Patient education: Chronic kidney disease (Beyond the Basics)

Author: Jeffrey S Berns, MD
Section Editor: Gary C Curhan, MD, ScD
Deputy Editor: Alice M Sheridan, MD

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CHRONIC KIDNEY DISEASE OVERVIEW — Chronic kidney disease (CKD, also called kidney failure or renal failure) is a condition in which the kidneys lose some of their ability to remove waste products and excess fluid from the bloodstream. As waste products and fluids build up in the body, other body systems are affected, which can be harmful to your health.

The most common causes of CKD are diabetes and high blood pressure. In the early stages of CKD, there are no symptoms. The disease can progress to complete kidney failure, also called end-stage renal/kidney disease. This occurs when kidney function has worsened to the point that dialysis or kidney transplantation is required to maintain good health and even life.

The main goal of treatment is to **prevent** progression of CKD to complete kidney failure. The best way to do this is to diagnose CKD early and control the underlying cause.

The symptoms, evaluation, and management of CKD will be reviewed here. Kidney transplantation, peritoneal dialysis, and hemodialysis are discussed separately. (See "Patient education: Dialysis or kidney transplantation — which is right for me? (Beyond the Basics)" and "Patient education: Hemodialysis (Beyond the Basics)".)

NORMAL KIDNEY FUNCTION — A brief overview of normal kidney function can help in the understanding of CKD. The kidneys function to remove wastes and excess water from the blood. These wastes and fluids are combined to form urine (figure 1). Many vital body functions are dependent upon the proper functioning of the kidneys. The kidneys also control the amount of sodium, potassium, phosphorous, calcium, and other chemicals in the body.

In order for this filtering process to occur properly, the blood pressure and blood flow to the kidneys must be adequate. If the arteries leading to the kidney are diseased, the filtering process will be affected. Filtering of the blood is done in the kidney by structures called "nephrons." The nephrons (figure 2), including the glomeruli and the tubules, must be healthy, and the path from the nephron to the urethra (figure 3) must not be blocked. There are normally approximately 700 thousand to 1 million filtering units or nephrons in each kidney. Diseases that reduce the number of normally functioning nephrons and/or reduce the function of nephrons cause CKD over time.

When the kidney filters are working properly, the result is a proper balance of fluids and chemicals in the body. If an imbalance occurs, many critical bodily functions can be affected, possibly producing symptoms associated with kidney disease. (See 'Chronic kidney disease complications' below.)

CHRONIC KIDNEY DISEASE RISK FACTORS — A number of factors can increase the risk of developing CKD, including:

- Diabetes mellitus
- High blood pressure
- A family history of kidney disease
- African-American and other ethnic minorities
- Obesity
- Smoking
- Older age
- Having protein in the urine
- Having autoimmune diseases such as lupus

CHRONIC KIDNEY DISEASE COMPLICATIONS — Most people with CKD do not have symptoms until the kidney function is severely impaired. The problem is often discovered when blood or urine tests done for other reasons show one or more of the abnormalities discussed above. The blood test that is most commonly used to check the level of kidney function is the creatinine concentration. As kidney function goes down, the creatinine concentration in the blood goes up. The most common urine tests are for protein or albumin in the urine. Sometimes, people with CKD will develop swelling, most commonly around the feet and ankles, before any other symptoms appear.

Even when kidney failure is advanced, most people still make a normal or near-normal amount of urine; this is sometimes confusing. Urine is being formed, but it does not contain sufficient amounts of the body's waste products.

With advanced kidney disease, you may develop edema (swelling of the feet, ankles, or legs), loss of appetite, increased sleepiness, nausea, vomiting, confusion, and difficulty thinking. Patients often develop high blood pressure, blood chemistry (electrolyte) abnormalities such as a high potassium concentration, anemia (a decrease in red blood cells, which can cause fatigue and other symptoms), and bone disease. (See "Patient education: Edema (swelling) (Beyond the Basics)".)

Uremia — People with advanced kidney failure may develop a group of symptoms referred to as **uremia**. The symptoms of uremia include loss of appetite, nausea, vomiting, a build-up of fluid around the heart, nerve problems, and changes in mental status, including drowsiness, seizures, or coma.

