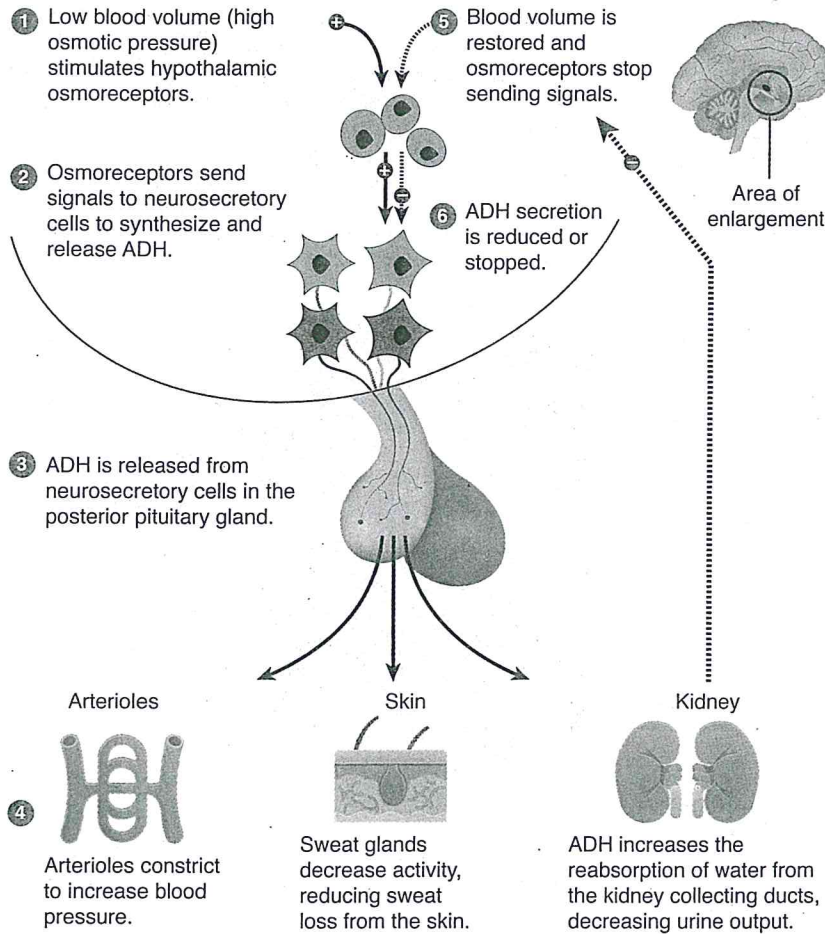


# Control of Urine Output

Variations in salt and water intake, and in the environmental conditions to which we are exposed, contribute to fluctuations in blood volume and composition. The primary role of the kidneys is to regulate blood volume and composition (including the removal

of nitrogenous wastes), so that homeostasis is maintained. This is achieved through varying the volume and composition of the urine. Two hormones, **antidiuretic hormone (ADH)** and **aldosterone**, are involved in the process.



**Osmoreceptors** in the **hypothalamus** of the brain respond to changes in blood volume. A blood volume stimulates the synthesis and secretion of the hormone ADH (antidiuretic hormone), which is released from the posterior pituitary into the blood. ADH increases the permeability of the kidney collecting duct to water so that more water is reabsorbed and urine volume decreases. A second hormone, aldosterone, helps by increasing sodium reabsorption.

- |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>Factors causing ADH release</b></p> <ul style="list-style-type: none"> <li>▶ Low blood volume<br/>= More negative water potential<br/>= High blood sodium levels<br/>= Low fluid intake</li> <li>▶ Nicotine and morphine</li> </ul> <p><b>Factors inhibiting ADH release</b></p> <ul style="list-style-type: none"> <li>▶ High blood volume<br/>= Less negative water potential<br/>= Low blood sodium levels</li> <li>▶ High fluid intake</li> <li>▶ Alcohol consumption</li> </ul> |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

- |                                                                                                                                                                                                                                                                                        |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>Factors causing the release of aldosterone</b></p> <p>Low blood volumes also stimulate secretion of aldosterone from the adrenal cortex. This is mediated through a complex pathway involving osmoreceptors near the kidney glomeruli and the hormone renin from the kidney.</p> |
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The Urinary System

1. (a) **Diabetes insipidus** is a disease caused by a lack of ADH. Based on what you know of the role of ADH in regulating urine volumes, describe the symptoms of this disease:

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(b) Suggest how this disorder might be treated: \_\_\_\_\_

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2. Explain why alcohol consumption (especially to excess) causes dehydration and thirst: \_\_\_\_\_

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3. Explain how negative feedback mechanisms operate to regulate blood volume and urine output: \_\_\_\_\_

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4. **Diuretics** are drugs that increase urine volume. Many work by inhibiting the active transport of sodium and chloride in the nephron. Explain how this would lead to an increase in urine volume:

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# Urine Analysis

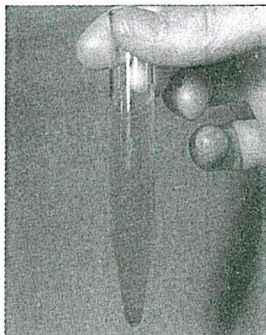
**Urine** is the liquid waste product of the body. It contains water, electrolytes, and other waste metabolites which are filtered out of the blood by the kidneys. **Urine analysis** (urinalysis) is used as a

medical diagnostic tool for a wide range of metabolic disorders. In addition, urine analysis can be used to detect the presence of illicit (non-prescription) drugs and for diagnosing pregnancy.

