Some of the kidney's endocrine functions include

* A. Erythropoietin synthesis
* B. Renin synthesis
  C. Atrial Naturietic peptide synthesis
  D. Vitamin C metabolism
* E. Vitamin D metabolism

  Besides excreting Blood urea nitrogen (BUN, a product of amino-acid degradation) and Creatinine (muscle metabolism), the kidney also excretes toxins, drugs, ketones, sulphates and other molecules. <p>Its endocrine products are Renin, Erythropoietin and Vitamin D. Renin, also known as angiotensinogenase, is a circulating enzyme released mainly by juxtaglomerular cells in the JGA of the kidneys in response to low blood volume or low body NaCl content. Although it has hormone-like actions, it cleaves a protein precursor in the circulation rather than working on a cellular target. Thus it is not truly a hormone. Erythropoietin or EPO is a glycoprotein hormone that is a cytokine for erythrocyte (red blood cell) precursors in the bone marrow. Also called hematopoietin or hemopoietin, it is produced by the kidney, and is the hormone regulating red blood cell production. Once vitamin D is produced in the skin or consumed in food, it requires chemical conversion in the liver and kidney to f

2) The primary function of glomeruli is

  A. Reabsorption, and in a normal dog this rate is approximately 3-5 ml/kg/minute
  B. Filtration, and in a normal dog this rate is approximately 0.3-0.5 ml/kg/minute
  C. Reabsorption, and in a normal dog this rate is approximately 0.3-0.5 ml/kg/minute
* D. Filtration, and in a normal dog this rate is approximately 3-5 ml/kg/minute

  Glomerular filtration rate (GFR) is the volume of fluid filtered from the renal glomerular capillaries into the Bowman's capsule per unit time. In clinical practice, creatinine clearance is used to measure GFR. <p> Normal GFR ranges are 3-5 ml/kg/min in a 10 kg dog and 1-3 ml/kg/min in a 500 kg horse. Put differently, a 10 kg dog produces about 30-60 litres of filtrate every day (99% of which is reabsorbed).

  A. Water, molecules less than 2 nm in size and positively charged proteins
  B. Water, molecules less than 2 nm in size and negatively charged molecules upto 4 nm in size
* C. Water, molecules less than 2 nm in size and many positively charged molecules upto 4 nm in size
  D. Water and molecules less than 5 nm in size

  The filtration barrier of the glomerulus restricts the filtration of molecules on the basis of size and electric charge. Molecules with a radius of less than 2 nM pass through freely while those above 4 nM are retained. Sizes between 2 and 4 nM filter through depending on their charge - with preference given to positively charged particles. The barrier consists of the following : Capillary Endothelial cells of the glomerulus contain numerous pores (fenestrae). The cells have openings which are so large that nearly anything smaller than a red blood cell passes through that layer. Basement membrane : Glomerular endothelium sits on a very thick (100-200 nm) glomerular basement membrane. It is not only uncharacteristically thick compared to most other basement membranes (40-50 nm), but it is also rich in negatively charged glycosaminoglycans such as heparan sulfate. The negatively-charged basement membrane repels negatively-charged proteins from the blood, helping to prevent thei

4) Filtration within the glomerular capillary is a function of :

* A. Hydrostatic pressure, Oncotic pressure, Ultrafiltration coefficient
  B. Oncotic pressure, Ultrafiltration coefficient, Active transport
  C. Hydrostatic pressure, Oncotic pressure, Blood pressure
  D. Hydrostatic pressure, Osmotic pressure, Active transport

  Filtration within the glomerular capillary bed is a passive process driven by the same 3 physical forces as filtration at every other capillary bed in the body: hydrostatic pressure, oncotic pressure and ultrafiltration coefficient (function of surface area and permeability). <p> Recent studies have shown that surface area may vary greatly as mesangial cells contract in response to stimuli such as angiotensin II and parathyroid hormone. <p>The interaction of these factors is defined by the equation
GFR = KUF [(PGC-PB) - (pGC - pB)] where KUF=ultrafiltration coefficient P=hydrostatic pressure p=oncotic pressure GC=glomerular B=Bowman's capsule <p><img src="Glomerular-barrier.jpg">

* A. Macula densa located in the distal tubule
  B. Macula densa located in the afferent arteriole
  C. Vascular smooth muscle responses
  D. Renin secretion by cells of the juxtaglomerular apparatus

  The macula densa is an area of closely packed specialized cells lining the region of the distal convoluted tubule lying next to the glomerulus. The macula densa senses fluid flow rate as well as sodium chloride concentration in the distal tubule of the kidney. Regulation of GFR requires both a mechanism of detecting an inappropriate GFR as well as an effector mechanism that corrects it. The macula densa serves as the detector, while the glomerulus acts as the effector. When the macula densa detects an elevated GFR, it releases several molecules that cause the glomerulus to rapidly decrease its filtration rate. (Technically, the macula densa detects a SNGFR, single nephron GFR, but GFR is used here for simplicity.) This is the renal-specific response. <p>GFR may also be modified by the Myogenic response (vascular smooth muscle of arterioles contracting/relaxing) Hormonal response (SNS vascular responses)
<a href="http://en.wikipedia.org/wi informati