EVALUATION AND DIAGNOSIS — A health care provider may use several tests to diagnose CKD and determine if there is a treatable underlying cause. These include the following:

Kidney function tests — The glomerular filtration rate (GFR) gives an approximate measure of the number of functioning nephrons. GFR is used to monitor the severity of kidney impairment. Actually measuring GFR is difficult and not practical in the care of most patients. Instead, GFR is usually estimated. The most common way to estimate the GFR in adults is by measuring the creatinine level in the blood stream and then using this number to calculate an estimated GFR (eGFR) level. This eGFR level is often shown on routine blood chemistry lab reports that your doctor obtains. A measure of kidney function can also be obtained by collecting a 24-hour urine sample and measuring the concentration of creatinine in the blood and urine. The blood urea nitrogen level is also commonly measured with blood tests and, like the blood creatinine concentration, generally goes up as kidney function declines.

- A reduction in GFR implies either worsening of the underlying kidney disease or the development of another, occasionally reversible kidney problem.
- An increase in GFR, on the other hand, indicates improvement in kidney function.
- A stable GFR in people with CKD implies stable disease.

Urine tests — The presence of albumin or protein in the urine (called albuminuria or proteinuria) is a marker of kidney disease. Even small amounts of albumin in the urine may be an early sign of CKD in some people, particularly those with diabetes and high blood pressure. (See "Patient education: Protein in the urine (proteinuria) (Beyond the Basics)".)

Imaging studies — Imaging tests (such as computed tomography [CT] or ultrasound) may be recommended to determine if there are any obstructions (blockages) of the urinary tract, kidney stones, or other abnormalities, such as many large cysts seen in a genetic disease called polycystic kidney disease. (See "Patient education: Kidney stones in adults (Beyond the Basics)".)

Kidney biopsy — In a kidney biopsy, a small piece of kidney tissue is removed and examined under a microscope. The biopsy helps to identify abnormalities in kidney tissue that may be the cause of kidney diseases. (See "Patient education: Renal (kidney) biopsy (Beyond the Basics)".)

CHRONIC KIDNEY DISEASE TREATMENT — The first step in the treatment of CKD is to determine the underlying cause. Some causes are reversible, including use of medications that impair kidney function, blockage in the urinary tract, or decreased blood flow to the kidneys. Treatment of reversible causes may prevent CKD from worsening.

Research has shown that management of CKD is best done with the assistance of a nephrologist, a doctor who specializes in kidney diseases. Early referral to a nephrologist decreases the chance of developing complications associated with CKD.

Hypertension — Hypertension, or high blood pressure, is present in 80 to 85 percent of people with CKD. Maintaining good blood pressure control is the most important goal for trying to slow the progression of CKD. Taking a medication called an angiotensin-converting enzyme (ACE) inhibitor or angiotensin receptor blocker (ARB) reduces blood pressure and levels of protein in the urine and is thought to slow the progression of CKD to a greater extent than some of the other medicines used to treat high blood pressure.

Sometimes, a diuretic (water pill) or other medication is also added. You may be asked to monitor your blood pressure at home to be sure that your blood pressure is well controlled. (See "Patient education: High blood pressure treatment in adults (Beyond the Basics)".)

Anemia — People with CKD are at risk for anemia. This occurs because improperly functioning kidneys produce reduced amounts of a substance called erythropoietin. Anemia can lead to fatigue and other complications.

Selected patients can be treated with drugs that stimulate production of red blood cells. You or a family member may be able to inject these drugs at home. In some cases, iron supplements are also prescribed. (See "Treatment of anemia in hemodialysis patients".)

Dietary changes — Changes in your diet may be recommended to control or prevent some of the complications of CKD; most important is salt restriction to help control the blood pressure.

Protein — Restricting protein in the diet may slow the progression of CKD, although it is not clear if the benefits of protein restriction are worth the difficulty of sticking to a low-protein diet. Although a reduced-protein diet may delay dialysis for several years, the unappetizing nature of the diet is difficult for most people to tolerate.

