtration, secretion, and reabsorption, which are essential to maintaining homeostasis. | UT | Strand 14, Standards 4-5 -Identify the microscopic structures of the nephron: renal corpuscle, glomerulus, glomerular capsule, afferent arteriole, efferent arteriole, renal tubule, peritubular capillaries. -Describe the three basic physiological processes and the structures involved in urine formation. | FL | SC.912.L.14.47 Describe the physiology of urine formation by the kidney. |
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Editable Pacing Guides

The daily topic coincide with the previous standards document.

Lesson planning is now quick and easy!



50 min
classes

Urinary System Unit Pacing Guide

| | Day | Intro | Instruct | Assess | Homework |
|----------------------|-----|--|--|--|---|
| Gross Anatomy | 1 | Students add to prefix/suffix flashcards: • nephro-, pod-, glom- | <ul style="list-style-type: none"> Urinary System PPT- Section 1 & Section 2 Cornell Notes (The Kidneys & Nephron A&P) | <ul style="list-style-type: none"> Cornell Notes summaries Informal discussion and questions | |
| | 2 | Prefix/suffix flashcards: • ren-, urin- | <ul style="list-style-type: none"> Kidney Dissection Lab Materials: kidneys, dissection tools, dissection pins | <ul style="list-style-type: none"> Informal questioning during lab activity | |
| Microscopic A&P | 3 | Prefix/suffix flashcards: • -itis, -osis | <ul style="list-style-type: none"> Kidney Microscopy Lab Urinary System PPT- Section 3 Cornell Notes (Urine) | <ul style="list-style-type: none"> Informal questioning during lab activity Cornell Notes summaries Informal discussion and questions | <u>Honors:</u> Data Analysis: Body Fluid Compartments |
| Urine & Homeostasis | 4 | <u>Honors:</u> Discuss homework answers <u>Regular:</u> Review prefix/suffix flashcards or study for test | <ul style="list-style-type: none"> Urinary Homeostasis Worksheet 3 Diagrams: Urinary System, Kidney Anatomy, Nephron Anatomy | <ul style="list-style-type: none"> Informal questioning as students complete worksheets Verbally check or grade answers when finished? | |
| Diseases & Disorders | 5 | Review prefix/suffix flashcards or study for test | <ul style="list-style-type: none"> Digging Deeper: Urinalysis | <ul style="list-style-type: none"> Informal questioning as students complete worksheets Verbally check or grade answers when finished? | <u>All:</u> Study for Test |
| Review | 6 | Review notes for test | <ul style="list-style-type: none"> Task Card Review with student Task Card Answer Sheet | <ul style="list-style-type: none"> Informally assess understanding during task card review | <u>All:</u> Study for Test |
| Assess | 7 | Review notes for test | Urinary System Test | <ul style="list-style-type: none"> Formal assessment | |



Coincide with State Standards document in Unit Planning Folder

***Bold items** must be photocopied.



This icon is found on the top right corner of Honors pages for easy identification.

Differentiation Ideas for:

- Student Interest
- Student Ability
- Teaching Pace
- Teaching Environment (Virtual, in-class, or hybrid)

Differentiation

Teaching Environment

- Virtual or Hybrid students
 - Digital Options:
 - Links for PowerPoints
 - Digital Students pages using Google Slides™ for students to type on
 - Digital Doodle Notes™
- All histology labs can be completed using virtual slides on [Histology Guide](#).
- For the Kidney Dissection Lab, students can watch the video demonstration at home instead of dissecting in class.
- Digital drag-and-drop diagrams can be provided for students to self-check and turn it electronically. I have these available for every body

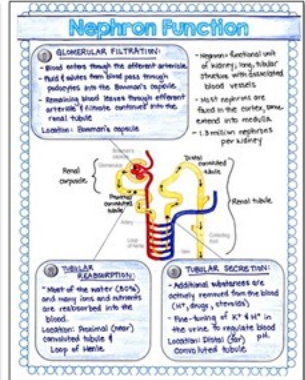
Student Interest/Choice

- Both Cornell notes and Doodle Notes™ are included in this unit. Although most of my students preferred the Doodle Notes™, they may not resonate with everyone. Some students may prefer the structure of the Cornell notes.

es

OR

Doodle Notes



Honors Assignment List

Although there are no official education standards for what makes an "honors" class, honors assignments generally provide one of three options:

- Greater depth of knowledge
- Additional critical thinking
- More independent work

In this unit, you can find some additional assignments used to increase knowledge for honors students. These can certainly be used for all students also be helpful for extra credit, homework, or sub days if you need it. Because answers to these assignments are often less straightforward, grading for completion and then discussing the answers to make sure

| Assignment | Type of work | Skills addressed |
|--|----------------|-----------------------|
| Data Analysis: Body Fluid Compartments | Math extension | Calculations, percent |

All honors assignments are designated by a  in the top right corner for identification.

For additional skill-work in pathology or for students thinking of going to medical school, I also use my Anatomy case studies. There is one for each body system that require critical thinking, research, and allow students to integrate the body system to another.

[Click here to see the Case Studies](#)

Differentiation

Student Ability

- Advanced students
 - Honors options are included in the student pages. These can be given to a whole advanced class or individual students, as needed.
 - Honors extensions are provided for the Homeostasis in Cardiovascular and Respiratory Systems Lab for students to use MS Excel or Google Sheets to analyze data and create graphs.
 - Editable Cornell notes (found in the Notes folder)
 - Delete the fill-in-the-blank notes on the right side leaving only questions for a more independent note-taking experience.
 - Delete the summary and allow students to come up with their own.
 - When using diagram quizzes, use the option without the word bank and/or grade on spelling of the structures.
 - Tests:
 - Don't allow students to use prefix/suffix flashcards on the test.
 - Use the "Honors" tests that don't have word banks for the diagrams and include additional short answer questions.
- Struggling students
 - Eliminating homework altogether may work well for students that have trouble thinking independently or have home situations that don't allow for work outside of class. Make sure to account for the extra class time needed to complete all assignments in class.
 - Although I always help students during labs and answer questions as they complete lab worksheets, these students may need to have each lab answer discussed and checked the following day rather than grading the labs for accuracy.
 - Editable Cornell notes (found in the Unit Planning folder)
 - Use the fill-in-the-blank style of notes for these students so they can focus on material and less on summarizing.
 - Using the fill-in-the-blank summary, see if students can come up with the words that go in the blanks before providing the summary to them.
 - Diagram Quizzes: use the option with the word bank or use the option without the word bank but don't grade spelling.
 - Tests:
 - Allow students to use prefix/suffix flashcards on the test rather than memorizing them.
 - Use the "Regular" tests that eliminate some of the short answer questions and include word banks for the diagrams.
- For any ability
 - Both the PowerPoints and the Cornell notes have editable options so whole topics or vocabulary words can be added or deleted.