  A. GFR increases in proportion, by 50%
* B. GFR remains constant
  C. GFR increases, but less than the proportional increase in blood pressure
  D. GFR increases, but more than the proportional increase in blood pressure

  Within a wide range of blood pressure (about 80 mmHg to around 180 mmHg), the GFR remains nearly constant through "auto-regulation". <p>For example, if blood pressure reduces, GFR is maintained by the following 3 responses : Myogenic response - inherent tendency of arterial smooth muscle (within afferent arterioles) to contract when under pressure and vice-versa
Tubuloglomerular feedback mechanism of the macula densa within the juxtaglomerular apparatus. This senses the rate of fluid delivery (specifically that of Cl mediated by the Na-K-2Cl cotransporter) that allows afferent arterioles to dilate/contract Neurohormonal influences. When low blood pressure is sensed, Angiotensin II, triggered by Renin, stimulates Na+ resorption in the proximal tubule constricts afferent arterioles to reduce flow through the kidneys but also constricts efferent arterioles to maintain GFR
increases the secretion of ADH and aldosterone stimulates the hyp

7) In typical horses or cattle, which kidney is palpable during a rectal exam?

* A. Left
  B. Neither
  C. Right
  D. Both

  The caudal pole of the left kidney is palpable. The right kidney, more cranially located than the left, cannot be palpated through a rectal exam.

8) The kidney has a heterogenous population of "short-loop" and "long-loop" nephrons the proportion of which is species-variable. Which of the following statements is true?

  A. Shorter loops are thought to enhance the ability to concentrate urine
* B. Longer loops are thought to enhance the ability to concentrate urine
  C. Shorter loops are thought to enhance the ability to reabsorb glucose
  D. Longer loops are thought to enhance the ability to reabsorb glucose

  A. the volume of creatinine that is cleared per unit time
* B. the volume of blood plasma that is cleared of creatinine per unit time
  C. the net weight of creatinine cleared in 24 hours
  D. the rate at which creatinine is created less the rate at which it is cleared

  In renal physiology, creatinine clearance (CCr) is the volume of blood plasma that is cleared of creatinine per unit time. Clinically, creatinine clearance is a useful measure for estimating the glomerular filtration rate (GFR) of the kidneys. However, because there is a slight tubular secretion of creatinine (in humans, but not dogs or cats), GFR is usually overestimated. <p>Inulin, as it is completely filtered at the glomerulus and is neither secreted nor reabsorbed in the tubules, has been used as an important medical test of renal function, specifically a measure of glomerular filtration rate (GFR). The measurement of GFR by inulin is still considered the gold-standard, although it has been now largely replaced by other, simpler measures that are actually estimations of GFR, which have been confirmed in large cohorts of patients with chronic kidney disease (e.g. Iothalomate, EDTA, creatinine clearance).<p>Creatinine clearance = Ucr x V / Pcr where Ucr - Urine creatinine concentration</l

* A. is an increased concentration of urea and creatinine in the bloodstream
  B. is similar to uremia, except a more serious condition
  C. is caused by failure of a large number of nephrons
  D. encapsulates the clinical signs resulting from renal failure, when kidney function is compromised and urea is retained in the blood.

  Azotemia is a medical condition characterized by abnormal levels of urea, creatinine, various body waste compounds, and other nitrogen-rich compounds in the blood as a result of insufficient filtering of the blood by the kidneys (i.e. low GFR). <p>Azotemia can be classified according to its cause. Prerenal azotemia : the blood supply to the kidneys is inadequate. (e.g. hypovolemia, shock, dehydration, heart failure) Renal : due to intrinsic renal dysfunction. Note that dysfunction of 75% of renal nephrons is required to development of azotemia. Postrenal azotemia : the urinary outflow tract is obstructed or the urinary bladder is ruptured. Prompt treatment of some causes of azotemia can result in restoration of kidney function; delayed treatment may result in permanent loss of renal function. Treatment may include hemodialysis or peritoneal dialysis, medications to increase cardiac output and increase blood pressure, and the treatment of the condition that caused the azot

11) Assuming a normal animal, which of the following statements regarding glomerular filtrate is closest to the truth?