Speak to your health care provider about the advantages and disadvantages of a low-protein diet. Some people may benefit from a plant-based diet. (See "Dietary recommendations for patients with nondialysis CKD".)

Potassium — Some people with CKD develop a high blood potassium level, which can interfere with normal cell function. This is frequently treated with a diuretic. Measures to prevent high potassium might also be recommended, including a low-potassium diet and avoiding medicines that raise potassium levels. (See "Patient education: Low-potassium diet (Beyond the Basics)".)

Phosphate — Phosphate is a mineral that helps to keep the bones healthy. Early in the course of CKD, the body begins to retain phosphate. As the disease progresses, high blood phosphate levels can develop. This is usually treated with medicines that prevent phosphate (found in foods) from being absorbed in the digestive tract. Dietary phosphate restrictions are also recommended (table 1A-B).

Cholesterol and triglycerides — High cholesterol and triglyceride levels are common in people with kidney disease. High triglycerides have been associated with an increased risk of coronary artery disease, which can lead to heart attack.

Treatments to reduce the risk of coronary artery disease are usually recommended, including dietary changes, medications for high triglyceride and cholesterol levels, stopping smoking, and tight blood sugar control in people with diabetes. (See "Patient education: High cholesterol and lipids (hyperlipidemia) (Beyond the Basics)" and "Patient education: Quitting smoking (Beyond the Basics)" and "Patient education: Self-blood glucose monitoring in diabetes mellitus (Beyond the Basics)".)

Sexual function — Men and women with advanced CKD often have difficulties with sexual function and infertility. Over 50 percent of men with end-stage kidney disease have difficulties with erection and decreased sex drive. Women often have disturbances in the menstrual cycle and fertility, usually leading to a stop in menstrual periods. Decreased sex drive may also occur in women.

You should discuss any changes in your sexual function with your health care provider because medications or other treatments may be effective. (See "Patient education: Sexual problems in men (Beyond the Basics)" and "Patient education: Sexual problems in women (Beyond the Basics)".)

Pregnancy — The risk that pregnancy will worsen kidney function or that decreased kidney function will interfere with pregnancy depends upon a number of factors. A woman with mild to moderate CKD who is considering becoming pregnant should discuss the possible risks with her nephrologist and obstetrical provider before trying to conceive.

Women with end-stage kidney disease who are on dialysis and who become pregnant are at increased risk for miscarriage, premature delivery, severe hypertension, and preeclampsia. A woman who undergoes successful renal transplantation has a lower risk of these complications. It may be advantageous for a woman to delay becoming pregnant while on hemodialysis if renal transplantation in the near future is likely. Hemodialysis may need to be done six to seven times per week during pregnancy.

PREPARING FOR DIALYSIS — Some people with CKD progressively worsen over time and will eventually need dialysis or a kidney transplant. There are two types of dialysis: hemodialysis and peritoneal dialysis. Kidney transplantation is also an option for some people with CKD even before ever starting dialysis. Patients should talk with their doctors about getting an evaluation for a kidney transplant long before they are getting close to needing dialysis.

An important component of treatment for patients with CKD is planning for dialysis in advance. Although kidney transplantation is the treatment of choice in most cases, many people must wait months or years for a kidney to become available. Dialysis will likely be needed, often for an extended period.

Dialysis and kidney transplantation are discussed in detail separately. (See "Patient education: Dialysis or kidney transplantation — which is right for me? (Beyond the Basics)" and "Patient education: Hemodialysis (Beyond the Basics)" and "Patient education: Peritoneal dialysis (Beyond the Basics)".)

WHERE TO GET MORE INFORMATION — Your health care provider is the best source of information for questions and concerns related to your medical problem.

This article will be updated as needed on our website (www.uptodate.com/patients). Related topics for patients, as well as selected articles written for health care professionals, are also available. Some of the most relevant are listed below.

Patient level information — UpToDate offers two types of patient education materials.

The Basics — The Basics patient education pieces answer the four or five key questions a patient might have about a given condition. These articles are best for patients who want a general overview and who prefer short, easy-to-read materials.