Every student page also comes in a **digital** version on Google Slides

Virtual, hybrid, or absent students can stay right on track!

The Kidneys

Where are the kidneys located?

The kidneys are the most important organs in the urinary system. They are bean-shaped organs located on either side of the spine. The kidneys are protected and held in place by perirenal fat tissue and renal fascia (connective tissue). The right kidney is slightly lower to make space for the liver.

What is the anatomy of a kidney?

Each kidney is surrounded by a renal capsule made of connective tissue. Cross-section of a kidney:

- outer cortex
- inner medulla made of renal pyramids

The renal pyramids are the site of urine production.

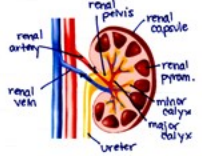

How is urine collected in the kidneys?

After formation in the renal pyramid, urine drains into a tube called the minor calyx (plural: calyces), then into the major calyx. The major calyces converge at the renal pelvis, which then forms the ureter, ultimately removing the urine from the kidney and passing it to the urinary bladder.

How does blood flow through the kidney?

Blood flows into the kidney through the renal artery. As it enters the hilum (indented region), it separates into increasingly smaller arteries through the renal medulla and then cortex. Blood flows out in a reverse pathway and through the renal vein.

Summary: The kidneys are located on either side of the spine and protected by fat and a renal capsule. Urine is formed in the renal pyramids and collected in the minor and major calyces. Blood is supplied by the renal artery and leaves through the renal vein.



Label: renal capsule, renal pyramids, minor calyx, major calyx, renal pelvis, ureter, renal vein, renal artery

The Kidneys

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-

The renal pyramids are the site of urine production.

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Can be used in Google Classroom, Microsoft OneDrive or many other platforms!

Greek and Latin Roots for Medical Terminology Practice

Anatomical Prefixes/Roots/Suffixes:

| | Term | Definition |
|----------------|---------|-----------------|
| Urinary System | glom- | ball of yarn |
| | nephro- | kidney |
| | -itis | inflammation of |
| | -osis | condition of |
| | pod- | foot |
| | ren- | kidney |
| | urin- | urine |

Using Prefixes/Suffixes in your Classroom:

Why study prefixes and suffixes at all?

The basis of scientific terminology comes from Latin & Greek. By teaching science students Latin & Greek prefixes, suffixes and root words, they can learn to dissect new scientific terms when they come across them in news articles or textbooks. This is a great way to train our students to be scientifically literate adults. Even if they don't remember all the facts they've memorized in this class, they can interpret scientific information from the media and from their own doctors.

How can you use them in class?

- **How I do it:**
 - **Beginning of the year:** I ask students to bring in a stack of 300 3"x5" index cards. I always have a few extra on hand for students that forget or can't afford them, although they're fairly inexpensive.
 - **Beginning of (almost) every class:** I write any prefixes and suffixes that are relevant to that day's topic on the board along with the definition. Students record the prefix/suffix on one side of an index card and the definition on the other. If there aren't any terms for that day, students can review the terms they already have written down.
 - **On test day:** I add approximately two scientific words to the end of every unit test. These are words that relate to the unit but are not ones we have discussed in class. Students must use the prefixes/suffixes we've studied to interpret the meaning of the new term. For on-level or advanced classes, I recommend not letting students use their index cards on the test, but for low-level students, it may be beneficial to allow it.

glom-

Uses in your Classroom:

Helpful tips for using cards:

- Always have a master list of the terms you've given out or keep your own set of notecards. It may be helpful to have students write the date in the top corner of the card. This allows absent students to copy the terms they missed when they return.
- Starting class with these terms is a great way to give yourself a few more minutes to get organized. Students can always review their index cards or quiz each other if you need a few more minutes.
- Students will need some way to keep the cards organized- put them on a ring, rubber band them together, or keep them in a bag.
- Students add to these index card stacks throughout the year without removing terms. The course builds on itself, so it's always beneficial to review terms from previous units as well as the current unit. You may find that some terms are duplicated from one unit to another. No need to have students write the same term twice.
- For advanced students, you may want to have them look up the definition in a textbook rather than providing it to them. Be sure to mention these prefixes and suffixes again as they come up in class. Using the terms in context is the best way for students to recognize and remember them.

Prep sub plans:

Students can type the terms into Quizlet or a similar site and quiz themselves.

Students can make up scientific terms (real or not) and have other students interpret the meaning of the term.

Use a blank bingo board (provided on the next page) and have students fill in the definitions for the current or past unit in any blank. The sub can call out a prefix or suffix and students mark off the definition until someone wins bingo.

*This is another important reason to have a master list or set of cards for all the terms students have already learned.

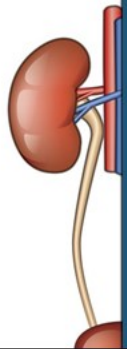
A great way to encourage scientific literacy and prepare students for higher level science courses.

Highly Visual PowerPoint Presentation

18 editable, fully-animated slides

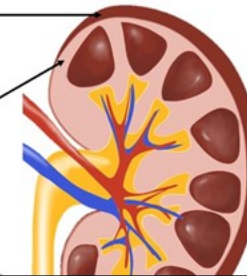
Where are the kidneys located?

- The **kidneys** are the most important organs in the urinary system.
- They are **bean-shaped** organs located on either side of the **spine**.
- The kidneys are protected and held in place by **perirenal fat tissue** and **renal fascia** (connective tissue).
- The right kidney is slightly **lower** to make space for the **liver**.