* A. 60% of the Na+ and water are reabsorbed in the proximal convoluted tubule
  B. 60% of water and 30% of Na+ is reabsorbed in the proximal convoluted tubule
  C. 40% of inulin is reabsorbed in the proximal tubule, the remainder in the descending loop of Henle
  D. 50% of glucose is reabsorbed in the proximal tubule, the remainder in the descending loop of Henle
  E. 20% of creatinine is reabsorbed in the proximal tubule, the remainder is excreted

  99% of the glomerular filtrate is reabsorbed in a healthy animal. The proximal tubule plays a significant role in this reabsorption. Of solutes and water from the glomerular filtrate, it reabsorbs
100% of amino acids, glucose and bicarbonate 60-65% of Na+, K+, Cl- and water <p>Angiotension II plays a role in stimulation of Na absorption in the proximal tubule by enhancing activity of the Na/K/ATPase pump as well as the Na/H exchanger. <p>Inulin, specifically because it is not reabsorbed in any part of the nephron, is an ideal candidate for assessing GFR. <p>Creatinine is a slightly more practical candidate for assessing GFR because its concentration in the blood is fairly constant. However, since it is also actively secreted by the nephron (in most animals, but not dog), creatinine clearance tends to overestimate actual GFR by about 10%.

12) The loop of Henle immediately follows the proximal tubule. It has a descending limb which travels from the cortex into the medulla of the kidney, followed by an ascending limb. In the descending limb

  A. The osmolality of the filtrate continues to reduce due to reabsorption of Na+ and water
* B. The osmolality of the filtrate progressively increases due to diffusion of Na+ into the tubule and due to the continued reabsorption of water
  C. The osmolality of the filtrate progressively reduces due to reabsorption of water
  D. The osmolality of the filtrate progressively increases due to diffusion of water into the tubule

  Following 60% reabsorption of Na+ and water in the proximal convoluted tubule, the net action within the loop of Henle is a further reabsorption of about 20% of water and about 30% of Na+. <p>The descending tubule is permeable to Na, Cl, urea and water. However, while water continues to be reabsorbed at a steady rate, Na+ actually diffuses back into the tubule, thus raising osmolality of the filtrate. <p>Later, in the ascending tubule, Na+ is rapidly reabsorbed while water continues to be reabsorbed steadily.<p>By the time filtrate reaches the end of the loop of Henle, only 10% of Na+ and about 20% of water of the original glomerular filtrate remain, with osmolality between 100 and 150 mOsm/L (about 50% of the value of plasma).

13) By the time filtrate reaches the distal tubule, only 10% of Na+ and about 20% of water of the original glomerular filtrate remain.

  A. Most of the remaining water and Na+ is reabsorbed in the distal tubule
  B. Some of the remaining water and Na+ is reabsorbed in the distal tubule
  C. Most of the remaining water is reabsorbed in the distal tubule
* D. Most of the remaining Na+ is reabsorbed in the distal tubule

  The distal tubule is impermeable to water. However, of the approximately 10% of Na+ that remains in the filtrate prior to entry into the distal tubule, about 7% is reabsorbed under regulation of aldosterone. Aldosterone controls reabsorption of about 2% of filtered sodium in the kidneys. (Aldosterone also acts in the collecting duct to stimulate secretion of H+ ions)<p>This decreases the concentration to a value less than that in plasma setting up the filtrate for the action of ADH on the collecting duct. <p>In the collecting duct, the filtrate has a lower concentration than plasma. Water therefore tends to be reabsorbed. However, water can only travel through aquaporins, the number of which are controlled by ADH : the higher the ADH, the higher the number of aquaporins and the greater the water that is reabsorbed. <p>The collecting duct also reabsorbs most of the remaining Na+ (2-3%).

  A. Fractional excretion rate minus Fractional reabsorption rate = 100
  B. Fractional excretion rate multiplied by Fractional reabsorption rate = 100
  C. Fractional excretion rate divided by Fractional reabsorption rate = 100
* D. Fractional excretion rate plus Fractional reabsorption rate = 100

  Fractional excretion is the "clearance" of the substance as a fraction of the clearance of a reference substance (like creatinine or inulin). The fractional excretion rate of Na+ in a healthy animal is less than 1%, while that of potassium is between 65 and 115%, varying with diet. <u>This is why renal failure invariably causes hyperkalemia.</u> <p>Since a substance passing through the glomeruli of kidneys can either be excreted or reabsorbed, the fractional reabsorption rate equals 100 - fractional excretion %. <p>Clinically, values for FE can be useful in the evaluation of renal tubular function. For example, the FE for sodium is usually <1% (implying that more than 99% of filtered sodium is reabsorbed). In an animal in renal failure, the FE for sodium may exceed 3% - a reflection of renal tubular dysfunction.<p>FE for substance X is given by : FE(X) = [U(X) / P(X)] x 100 / [U(Cr) / P(Cr)] where
FE(X) = Fractional excretion of X U(X) = Urine concentration of X
P(X) = Plasma con

A. The key driving force is the Na-K-ATPase activity with the pumps residing on the apical (lumen) end of lumen epithelial cells.
* B. The key driving force is the Na-K-ATPase activity with the pumps residing on the basal (capillary) end of lumen epithelial cells.
C. The key driving force is the Na/H antiporter activity with the pumps residing on the basal (capillary) end of lumen epithelial cells.
D. The key driving force is the Na/H antiporter activity with the pumps residing on the apical (lumen) end of lumen epithelial cells.