Patient education: Chronic kidney disease (The Basics)
Patient education: Swelling (The Basics)
Patient education: Diabetes and diet (The Basics)
Patient education: Polycystic kidney disease (The Basics)
Patient education: Hemodialysis (The Basics)
Patient education: Preparing for hemodialysis (The Basics)
Patient education: Preparing for pregnancy when you have diabetes (The Basics)
Patient education: Peritoneal dialysis (The Basics)
Patient education: Choosing between dialysis and kidney transplant (The Basics)
Patient education: Kidney transplant (The Basics)
Patient education: Planning for a kidney transplant (The Basics)
Patient education: Glomerular disease (The Basics)
Patient education: Polyarteritis nodosa (The Basics)
Patient education: Low-potassium diet (The Basics)
Patient education: Granulomatosis with polyangiitis (The Basics)
Patient education: Medicines for chronic kidney disease (The Basics)

Beyond the Basics — Beyond the Basics patient education pieces are longer, more sophisticated, and more detailed. These articles are best for patients who want in-depth information and are comfortable with some medical jargon.

Patient education: Dialysis or kidney transplantation — which is right for me? (Beyond the Basics)
Patient education: Hemodialysis (Beyond the Basics)
Patient education: Glomerular disease overview (Beyond the Basics)
Patient education: Polycystic kidney disease (Beyond the Basics)
Patient education: Edema (swelling) (Beyond the Basics)
Patient education: Protein in the urine (proteinuria) (Beyond the Basics)
Patient education: Kidney stones in adults (Beyond the Basics)
Patient education: Renal (kidney) biopsy (Beyond the Basics)
Patient education: High blood pressure treatment in adults (Beyond the Basics)
Patient education: Low-potassium diet (Beyond the Basics)
Patient education: High cholesterol and lipids (hyperlipidemia) (Beyond the Basics)
Patient education: Quitting smoking (Beyond the Basics)
Patient education: Self-blood glucose monitoring in diabetes mellitus (Beyond the Basics)

Patient education: Sexual problems in men (Beyond the Basics)
Patient education: Sexual problems in women (Beyond the Basics)
Patient education: Peritoneal dialysis (Beyond the Basics)

Professional level information — Professional level articles are designed to keep doctors and other health professionals up-to-date on the latest medical findings. These articles are thorough, long, and complex, and they contain multiple references to the research on which they are based. Professional level articles are best for people who are comfortable with a lot of medical terminology and who want to read the same materials their doctors are reading.

Treatment of anemia in hemodialysis patients
Antihypertensive therapy and progression of nondiabetic chronic kidney disease in adults
Assessment of nutritional status in hemodialysis patients
Bone biopsy and the diagnosis of renal osteodystrophy
Chronic kidney disease and coronary heart disease
Clinical manifestations and diagnosis of coronary heart disease in end-stage renal disease (dialysis)
Darbepoetin alfa for the management of anemia in chronic kidney disease
Diagnostic approach to adult patients with subacute kidney injury in an outpatient setting
Epidemiology of chronic kidney disease
Treatment of anemia in nondialysis chronic kidney disease
Hyporesponse to erythropoiesis-stimulating agents (ESAs) in chronic kidney disease
Treatment of anemia in peritoneal dialysis patients
Hypertension following erythropoiesis-stimulating agents (ESAs) in chronic kidney disease
Indications for initiation of dialysis in chronic kidney disease
Management of secondary hyperparathyroidism and mineral metabolism abnormalities in adult predialysis patients with chronic kidney disease
Management of secondary hyperparathyroidism and mineral metabolism abnormalities in dialysis patients
Overview of the management of chronic kidney disease in adults
Pathogenesis, consequences, and treatment of metabolic acidosis in chronic kidney disease
Dietary recommendations for patients with nondialysis CKD
Risk factors and epidemiology of coronary heart disease in end-stage renal disease (dialysis)
Secondary factors and progression of chronic kidney disease
Urinalysis in the diagnosis of kidney diseases

The following organizations also provide reliable health information.