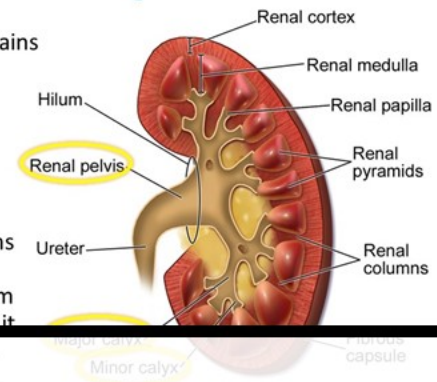
What is the anatomy of a kidney?

- Each kidney is surrounded by a **renal capsule** made of connective tissue.
- Cross-section of a kidney:
 - Outer cortex**
 - Inner medulla** made of renal pyramids



How is urine collected in the kidneys?

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, urine drains
called the
olural:
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cyces
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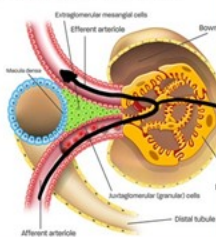
Sample Slides

How is urine formed?

- Urine is formed within the nephron using 3 processes:

1. Glomerular filtration

- Blood enters through the **afferent arteriole**.
- Fluid and **solutes** from the blood pass through special filtration cells called **podocytes** into the Bowman's capsule.
- Once in the capsule, the fluid is called **filtrate**.
- The remaining blood leaves through the **efferent arteriole** and the filtrate continues into the **renal tubule**.



Overview

1 Filtration:

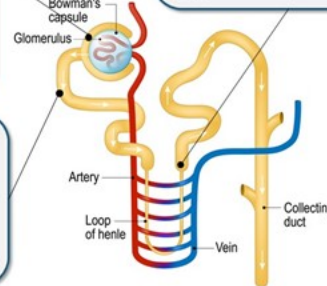
- Blood enters through the afferent arteriole.
- Fluid and solutes from the blood pass through podocytes into the Bowman's capsule.
- Remaining blood leaves through the efferent arteriole and the filtrate continues into the renal tubule.
- Location: Bowman's capsule

2 Reabsorption:

- Most of the water (80%) and many ions and nutrients are reabsorbed into the blood
- Location: Proximal (near) Convoluted Tubule & Loop of Henle

3 Secretion:

- Additional substances are actively removed from the blood (H⁺, drugs, steroids)
- Fine-tuning of K⁺ and H⁺ in the urine to regulate blood pH
- Location: Distal (far) Convoluted Tubule



How does urine leave the body?

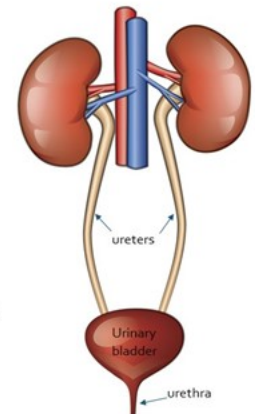
n the kidneys, urine enters the
e-like **ureters** and empties into the
tic **urinary bladder** for storage.

n the bladder, the urine passes
ugh the **urethra** and is released
n the body by 2 **sphincter** muscles.

as in the rectum, there is an
anal (involuntary) **sphincter** and an
anal (voluntary) **sphincter**.

of control (often with age) in the
anal urethral sphincter is the cause
continence.

process of emptying the bladder is
d **micturition** or **voiding**.



Two note-taking styles are included:

Cornell Notes

The Kidneys

Where are the kidneys located?

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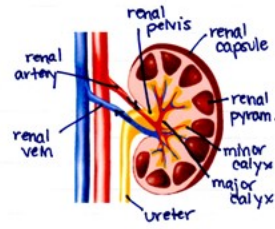

How is urine collected in the kidneys?

After formation in the renal pyramid, urine drains into a tube called the minor calyx (plural: calyces), then into the major calyx. The major calyces converge at the renal pelvis, which then forms the ureter, ultimately removing the urine from the kidney and passing it to the urinary bladder.

How does blood flow through the kidney?

Blood flows into the kidney through the renal artery. As it enters the hilum (indented region), it separates into increasingly smaller arteries through the renal medulla and then cortex. Blood flows out in a reverse pathway and through the renal vein.

Summary: The kidneys are located on either side of the spine and protected by fat and a renal capsule. Urine is formed in the renal pyramids and collected in the minor and major calyces. Blood is supplied by the renal artery and leaves through the renal vein.



Label: renal capsule, renal pyramids, minor calyx, major calyx, renal pelvis, ureter, renal vein, renal artery

Doodle Notes™

Kidney Structure

Location of kidneys:

- Bean-shaped organs on either side of spine
- Protected & held in place by perirenal fat tissue & renal fascia (connective tissue).
- Right kidney is slightly lower because of liver.

RENAL CAPSULE:
A protective layer of connective tissue that prevents injury

RENAL CORTX:
Outer layer of the kidney that contains the Bowman's capsule & collecting duct of the nephron

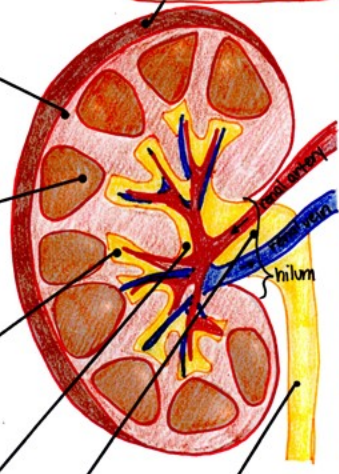
RENAL PYRAMIDS:
- Make up the medulla (inner) layer of the kidney
- Site of urine formation

MINOR CALYX:
Receives urine from papillae of renal pyramids & passes it to major calyx