The key driving force for proximal tubular reabsorption is Na-K-ATPase (primary active transport) activity that takes place at the basolateral (capillary) end of lumenal epithelial cells. 3 Na+ are pushed into the capillary for every 2 K+ pulled into the cell. This sets up an electrochemical gradient for Na+ between the lumen filtrate and the epithelial cell, pulling in Na+ into the epithelial cells through the Na+/H+ antiporter. The Na+ gradient also supports secondary active transport of glucose, amino acids, phosphorus, sulphur and other organic ions. Subsequently, these diffuse through the basolateral membrane into the capillary passively or through facilitated diffusion. H+, pushed into the lumen filtrate through the Na/H antiporter, reacts with HCO3- in the filtrate to produce H2O and CO2, the latter diffusing from the lumen into the epithelial cell CO2 in the cell, in the presence of carbonic anhydrase, combines with H2O to create H+ (thus replenishes H+ lo

A. facilitated diffusion across the luminal membrane, then primary active transport across the basolateral membrane
B. primary active transport across the luminal membrane, then passive, carrier-mediated diffusion across the basolateral membrane
* C. secondary active transport across the luminal membrane, then passive, carrier-mediated diffusion across the basolateral membrane
D. secondary active transport across the luminal membrane, then active transport across the basolateral membrane

The key driving force for proximal tubular reabsorption is Na-K-ATPase (primary active transport) activity that takes place at the basolateral (capillary) end of lumenal epithelial cells. 3 Na+ are pushed into the capillary for every 2 K+ pulled into the cell. This sets up an electrochemical gradient for Na+ between the lumen filtrate and the epithelial cell, pulling in Na+ into the epithelial cells through the Na+/H+ antiporter. This Na+ gradient also supports secondary active transport of glucose using SGLT1 and SGLT2 (as well as amino acids, phosphorus, sulphur and other organic ions). Subsequently, glucose (and others) diffuse through the basolateral membrane through carrier-mediated diffusion using GLUT1 and GLUT2 transport proteins. <p>IMPORT : Glucose reabsorption is a saturable process. In other words, if the glucose concentration in the filtrate is too high (over about 10mmol/L), some glucose will fail to be reabsorbed, resulting in glucosuria (glucos

17) Diabetes Mellitus results in glucosuria (glucose in urine) primarily because

* A. Glucose reabsorption is a saturable process and can be overwhelmed
  B. Glucose diffuses from peritubular capillaries into the distal tubule
  C. Diabetes upsets the Na-K-ATPase pump, the primary driver of reabsorption in the proximal tubule
  D. Glucose diffuses from peritubular capillaries into the proximal convoluted tubule
  E. Diabetes causes damage to nephrons

  Glucosuria has many causes, the most common ones being : Diabetes mellitus. Due to a lack of the hormone insulin, plasma glucose levels are above normal. This leads to saturation of receptors in the kidneys, and occurs at plasma glucose levels above about 10 mmol/L. Renal Glucosuria : This is usually a congenital defect in proximal tubular handling of glucose that results in glucosuria despite normal blood glucose concentration. Affected animals may be asymptomatic, have polydipsia and polyuria, or have recurrent urinary tract infections due to bacterial colonization in the presence of glucose. Diagnosis is made by demonstrating persistent glucosuria despite a normal blood glucose concentration and by identifying no other renal reabsorptive abnormalities. The general consensus is that it is not progressive and does not require treatment.
F syndrome : a generalized proximal tubular reabsorptive defect resulting in excessive urinary loss of glucose, sodium,

18) 60-65% of glomerular filtrate is reabsorbed in the proximal convoluted tubule (PCT). With respect to this reabsorption

  A. Diffusion is the primary driving force
  B. Na+ initially diffuses into the filtrate; however, by the end of the passage through the PCT, there's a 30% (approx.) reduction in filtrate Na+.
* C. The osmolality of the filtrate does not change significantly during its passage through the PCT
  D. Nearly 100% of sodium and glucose are reabsorbed
  E. If inulin is present in the filtrate, is it absorbed in proportion (60-65%)

  Key points of reabsorption with the PCT are : 60-65% of glomerular filtrate reabsorbed 60-65% of Na+, K+, Cl-, water reabsorbed Nearly 100% of bicarbonate, glucose and amino acids reabsorbed Various organic wastes are secreted in the proximal tubule : these include acids (e.g. uric), bases, creatinine, bile pigments, steroid hormones, and drugs (penicillin, atropine, morphine). Primary and secondary active transport of Na+ are the key driving forces Filtrate absorption is isotonic - that is, osmolality does not change

19) Anti-diuretic hormone (ADH) is synthesized in the hypothalamus and is released when the body needs to conserve water. Which part of the nephron does it act upon?