- National Library of Medicine

  (www.nlm.nih.gov/medlineplus/healthtopics.html)

- National Institute of Diabetes and Digestive and Kidney Diseases

  (www.niddk.nih.gov)

- National Kidney Foundation

  (800) 922-9010
  (www.kidney.org)

- United Network for Organ Sharing (UNOS)

(888) 894-6361
(www.unos.org)

- American Kidney Fund

(www.kidneyfund.org)

- American Association of Kidney Patients

(www.aakp.org)

[1-4]

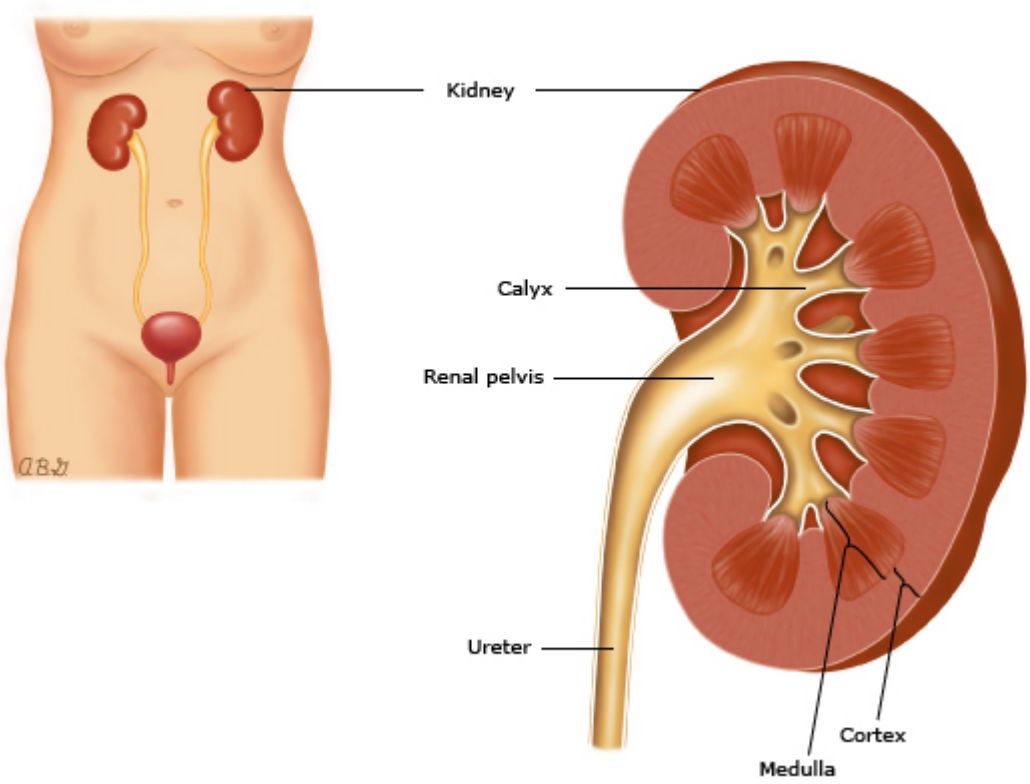
REFERENCES

1. Levey AS, Eckardt KU, Tsukamoto Y, et al. Definition and classification of chronic kidney disease: a position statement from Kidney Disease: Improving Global Outcomes (KDIGO). Kidney Int 2005; 67:2089.
2. Levey AS, Coresh J, Balk E, et al. National Kidney Foundation practice guidelines for chronic kidney disease: evaluation, classification, and stratification. Ann Intern Med 2003; 139:137.
3. Jafar TH, Stark PC, Schmid CH, et al. Progression of chronic kidney disease: the role of blood pressure control, proteinuria, and angiotensin-converting enzyme inhibition: a patient-level meta-analysis. Ann Intern Med 2003; 139:244.
4. Khan SS, Xue JL, Kazmi WH, et al. Does predialysis nephrology care influence patient survival after initiation of dialysis? Kidney Int 2005; 67:1038.