MAJOR CALYX:
Receives urine from minor calyces & converges to form renal pelvis

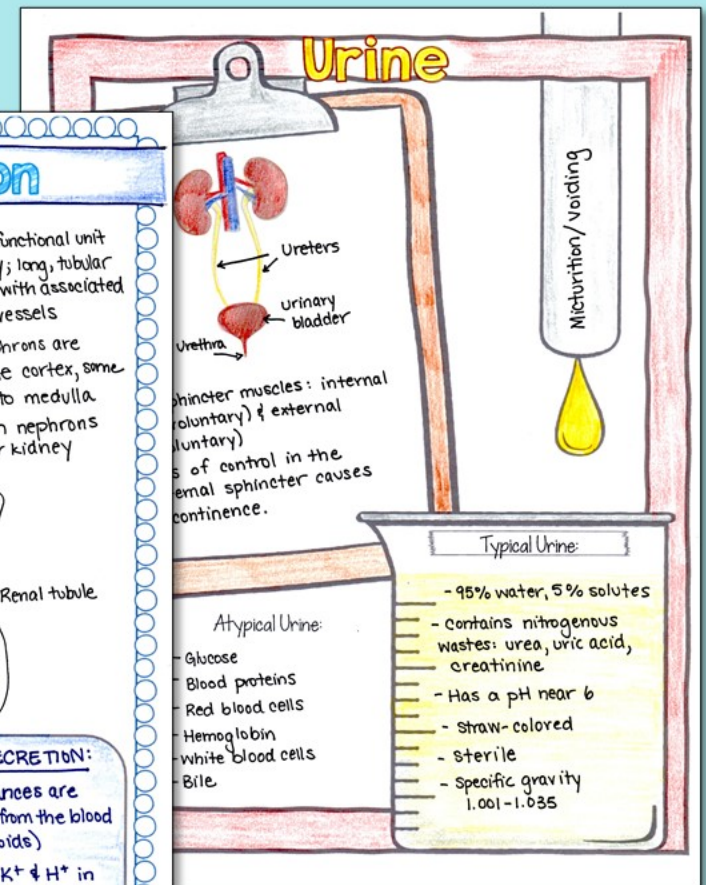
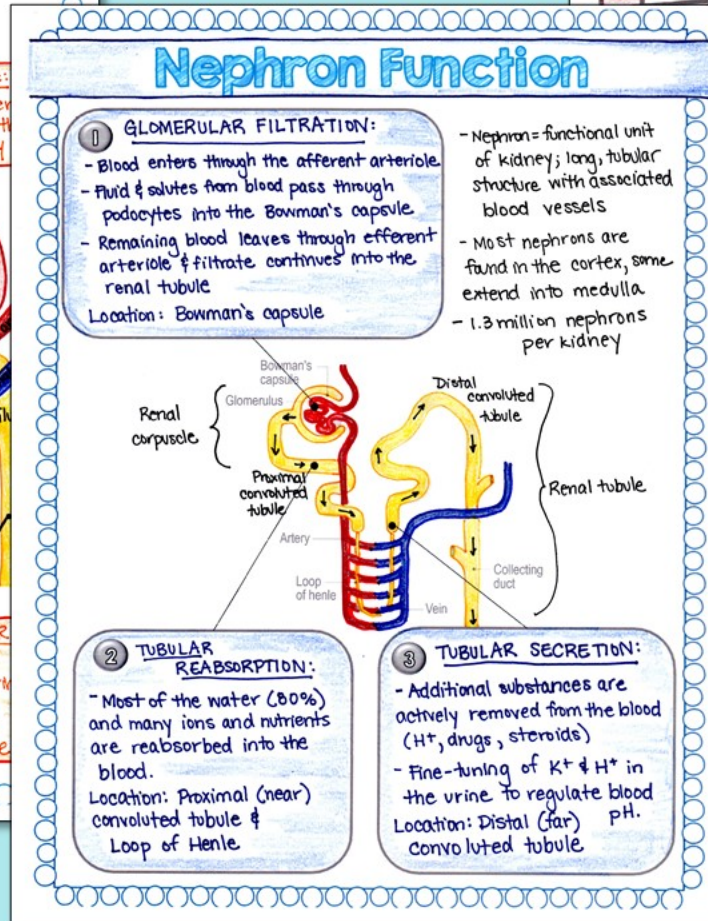
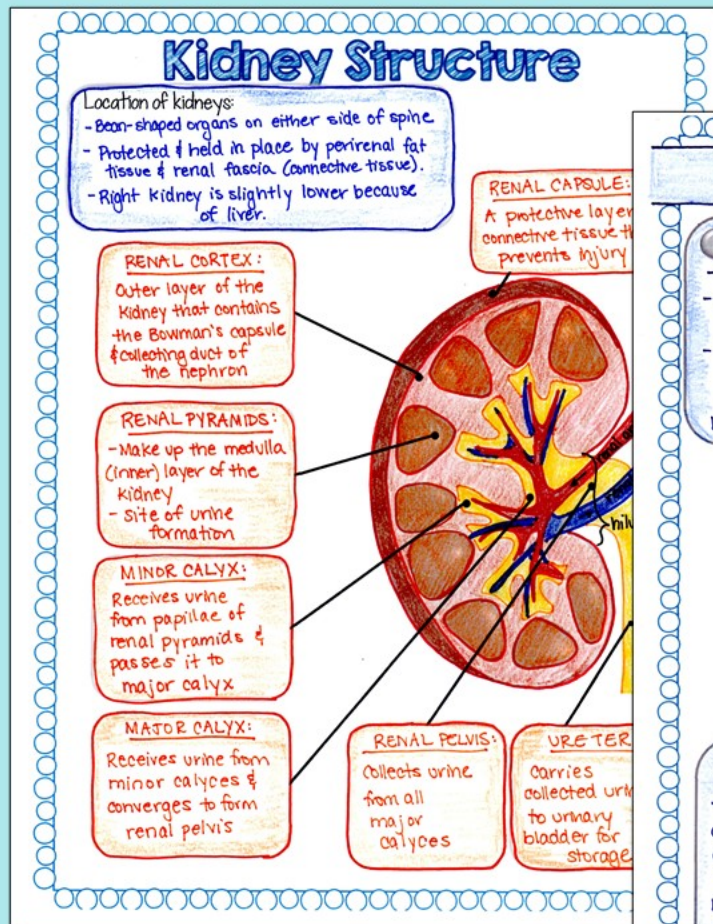
RENAL PELVIS:
Collects urine from all major calyces