  A. Loop of Henle
  B. Proximal convoluted tubule
  C. Distal tubule
  D. Glomerulus
* E. Collecting duct

  ADH, also called vasopressin, exerts control of free water reabsorption in the collecting ducts of the kidneys (especially the cortical and outer medullary collecting ducts). Activation of adenylate cyclase causes increase in cAMP which leads to the insertion of aquaporin-2 (AQP2) channels (water channels) into the apical membrane of the cells lining the collecting duct. This allows water to be reabsorbed down an osmotic gradient, equilibrating urine to the osmolality of the medullary interstitium (2800 to 3000 mOsm/Kg). <p>Also see Wikipedia

  A. Glomerular function
  B. Blood pressure
  C. Potassium balance
* D. Na+ balance

  Even though the kidneys are the main regulator ECF volume, Na+ content in the body determines the actions of the kidney. <p>For example, if an animal has a sudden increase in intake of NaCl, the following sequence of events occurs : ECF osmolality increases (due to the absorption of NaCL) The increased ECF osmolality triggers thirst centres of the brain, so that water intake is increased. Increased ECF osmolality attracts intra-cellular water resulting in blood volume expansion increasing preload (atrial stretch). This increases the production of atrial natruiretic peptide (ANP). ANP directly decreases Na+ reabsorption in the distal tubule and cortical portion of the collecting duct. In addition, higher ANP lowers the production of aldosterone. This increases Na+ clearance in the distal tubule and cortical collecting duct.
Blood volume sensors (atrium, pulmonary vessels, baroreceptors, kidney) react to increased blood volume, reducing the producti

21) Relative changes in volume of ECF are sensed by

  A. Low-pressure sensors in the atria & pulmonary vessels, aortic arch and carotid sinus and the juxtaglomerular apparatus of the kidney
* B. Low-pressure sensors in the atria & pulmonary vessels, high pressure baroreceptors in the aortic arch and carotid sinus and the juxtaglomerular apparatus of the kidney
  C. High-pressure sensors in the atria & pulmonary vessels, low pressure baroreceptors in the aortic arch and carotid sinus and the juxtaglomerular apparatus of the kidney
  D. High-pressure sensors in the atria & pulmonary vessels, aortic arch and carotid sinus and the juxtaglomerular apparatus of the kidney

22) When Na+ intake occurs, the ratio of ECF (extra-cellular fluid) to ICF (intra-cellular fluid) changes as follows

* A. Increases because the osmolality of ECF increases as Na+ is prevented from entering ICF
  B. Decreases because the osmolality of ECF increases as Na+ is prevented from entering ICF
  C. Increases because the osmolality of ECF decreases as Na+ is prevented from entering ICF
  D. Remains the same because along with excess Na+ absorbed into the ECF, water also follows

  The primary reason why the ECF/ICF ratio changes with an increased intake of Na+ is that Na+ is not freely permeable into cells. As a result the osmolality of ECF increases pulling in water from the ICF, thus increasing the ECF to ICF ratio in the short term. <p>This triggers an immediate response (ADH upregulation & thirst, to reduce ECF osmolality), a short term response (SNS downregultion, aimed at lowering blood pressure) and a medium term response (RAAS & ANP downregulated, to increase Na+ excretion).

  A. A rapid uptake by cells primarily triggered by epinephrine
* B. A rapid uptake by cells primarily triggered by insulin
  C. A rapid secretion by cells of the late distal tubule and cortical collecting ducts primarily triggered by aldosterone
  D. A rapid increase in GFR so that net excretion of K+ occurs

  Ingested K+ is rapidly absorbed from the gastrointestinal tract. Rapid cellular uptake of ingested K+ is essential to prevent a rise in ECF K+ concentration that would have severe adverse effects on cardiac function. The body responds as follows <p>
Acute response : Under the influence mainly of insulin, the ingested K+ is rapidly transported from the ECF to the ICF by the cell membrane Na+,K+-ATPase ion pump which is present in all cell membranes. Epinephrine and aldosterone also play a role.
Renal regulation (non-acute) : The acute response takes care of most K+. However, it still results in a mild increase in K+ which is sufficient to stimulate increased renal K+ excretion (as it should! The excess K+ does have to be excreted). This occurs through active secretion by cells of the late distal tubule and cortical collecting ducts primarily triggered by aldosterone Depletion of excess in ICF : As renal K+ excretion proceeds, plasma K+ concentration falls increas

  A. Loop of Henle, through the influence of aldosterone
  B. Loop of Henle, through the influence of norepinephrine
  C. Glomerulus to increase GFR
* D. Late distal convuluted tubule and cortical collecting duct
  E. Proximal tubule, through the influence of aldosterone