Topic 4410 Version 18.0

GRAPHICS

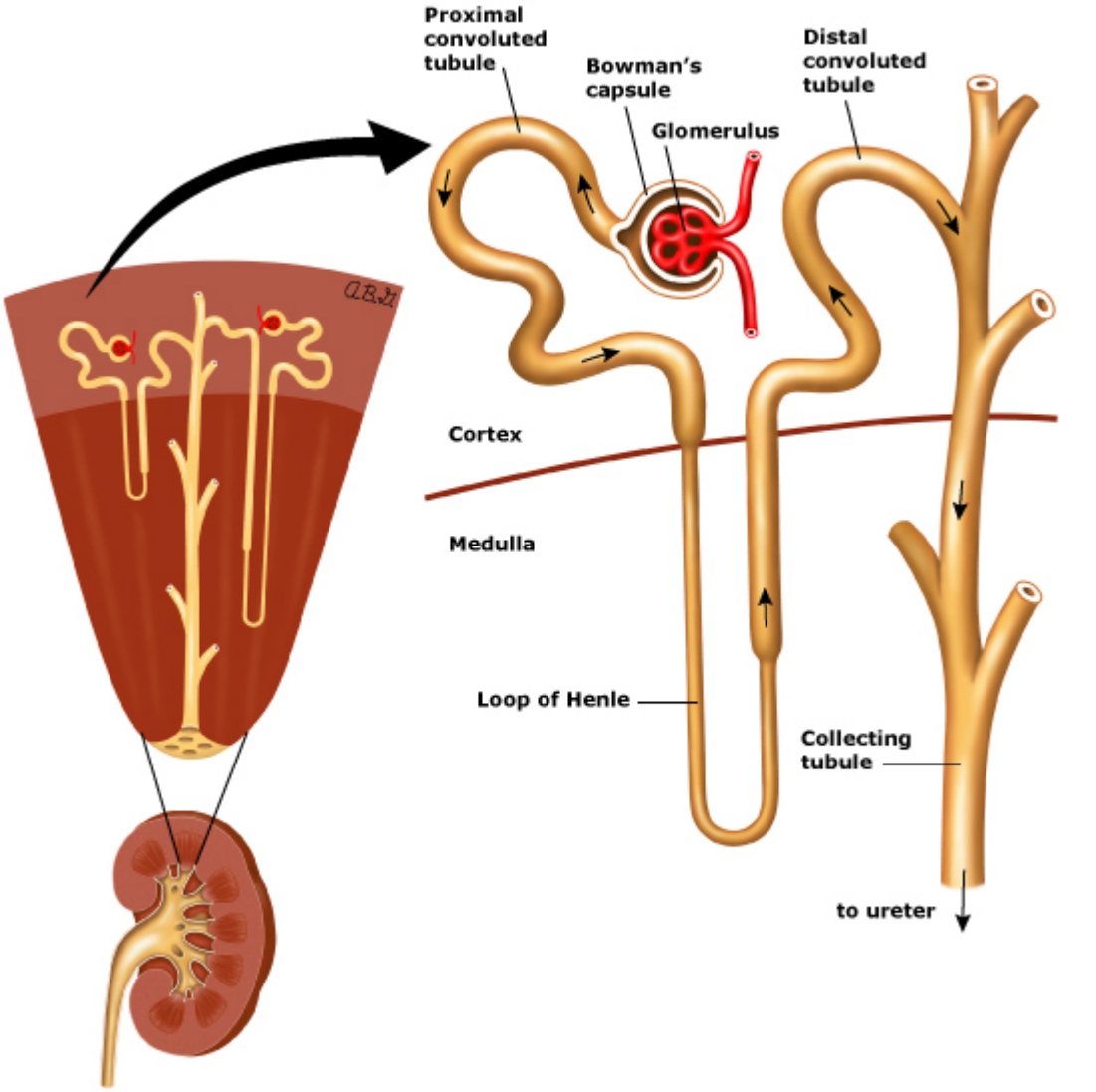
Anatomy of the kidney



This figure shows the structure of a kidney. The outer portion (the cortex) contains the glomeruli. The tubules are located in the cortex and medulla. The collecting tubules form a large portion of the inner medulla (the papilla). Urine travels from the collecting tubules into the caylces, and then to the renal pelvis, ureter, and bladder.