URETER:
Carries collected urine to urinary bladder for storage



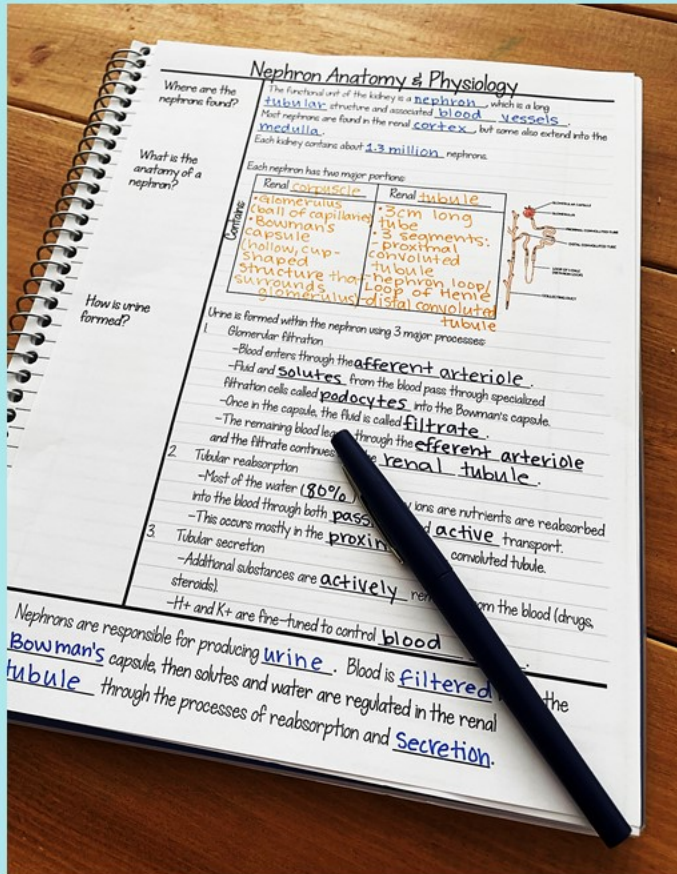
Both coincide perfectly with the presentation for
error-proof notes!

3 pages of Doodle Notes



Doodle Notes™ increase student focus and memory-
and they're great fun!
A guide for using them in your classroom is included.

3 pages of Cornell Notes



Big
concept
questions

Content
summary for
each page

Nephron Anatomy & Physiology

Where are the nephrons found?

The functional unit of the kidney is a nephron, which is a long tubular structure and associated blood vessels. Most nephrons are found in the renal cortex, but some also extend into the medulla. Each kidney contains about 1.3 million nephrons.

What is the anatomy of a nephron?

Each nephron has two major portions:

| Renal <u>corpuscle</u> | Renal <u>tubule</u> |
|---|---|
| <ul style="list-style-type: none">• <u>glomerulus</u> (ball of capillaries)• <u>Bowman's capsule</u> (hollow, cup-shaped structure that surrounds <u>glomerulus</u>) | <ul style="list-style-type: none">• <u>3cm long tube</u>• <u>3 segments</u>:<ul style="list-style-type: none">- <u>proximal convoluted tubule</u>- <u>nephron loop/ Loop of Henle</u>- <u>distal convoluted tubule</u> |

How is urine formed?

Urine is formed within the nephron using 3 major processes:

1. Glomerular filtration
 - Blood enters through the afferent arteriole.
 - Fluid and solutes from the blood pass through specialized filtration cells called podocytes into the Bowman's capsule.
 - Once in the capsule, the fluid is called filtrate.
 - The remaining blood leaves through the efferent arteriole and the filtrate continues into the renal tubule.
2. Tubular reabsorption
 - Most of the water (80%) and many ions are nutrients are reabsorbed into the blood through both passive and active transport.
 - This occurs mostly in the proximal convoluted tubule.
3. Tubular secretion
 - Additional substances are actively removed from the blood (drugs, steroids).
 - H^+ and K^+ are fine-tuned to control blood pH.

Summary: Nephrons are responsible for producing urine. Blood is filtered within the Bowman's capsule, then solutes and water are regulated in the renal tubule through the processes of reabsorption and secretion.

Each page is **editable**.
Add and delete text, questions, and summaries
to meet the needs of your students.

Includes 2 Labs

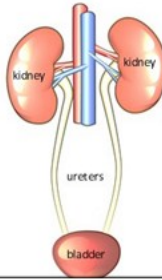
- Kidney Dissection Lab (video demonstration also included)
- Microscopy Lab

Kidney Dissection

Overview of Excretory System:

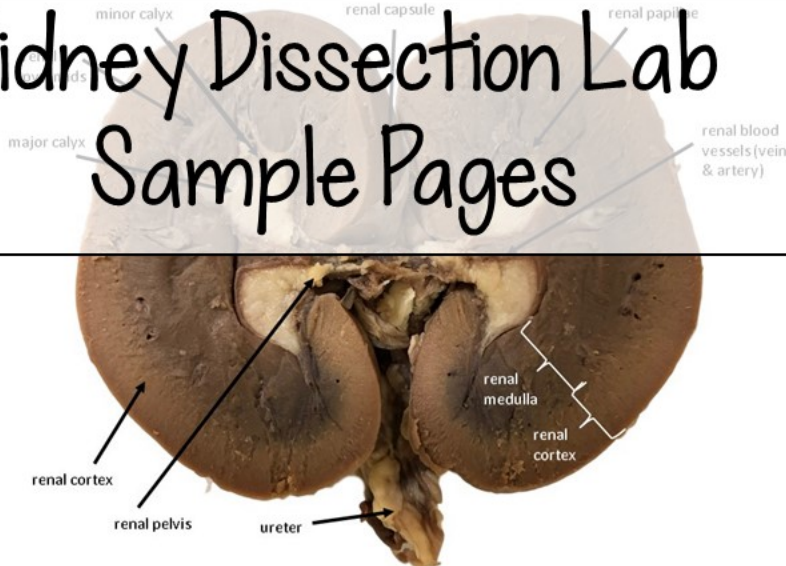
The **kidneys** are the most important organs in the excretory (or urinary) system. They are bean-shaped organs located on either side of the spine and held in place by **perirenal fat tissue**. The right kidney is located slightly lower than the left kidney to provide space for the liver. The kidneys are responsible for filtering the blood by removing waste, regulating the amount of water in the blood, and maintaining the correct pH for the blood.

The functional unit of the kidney is called a **nephron**. Each human kidney contains about 1.3 million nephrons. They are closely linked with the circulatory system and produce **urine** after removing the wastes from the blood. After urine is produced in the kidneys, it passes through a series of tubes until it collects in the **urinary bladder** and is removed from the body.