  About 50-60% of K+ in glomerular filtrate is reabsorbed by the proximal tubule, irrespective of plasma concentration. The thick ascending limb of the loop of Henle reabsorbs another 30-40% of filtered K+. Consequently, the fluid reaching the distal convoluted tubule contains less than 10% of the filtered K+ regardless of the K+ intake. Nevertheless, regulation of K+ balance is primarily a function of distal nephron K+ secretion or reabsorption. This process has the following components : First, K+ is pumped into the cells lining the tubule. This is achieved by primary active transport of K+ by the Na/K-ATPase pumps in the basolateral membrane. Within the luminal epithelial cell, this creates a high intracellular K+ concentration as well as an electrical gradient which drives K+ efflux across the luminal cell membrane into the lumen. Aldosterone, upregulated by higher than normal K+ in the plasma, is the key driver. It increases activity of the Na/K/ATPase pump

25) A healthy dog would have plasma corresponding to approximately

* A. About 20% of extra-cellular fluid
  B. About 4-5% of intra-cellular fluid
* C. 4-5% body weight
  D. About 20% body weight

  Body fluids - distribution : Intra-cellular fluid : About 40% of body weight
E fluid : About 20% of body weight, of which Plasma volume : about 4-5% body weight Interstitial fluid : about 15% body weight Note about blood : Blood, in a healthy animal, usually constitutes about 10% of body weight. Plasma is responsible for about half of that, while blood cells would account for the remainder.

26) Osmotic pressure is measured in units of

* A. Hydrostatic pressure
  B. Difference in particle concentrations
  C. Osmolarity
  D. Osmolality

  Osmotic pressure is defined as the hydrostatic pressure required to oppose the movement of water through a semi-permeable membrane in response to an osmotic gradient. <p>Put differently, an osmotic gradient (difference in particle concentration) tends to drive water towards the side with the higher osmolarity. If that same side's hydrostatic pressure is increased, water will tend to flow in the opposite direction. The hydrostatic pressure differential at which flow due to the osmotic gradient is nullified is the osmotic pressure (of the osmotic gradient).

27) Osmolarity and osmolality are, essentially, identical concepts. The difference between them is

A. How they are measured. Osmolality is solute/litre; osmolarity is solute/Kg
B. They are identical concepts; in fact, there is no difference between them.
C. They are not identical concepts. Osmolarity related to hydrostatic pressure while osmolality relates to solute concentration
* D. How they are measured. Osmolarity is solute/litre; osmolality is solute/Kg

Osmolality, in biology and chemistry, is a measure of moles of solute per kilogram of solvent. The similar measurement osmolarity measures moles per liter of solvent. If the solvent is water, these measurements are practically equivalent, because the weight of 1 litre of water is 1 kg. <p> Also see Wikipedia

28) The approximate osmolarity of ECF is 300 mOsm/L. Substance ABC is permeable across the cell membrane. If 1 litre of 600 mOsm/L ABC solution is intravenously fed to a dog, the short-term impact will be

* A. The ECF/ICF proportion will remain the same as ABC will equilibrate between ICF and ECF
B. ECF volume will increase by exactly 1 litre because ICF volume is tightly regulated by active transport mechanisms.
C. ECF volume will increase by less than 1 litre because the 600 mOsm/L ABC will result in ECF hypotonicity thus pushing water from ECF to ICF.
D. ECF volume will increase by more than 1 litre because the 600 mOsm/L ABC will result in ECF hypertonicity thus drawing in water from ICF.

Tonicity refers to the ability of a solute (particle) to cause movement of water across the cell membrane due to the impermeability of the membrane to the solute. <p>If, as in the case of ABC above, the solute is permeable, it will be ABC that will move into ICF from ECF rather than water into ECF from ICF. Consequently, even though osmolality of ECF has increased, so has that of ICF. This would result in the intravenous solution being proportionately distributed between ICF and ECF in the short term. <p>In the medium term, the overall increase in body fluid would trigger a renal (RAAS) and cardio-vascular (ANP) response that would gradually eliminate ABC and excess water out of the system.

29) Oncotic pressure is

A. the total osmotic pressure of a solution
B. the difference between the hydrostatic pressure and the osmotic pressure of a solution
C. the osmotic pressure created due to the presence of all dissolved substances
* D. the osmotic pressure created due to the presence of large protein molecules

In blood plasma, the dissolved compounds have an osmotic pressure. A portion of the total osmotic pressure is due to the presence of large protein molecules (albumin, in particular); this is known as the colloidal osmotic pressure, or oncotic pressure. Because large plasma proteins can't easily cross through the capillary walls, their effect on the osmotic pressure of the capillary interiors will, to some extent, balance out the tendency for fluid to leak out of the capillaries. In conditions where plasma proteins are reduced, e.g. from being lost in the urine (proteinuria) or from malnutrition, the result of the too low oncotic pressure can be edema - excess fluid buildup in the tissues.