Graphic 80336 Version 2.0

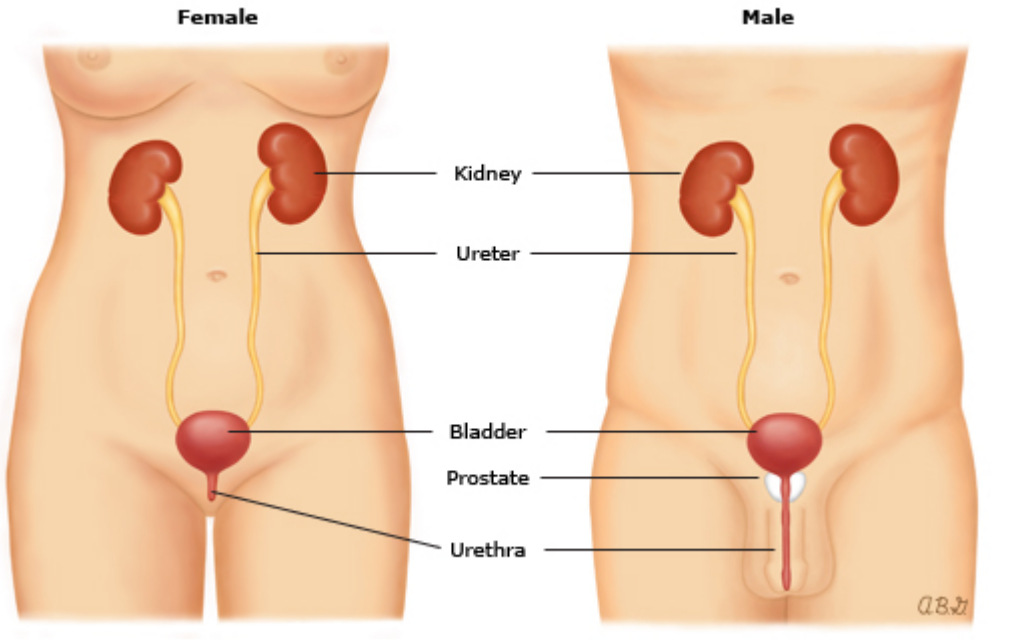
Anatomy of the nephron



This figure shows the structure of the nephron, which filters waste from the body's blood supply. Each nephron is composed of a glomerulus and a tubule. The glomerulus filters wastes and excess fluids, while the tubules modify the waste to form urine.

Graphic 82497 Version 4.0

Anatomy of the urinary tract



Urine is made by the kidneys. It passes from the kidneys into the bladder through two tubes called the ureters. Then it leaves the bladder through another tube called the urethra.

Graphic 79864 Version 7.0

Table 20. Phosphorus content of protein-containing foods

Food	Common Measure	Phosphorus (mg)	Protein (g)	mg P/ g protein
Beans, Legumes, Tofu				
Beans, Kidney	1 cup	251	15	16.7
Beans, Lima	1 cup	209	15	13.9
Beans, Navy	1 cup	286	16	17.9
Beans, Black	1 cup	241	15	16.1
Beans, Refried	1 cup	217	14	15.5
Soybeans, Boiled	1 cup	421	29	14.5
Soybeans, Roasted	1 cup	624	61	10.2
Sunflower Seeds	1 oz	322	6	53.7
Tofu, Firm	100 g	76	6	12.7
Tofu, Soft	100 g	52	4	13.0
Tofu, Lite	100 g	68	5	13.6
Cheese/Cheese Products				
Cheese, Cheddar	1 oz	145	7	20.7
Cheese, Swiss	1 oz	171	8	21.4
Cottage Cheese, Reg	1 cup	297	28	10.6
Cottage Cheese, 1%	1 cup	151	14	10.8
Cottage Cheese, 2%	1 cup	340	31	11.0
Cottage Cheese, Nonfat	1 cup	151	25	6.0
Cheese, Cream	2 Tb	30	2	15.0
Combination Foods				
Bean/Cheese Burrito, FF	2 small	180	15	12.0
Breakfast Biscuit, FF	1 egg/cheese/bacon	459	16.3	28.2
Cheeseburger, FF	Single w/condiments	310	28.2	11.0
Chicken Sandwich, FF	1 sandwich	405	29.4	13.8
Fried Shrimp, FF	6 to 8 small	344	18.9	18.2
Hot Fudge Sundae	1 small	227	5.6	40.5
Morningstar Breakfast Patty	1 patty	106	9.9	10.7
Pepperoni Pizza, 1 sl	Froz Pepperoni	222	16	13.9
Roast Beef Sandwich	1 sandwich	239	21.5	11.1
Sub Sandwich, FF	1 cold cuts	287	21.8	13.2
Taco, FF	Large	313	31	10.1
Dairy and Milk				
Buttermilk	1 cup	219	8	27.4
Cream Light	1 cup	192	7	27.4
Cream Sour	1 Tb	32	1.2	26.7
Cream, Half and Half	1 cup	230	7	32.9
Cream, Heavy	1 cup	149	5	29.8
Milk, 2%	1 cup	232	8	29.0
Milk, 1%	1 cup	235	8	29.4
Milk, Low-Sodium	1 cup	209	8	26.1
Milk, Nonfat	1 cup	247	8	30.9
Milk, Whole	1 cup	227	8	28.4
Yogurt, Lowfat	4 oz	162	6	27.0
Yogurt, Nonfat	4 oz	177	6	29.5
Yogurt, Reg	4 oz	107	4	26.8