## Diagnostic Urinalysis

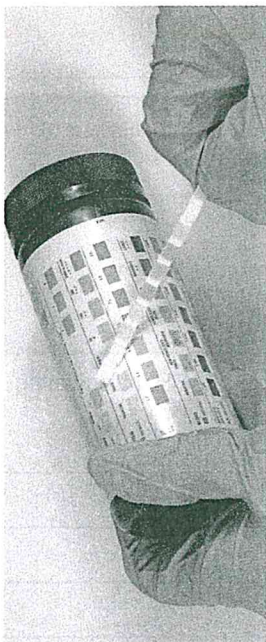
A urinalysis (UA) is an array of tests performed on urine. It is a common method of medical diagnosis, as most tests are quick and easy to perform, non-invasive, and well understood diagnostically.

A typical urinalysis usually includes a **macroscopic analysis**, a **dipstick chemical analysis**, in which the test results can be read as color changes, and a **microscopic analysis**, which involves centrifugation of the sample and examination for crystals, blood cells, or microbial contamination.



### MACROSCOPIC URINALYSIS

The first part of a urinalysis is direct visual observation. Normal, fresh urine is pale to dark yellow or amber in color and clear. Turbidity or cloudiness may be caused by excessive cellular material or protein in the urine. A red or red-brown (abnormal) color could be from a food dye, eating fresh beets, a drug, or the presence of either hemoglobin or myoglobin. If the sample contained many red blood cells, it would be cloudy as well as red, as in this sample indicating hematuria (blood in the urine).



### DIPSTICK URINALYSIS

Commonly dipstick tests indicate:  
**Urine pH:** normal range is 4.5-8.0.

**Specific gravity:** Normal is 1.002 - 1.035  
Specific gravity measures urine density, or the ability of the kidney to concentrate or dilute the urine over that of plasma.

**Protein:** Normal total protein excretion does not exceed 10 mg per 100 ml in any single specimen. More than 150 mg per day is defined as proteinuria.

**Glucose:** Less than 0.1% of glucose filtered by the glomerulus normally appears in urine. Excess sugar in urine generally indicates diabetes mellitus.

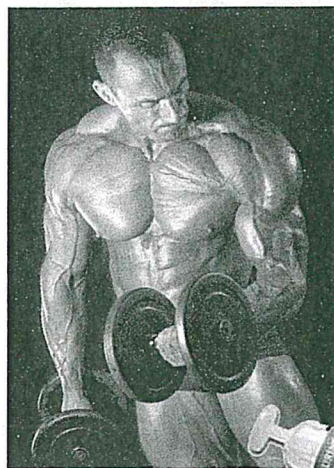
**Ketones:** Ketones in the urine result from diabetic ketosis or some other form of calorie deprivation (starvation).

**Nitrite:** Nitrites indicate that bacteria may be present in significant numbers.

**Leukocyte esterase:** A positive leukocyte esterase test results from the presence of whole or lysed white blood cells (indicating infection).

## Testing For Anabolic Steroids

**Anabolic steroids** are synthetic steroids related to the male sex hormone **testosterone** (right). They work by increasing protein synthesis within cells, causing tissue, especially skeletal muscle, to build mass. They are used legitimately to stimulate bone growth and appetite, induce male puberty, and treat chronic wasting conditions. Misuse of anabolic steroids can have many adverse effects including elevated blood pressure, cardiovascular disease, and altered cholesterol ratios.

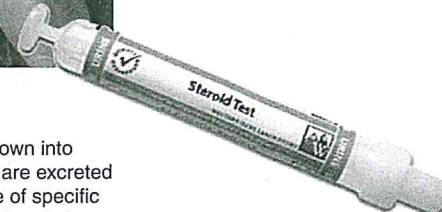


Steroids increase muscle mass and physical strength, and are used illegally by some athletes to gain an unfair advantage over their competitors.

Anabolic steroid use is banned by most major sporting bodies, but many athletes continue to use them illegally. Athletes are routinely tested for the presence of **performance enhancing drugs**, including anabolic steroids.

Anabolic steroids break down into known metabolites which are excreted in the urine. The presence of specific metabolites indicates which substance has been used by the athlete.

Some steroid metabolites stay in the urine for weeks or months after being taken, while others are eliminated quite rapidly. Athletes using anabolic steroids can escape detection by stopping use of the drugs prior to competition. This allows the body time to break down and eliminate the components, and the drug use goes undetected.



1. Explain why urinalysis is a frequently used diagnostic technique for many common disorders: \_\_\_\_\_
2. Explain why the pH of normal urine (4.5-8.0) is much more variable than the pH of the blood (pH 7.35-7.45): \_\_\_\_\_
3. Identify what each of the following might indicate in a urine sample:
  - (a) Cloudy, red color: \_\_\_\_\_
  - (b) Positive leukocyte esterase test: \_\_\_\_\_
4. Explain why athletes exploiting illegal drugs might withhold them for a period before competition: \_\_\_\_\_