Kidney Anatomy

Kidney Dissection Lab Sample Pages



Kidney Microscopy

Structures to identify and label:

- Renal corpuscle
- Bowman's capsule
- Glomerulus

Possible structures to identify and label (depending on your specimen):

- Renal tubule

Microscopy Lab Sample Page

Specimen: _____

Magnification: _____

1. What cells are found in the glomerulus that aid in the filtration of the blood?
2. The cells in this slide are arranged in circular patterns and are much less densely packed than some of the other slides you've seen. Why would this be?

I Extension Activity

Patient urinalysis mix up! Student match a patient with their suspected diagnosis using urinalysis samples and information from a physical examination. (No materials required)

Diseases and Disorders:

- **Chronic Kidney Disease-** Chronic kidney diseases is simply the gradual loss of kidney function. Kidney disease can have several different causes including diabetes, high blood pressure, inflammation, infection, or infection. Symptoms are initially mild, but become more apparent over time. They can include fatigue, frequent urination, insomnia, and nausea.
- **Diabetes Insipidus-** Although this disease is called "diabetes", it is not truly related to diabetes. It is caused by a lack of antidiuretic hormone (ADH) or because the kidneys are not responding to ADH correctly. Symptoms include frequent urination in large amounts and unexplained thirst.
- **Diabetes Mellitus-** Diabetes mellitus is commonly called diabetes. It is a metabolic disorder that causes high blood sugar levels because not enough insulin is made from the pancreas or the insulin is not used effectively. Type 1 diabetes is often diagnosed in childhood or adolescence. Symptoms of type 1 diabetes include unexplained weight loss, fatigue, and frequent urination. The presence of glucose in the urine is a good indicator of diabetes mellitus.
- **Hemolytic Anemia-** In hemolytic anemia, red blood cells are destroyed faster than

Patients:

These patients recently arrived at your clinic. They have each given a urine sample, but the lab mixed them up!

Shonne Jackson

57 years old. Experiencing severe pain in his lower back and abdomen, as well as vomiting, nausea, and very painful urination.

Eric Woodley

13 years old. Mother is concerned about unexplained weight loss, fatigue, and frequent urination.

Simone Williams

5 days old. Mother is concerned that the baby is losing weight and not breast feeding well. Metabolic blood tests were abnormal.

Victoria Martinez

49 years old. Experiencing excessive thirst and dry skin. Victoria reports that she's having trouble sleeping because she's been urinating frequently at night and the

Results:

Using the background urinalysis information and the explanations of each disease, match the patients with the urinalysis samples. One patient is healthy. In the last column, record the abnormal urinalysis properties that led you to this conclusion.

| Urinalysis Sample | Patient | Disease/Disorder | Notes |
|-------------------|---------|------------------|-------|
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |

Digging Deeper: Urinalysis

Background:

Urinalysis is the physical, chemical, and microscopic examination or testing of urine. It can provide information about the body's metabolic processes, kidney and liver function, acid-base balance, fluid intake and infections. Some urine properties fluctuate over a wide range of values, so the results of a urinalysis are usually combined with a physical examination and personal health history to determine if any diseases or disorders are present.

The properties of a normal urinalysis are listed below, as well as some common abnormalities that can be found for each property.

| Property | Expected range | Abnormal range |
|------------------|--------------------------|--|
| Clarity | Clear | Cloudy urine can indicate a urinary tract infection, kidney stones, or prostate problems. Turbid urine can indicate a urinary tract infection or kidney problem. |
| Color | Light to Dark Yellow | Clear urine can indicate overhydration, while light to dark yellow can indicate dehydration. If dehydration is suspected, the urine should be more concentrated. Pink or red urine can indicate hematuria (blood in the urine). Dark brown or black urine can indicate liver disease or blood clots. Pink urine can indicate the presence of a urinary tract infection. Rarely blue or green and most often this is caused by the presence of food coloring. |
| Odor | Slightly aromatic, nutty | Mal-smelling urine likely indicates an infection. Fruity smelling urine indicates the presence of glucose. |
| Protein | Negative | The presence of proteins can indicate that glomerular cells are unable to filter properly, which is likely caused by kidney damage. |
| Ketones | Negative | Ketones are byproducts of fat metabolism and can indicate an insulin deficiency. |
| Leukocytes | Negative | Urically indicates a bacterial infection in the urinary tract. Can also indicate a urinary tract infection or a urine sample contaminated by fecal or vaginal discharge. |
| Glucose | Negative | Presence of glucose indicates high levels of sugar in the blood or an inability for glomerular cells to properly filter, which is likely caused by kidney damage. |
| pH | 5.0-8.0 | Alkaline urine (high pH) may be a sign of kidney failure, since the renal tubules are unable to properly regulate acids. Bacteria in the urinary tract also cause alkaline urine. Alkaline urine can also indicate the presence or likelihood of kidney stones. Acidic urine (low pH) may indicate ketoacidosis or starvation. |
| Specific Gravity | 1.003-1.030 | Low specific gravity indicates a high amount of fluid in the urine. High specific gravity indicates the presence of additional molecules or cells (glucose, protein, hemoglobin, blood cells, etc.) |
| Bilirubin | Negative | Bilirubin is a byproduct of erythrocyte destruction. Bilirubin is normally recycled in the liver. The presence of bilirubin in urine indicates a liver disorder. |
| Nitrites | Negative | Bacteria break down natural nitrates in urine into nitrites, so the presence of nitrites is an indicator of bacterial infection. |

Sample #1

| Property | Results | Reference |
|------------|------------|----------------------|
| Clarity | Cloudy | Clear |
| Color | Light pink | Light to Dark Yellow |
| Odor | Foul | Nutty |
| Protein | Negative | Negative |
| Leukocytes | Present | Negative |
| Ketones | Negative | Negative |

Sample #2

| Property | Results | Reference |
|------------|----------|----------------------|
| Clarity | Cloudy | Clear |
| Color | Yellow | Light to Dark Yellow |
| Odor | Fruity | Nutty |
| Protein | Negative | Negative |
| Leukocytes | Negative | Negative |
| Ketones | Present | Negative |

Sample #5

| Property | Results | Reference |
|------------|----------|----------------------|
| Clarity | Clear | Clear |
| Color | Clear | Light to Dark Yellow |
| Odor | Nutty | Nutty |
| Protein | Negative | Negative |
| Leukocytes | Negative | Negative |
| Ketones | Negative | Negative |