30) The typical osmolality of blood in a healthy animal is approximately

  A. 250 Osmoles/liter
  B. 300 gms/liter
  C. 300 milliOsmoles/liter
* D. 300 milliOsmoles/Kg
  E. 300 mmHg

  Osmolality, in biology and chemistry, is a measure of moles of solute per kilogram of solvent. The similar measurement osmolarity measures moles per liter of solvent. If the solvent is water, these measurements are practically equivalent, because the weight of 1 litre of water is 1 kg. <p> The typical osmolatity of blood in a capillary is about 280 to 300 mOsm/Kg, made up of Na - about 140 mM K - about 4 mM Protei - about 1.5 mM Remainder - anions like bicarbonate and chloride.
Intracellula osmolality differs primarily in the values of Na+ (about 10 mM) and K+ (about 140 mM). <p>Also see this Wikipe article

31) The typical water requirements for a healthy small dog are

  A. 40 ml/kg/day
  B. 20 ml/kg/hour
  C. 10 ml/kg/hour
* D. 60 ml/kg/day

  The primary determinant of an animal's water requirement is calorie intake. Typically, 1 ml of water is required for the creation of 1 kcal of energy (calorific requirements are a logarithmic function of body weight, with unit requirements decreasing in larger animals). Large dogs, for example, need about 40 ml/kg/day. However, work may increase the need for water by as much as 20 to 300 percent. Other factors affecting water intake include diet and ambient conditions. Needless to say, health factors may dramatically affect water intake.

32) If you are told that an animal that normally weighs 50 kg is 5% dehydrated, it means that it need a water replenishment of (litres)

  A. 3.0
  B. 5.0
  C. 1.5
* D. 2.5

  Dehydration is always clinically expressed as % of body weight. Blood measures - hematocrit & plasma proteins - are usually the best way of assessing dehydration. <p>A physical can provide indications as well : Semidry oral mucous membranes, normal skin turgor, and eyes maintaining normal moisture indicate 4-5% dehydration. Dry oral mucous membranes, mild loss of skin turgor, and eyes still moist indicate 6-7%. Dry mucous membranes, considerable loss of skin turgor, and eyes retracted indicate 8-10%. Very dry oral mucous membranes, complete loss of skin turgor, severe retraction of the eyes, dull eyes, and possible alteration of consciousness indicate 12%.

33) Hypertonic dehydration can result from

  A. Excess sodium intake
  B. Hemorrhage
  C. Diuretic use that causes more salt than water to be lost
  D. Diarrhea or vomiting
* E. Diuretic use that causes more water than salt to be lost

  Hypertonic dehydration : When fluid lost has a tonicity less than that of body fluids. The water loss is shared by all body fluid compartments and relatively little reduction in extracellular fluids occurs. Thus, circulation is not compromised unless the loss is very large. This can be a result of decreased water intake, for example. Hypotonic dehydration : When fluid lost has a tonicity higher than that of body fluids. Depletion in both sodium and water with greater losses of sodium than water, resulting in extracellular fluid loss. Causes of hypotonic dehydration include overuse of diuretics, chronic salt wasting, renal disease, and decreased intake of both salt and water. Circulation is affected in hypotonic dehydration. Isotonic dehydration: a balanced depletion of water and sodium causing extracellular fluid loss. Causes of isotonic dehydration include vomiting and diarrhea. Circulation is affected in isotonic dehydration.

34) The osmolarity of plasma is approximately 300 mOsm/litre. What is the approximate osmolarity of a 0.9% NaCl solution?

  A. 30 mOsm/litre
  B. 150 mOsm/litre
* C. 300 mOsm/litre
  D. 3000 mOsm/litre
  E. It is impossible to convert as osmolarity and % concentration are different concepts.

  0.9% Nacl solution is known to be isotonic to plasma. This means that its osmolarity is approximately the same as that of plasma, 300 mOsm/litre. <p>Alternatively, osmolarity can be calculated as follows : One litre of 0.9% NaCl solution, by definition, would contain 0.9 x 1000/100 = 9 gms NaCL A mole of NaCl, by definition, is contained in approx. 58 gms (molecular weight of Na [23]+ that of Cl[35]) Therefore, 9 gms = 9/58 moles = 0.15 moles (approximately) of NaCl
Since NaCl dissociates in water, it creates 0.15 moles each of Na+ and Cl-. That's 150 mM each of Na+ and Cl-, making a total of 300 mOsm/liter Keeping this thumb rule in mind (0.9% NaCl is isotonic to plamsa), it also follows that 0.45% NaCl saline would by hypotonic to plasma, while 7.5% NaCl saline would be hypertonic.