Graphic 79877 Version 6.0

Table 20. Phosphorus content of protein-containing foods (cont'd)

Food	Common Measure	Phosphorus (mg)	Protein (g)	mg P/ g protein
Fish and Seafood				
Crab, Blue	3 oz.	175	17	10.3
Crab, Dungeness	3.oz.	149	19	7.8
Halibut	3 oz.	214	23	9.3
Oysters, Fried	3 oz.	196	13	15.1
Salmon	3 oz.	282	21	13.4
Shrimp	3 oz.	116	18	6.4
Meats/Poultry/Egg				
Beef Liver	3 oz.	392	23	17.0
Beef, Top Sirloin	3 oz.	203	25	8.1
Chicken, breast	3 oz.	196	27	7.3
Chicken, thigh	3 oz.	148	22	6.7
Egg, Large	1 large	86	6	14.3
Ham	3 oz.	239	19	12.6
Lamb Sirloin Chop	3 oz.	190	22	8.6
Pork Loin	3 oz.	146	22	6.6
Turkey	3 oz.	210	28	7.5
Veal Loin	3 oz.	189	22	8.6
Nuts/Nut Butter				
Almonds	1 oz.	139	6	23.2
Macadamia	1 oz.	56	2	28.0
Peanut Butter, Chunky	2 Tb	101	8	12.6
Peanut Butter, Smooth	2 Tb	118	8	14.8
Peanuts, Roasted	1 oz.	147	8	18.4
Walnuts	1 oz.	98	4	24.5
Other Sources of Phosphorus				
Beer	12 oz	43	1	43.0
Chocolate, Milk	1 miniature	95	3	31.7
Chocolate, Semi Sweet	1 oz	37	1	37.0
Coffee, Brewed	1 cup	2.3	0	
Coffee, Instant	1 tsp.	4.5	0	
Cola	12 oz	44	0	
Lemon Lime	12 oz	0	0	
Lemonade	1 cup	5	0.3	16.7
Root Beer	12 oz	0	0	
Tea, Brewed	1 cup	2.4	0	

A common way to determine a dietary phosphorus limit is to use an average of 10 to 12 mg/g of protein (multiply protein goal times 10 to 12 mg phosphorus). Thus, for a 70 kg individual requiring 84 g of protein, the phosphorus range is 840 to 1008 mg.

Considering all common sources of protein, the average phosphorus content per gram of protein is 17.8. If all diary products, nuts, beans, and seeds are eliminated, but meats and tofu are considered, the average phosphorus content per gram of protein is 10.3.

FF: fast food; Tb: tablespoon.

US Department of Agriculture, Agricultural Research Service. 2001. USDA Nutrient Database for Standard Reference, Release 14. Nutrient Data Laboratory Home Page, http://www.nalusda.gov/fnic/foodcomp.

Graphic 56081 Version 8.0

Contributor Disclosures

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