Sample #6

| Property | Results | Reference |
|------------|----------|----------------------|
| Clarity | Clear | Clear |
| Color | Yellow | Light to Dark Yellow |
| Odor | Nutty | Nutty |
| Protein | Negative | Negative |
| Leukocytes | Negative | Negative |
| Ketones | Present | Negative |

Sample #3

| Property | Results | Reference |
|------------|----------|----------------------|
| Clarity | Clear | Clear |
| Color | Yellow | Light to dark Yellow |
| Odor | Nutty | Nutty |
| Protein | Negative | Negative |
| Leukocytes | Negative | Negative |
| Ketones | Negative | Negative |

Sample #4

| Property | Reference | Reference |
|------------|-----------|----------------------|
| Clarity | Cloudy | Clear |
| Color | brown | Light to Dark Yellow |
| Odor | Nutty | Nutty |
| Protein | Negative | Negative |
| Leukocytes | Negative | Negative |
| Ketones | Negative | Negative |

Sample #7

| Property | Results | Reference |
|------------|----------|----------------------|
| Clarity | Foamy | Clear |
| Color | Yellow | Light to Dark Yellow |
| Odor | Nutty | Nutty |
| Protein | Present | Negative |
| Leukocytes | Positive | Negative |
| Ketones | Negative | Negative |

Sample #8

| Property | Results | Reference |
|------------|----------|----------------------|
| Clarity | Cloudy | Clear |
| Color | Brown | Light to Dark Yellow |
| Odor | Sweet | Nutty |
| Protein | Present | Negative |
| Leukocytes | Negative | Negative |
| Ketones | Positive | Negative |

Greater depth of knowledge & critical thinking

Other Extension Pages

Discussion Questions:

1. Choose one of the homeostatic mechanisms described in the boxes on the previous page. Draw a negative feedback loop to show how the steps involved in returning the levels to balance. *Hint: Start with a stimulus (ex: blood volume drops).*
2. What does an osmoreceptor detect?
3. You got a gastrointestinal virus and have had diarrhea for several days. What hormone would be released in your body to attempt to regulate the amount of water conserved in your cells?
4. A rare condition called diabetes insipidus causes the pituitary gland to be unable to produce ADH. One of the main diagnostic criteria for recognizing diabetes insipidus has to do with the amount of urine these individuals produce. Based on the lack of ADH, would these individuals produce more or less urine than a healthy individual?
5. Diuretics are commonly prescribed for individuals with would these medicines decrease blood pressure?

Data Analysis: Body Fluid Compartments

Fluids are found within the body in two major compartments: inside cells (called intracellular fluid) and outside cells (called extracellular fluid). Extracellular fluid is further categorized as interstitial fluid, blood plasma, and transcellular fluid, which includes cerebrospinal and serous fluids, humors of the eye, etc.

| | | Volume of Fluid (in L) | Percentage |
|-------------------|---------------------------|---------------------------|------------|
| Total Body Fluids | Intracellular Fluid (ICF) | 28 | |
| | Interstitial Fluid (IF) | 10.5 | |
| | Plasma | 3 | |
| | Transcellular Fluid (TF) | .5 | |

Discussion Questions:

1. Calculate the total volume of fluid (in liters) that can be found in a typical adult male's body. Put the total in the blank at the bottom of the table.

Urinary Homeostasis



Background:

The kidneys play a huge role in the homeostasis of the body. The filtration of the blood through the glomerulus can be altered by hormones which affect blood volume, electrolyte levels, blood pressure, and blood pH. Although these homeostatic mechanisms generally work together, we will investigate each of the separately to simplify the processes.

Read the explanations of how the urinary system works to maintain homeostasis in these ways.

Water Intake

When water is lost through sweat, feces, or exhalation, the solute concentration in the blood can increase. Even a slight increase in concentration can be recognized by osmoreceptors in the hypothalamus. The thirst center of the hypothalamus signals the salivary glands to conserve fluids. This causes a dry mouth, which indicates to an individual that she needs water. When water is ingested, it is absorbed into the cells of the mouth, throat, and gastrointestinal tract. As this water is absorbed, solute concentrations decrease again to normal levels.

Blood Volume

When blood volume drops, osmoreceptors in the hypothalamus detect this change and stimulate the posterior pituitary gland to release antidiuretic hormone (ADH). ADH (also known as vasopressin) causes the nephrons to increase the amount of water they reabsorb, which helps to increase blood volume and pressure to normal levels.

Blood pressure

Due to osmosis, water follows where Na^+ leads and the amount of water in the blood plasma directly affects blood pressure. When cells nearby the glomerulus (called juxtaglomerular cells) detect a decrease in blood pressure, they respond by releasing the enzyme renin. Renin converts an inactive protein known as angiotensin I into the active form (angiotensin II). Angiotensin II causes blood vessels to constrict, raising blood pressure. It also stimulates the release of aldosterone from the adrenal glands, which cause more Na^+ ions (and therefore water) to be reabsorbed in the nephrons. The combination of blood vessel constriction and water reabsorption raises the blood pressure.

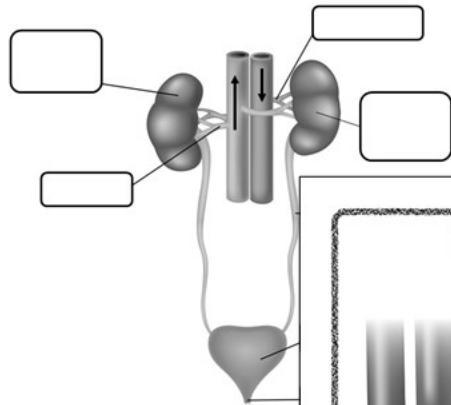
Blood pH

If the pH of the blood varies drastically from the normal range of 7.35-7.45, some enzymes may lose functionality. Acids donate H^+ ions quickly in water. Bicarbonate ions act to buffer acids by binding H^+ ions to them. The kidneys act to regulate blood pH by reabsorbing or secreting bicarbonate ions and H^+ ions. If blood pH becomes too acidic (drops), the kidneys will reabsorb more bicarbonate ions to buffer the extra H^+ ions. This causes the pH of the blood to slowly rise, returning it to the optimum levels.

Math Extension!

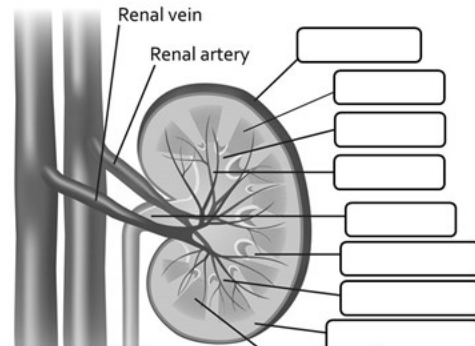
3 Anatomical Diagrams

Urinary System

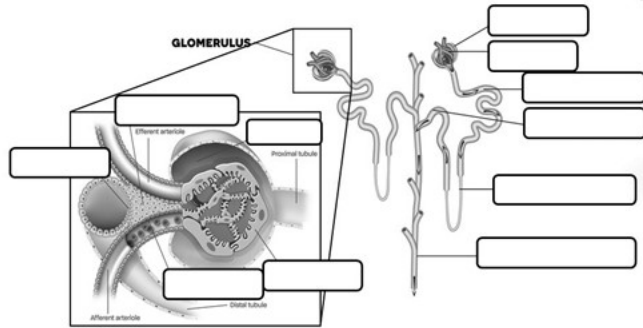


Word bank: renal artery, renal vein, right kidney, left kidney, ureter, urinary bladder, urethra

Kidney Anatomy



Nephron Anatomy

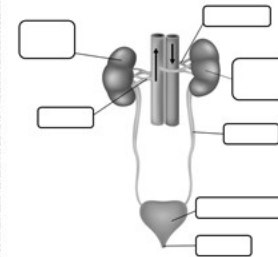


Word bank: collecting duct, macula densa cells, glomerular capsule (use twice), extraglomerular mesangial cells, distal convoluted tubule, proximal convoluted tubule, nephron loop (Loop of Henle), podocytes, granular cells, glomerulus

Each diagram comes in 4 versions:

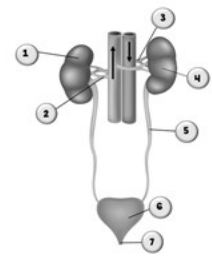
1. Fill-in the blank
2. Numbered quiz
3. Labeled black & white
4. Labeled color

Urinary System



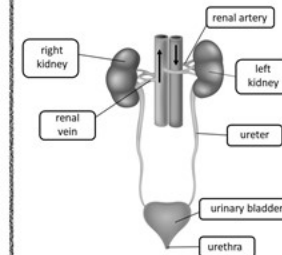
Word bank: renal artery, renal vein, right kidney, left kidney, ureter, urinary bladder, urethra

Urinary System

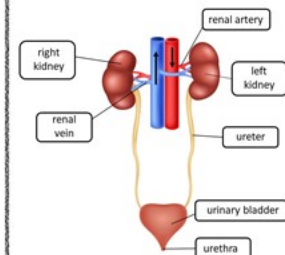


1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____

Urinary System



Urinary System



20 Editable Task Cards for Review

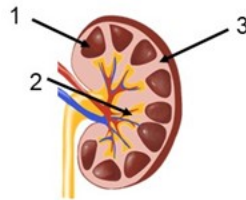
1 Name two tissues responsible for holding the kidneys in place.

2 What is the renal capsule?

Sample Task Cards

3 What are the 2 main layers of the kidney?

4 In which marked location is urine produced? What is this location called?



Using Editable Task Cards 🍏

How to set-up:

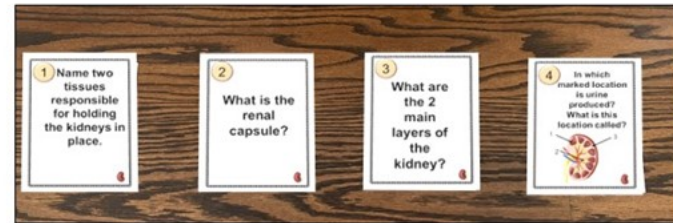
1. Print the cards on cardstock or paper.
2. Cut the pages so that each card is separate. If you'd like to use them in future years, it may be worth laminating them to protect them from student writing and other damage.
3. Place each task card at a seat around the room.
4. Students will rotate to each seat until all cards are finished. Answers are recorded on their "Task Card Answer Sheet" or notebook paper.

*TIP: It is important to set a timer. Usually 1-2 minutes is appropriate. Without a timer, students will get backed up while rotating and chaos will ensue. ☺

Teacher Tips

Modifications:

- These task cards are editable so you can change the text on any card.
- There are additional cards at the end of the document for adding questions. Be sure to add the correct number, as well!
- If moving around your room isn't possible, you can have students pass the cards in one direction.
- Other options:
 - Students can use notes or not depending on the level of memorization you expect prior to reviewing.
 - Students can work in pairs, which adds confidence.



Editable Unit Test

- 11 multiple choice questions
- 7 matching questions
- 2 Greek/Latin term questions
- 2 labeled diagrams
- 7 free response questions

Two Versions: Honors & Regular

Student answer
sheet & answer keys
included
(both fully editable)

Sample Test Pages
(blurred on preview to prevent cheating)

URINARY SYSTEM TEST ANSWER KEY

Diagram 2:

Multiple Choice:

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____

Free Response:

Matching:

12. _____
13. _____
14. _____
15. _____
16. _____
17. _____
18. _____

Terms:

1. _____
2. _____

Labeling:

Diagram 1:

1. _____
2. _____
3. _____
4. _____

I'd love to hear from you!

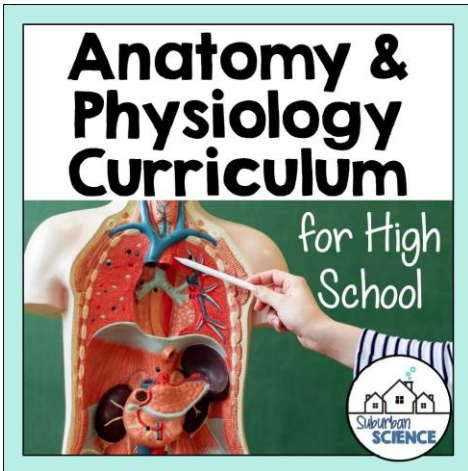
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Sincerely,
Anne from Suburban Science