35) In comparison to blood, Lactated Ringer's solution is

  A. hypertonic
* B. isotonic
  C. hypotonic or hypertonic; it depends on how warm it is.
  D. hypotonic

  A healthy animal's blood is approximately 300 mOsm/litre. Lactated Ringer's solution is a solution that is not only isotonic with blood but also containing similar ions to blood. It is intended for intravenous administration, although veterinary administration may also be subcutaneous. One liter of Lactated Ringer's Solution contains: 130 mEq of sodium ion. 109 mEq of chloride ion. 28 mEq of lactate. 4 mEq of potassium ion. 3 mEq of calcium ion Generally, the sodium, chloride, potassium and lactate come from NaCl (sodium chloride), NaC3H5O3 (sodium lactate), CaCl2 (calcium chloride), and KCl (potassium chloride).

36) D5W is dextrose (glucose) 5% in water with an osmolarity of about 250 mOsm/liter. When a substantial amount is administered intravenously, the patient's plasma is likely to get

  A. Very hypertonic
* B. Very hypotonic
  C. Mildly hypertonic
  D. No change, as the D5W's osmolarity is approximately the same as blood
  E. Mildly hypotonic

  Tonicity refers to the ability of a solute (particle) to cause movement of water across the cell membrane due to the impermeability of the membrane to the solute. <p>Glucose is easily permeable and rapidly absorbed into cells (in the presence of insulin). The net effect of a substantial volume of intravenous D5W, then, is addition of pure water to the blood, making it very hypotonic.

37) Aldosterone's main functions are :

* A. Activation of basolateral Na/K-ATPase pumps in the distal tubule and stimulation of H+ secretion in the collecting duct
  B. Activation of Na/H antiporter in the proximal tubule and stimulation of H+ secretion in the collecting duct
  C. Activation of basolateral Na/K-ATPase pumps in the loop of Henle and stimulation of H+ secretion in the distal tubule
  D. Activation of basolateral Na/K-ATPase pumps in the proximal tubule and stimulation of HCO- secretion in the collecting duct

  Aldosterone, produced in the adrenal cortex, is the sole endogenous member of the class of mineralocorticoids in human (corticosterone in rodent). It functions in two main locations of the kidney Distal tubule: Acting on mineralocorticoid receptors (MR) on principal cells in the distal tubule of the kidney nephron, it increases the permeability of their apical (luminal) membrane to potassium and sodium and activates their basolateral Na+/K+/ATPase pumps, stimulating ATP hydrolysis, reabsorbing sodium (Na+) ions and water into the blood, and secreting potassium (K+) ions into the urine. Collecting duct: Aldosterone also stimulates H+ secretion by intercalated cells in the collecting duct, regulating plasma bicarbonate (HCO3-) levels and its acid/base balance.

38) What is the significance of GFR?

* A. GFR is an index of the functioning renal mass
  B. GFR depicts the ability to reabsorb vital nutrients
  C. GFR is an index of diabetes mellitus
  D. GFR is an index of cardiovascular fitness

  GFR refers to the total filtration rate of both kidneys and represents the sum of the single-nephron glomerular filtration rates. As a result, total GFR is an index of the functioning renal mass and estimation of GFR can be used to evaluate the severity and the course of renal disease. For example, a fall in GFR means that the disease is progressing.

39) Urea concentration in plasma (BUN) is not a reliable indicator of GFR because :

  A. Urea excretion is not related to GFR as it is excreted directly into the distal tubule
* B. Urea is reabsorbed as a passive participant in Na, water reabsorption
  C. Actually, Urea is a reliable indicator of GFR
* D. Urea production is not constant

  Changes in GFR can also be detected by alterations in the concentration of urea in blood (blood urea nitrogen, BUN). As with plasma creatinine, BUN tends to vary inversely with GFR. However, the relationship is much less predictable because: Urea production is not constant
Approximately 50% of the filtered urea is reabsorbed, much of it passive reabsorption following the movement of water and sodium in the proximal tubule. Thus, under conditions of enhanced water and sodium reabsorption (e.g. hypovolemic states) BUN will increase out of proportion to any change in GFR or plasma creatinine concentration.</li

  A. Through both the paracellular route and the trancellular route
  B. Only passive reabsorption occurs in the proximal tubule
  C. Only through the paracellular route
* D. Only through the transcellular route

  The paracellular route accounts for only 1% of the surface area available for reabsorption and 5 to 10% of water transport i.e. 90 to 95% of water transport is via the transcellular route. Both passive and active transport processes occur by the transcellular route, and all active transport processes must occur by this route. <p>Active transport can be
Primary active transport - the movement of a substance across a membrane in combination with a carrier protein but against an electrochemical gradient (requires energy). Examples include the Na+-K+-ATPase in basolateral membranes and H+-ATPase in luminal membranes of tubular cells. Secondary active transport - the movement of two substances across a membrane after combination with a single carrier protein. The process is called cotransport (also known as a symport system) if the transported substances are moving in the same direction (sodium together with glucose or amino acids in the proximal tubule) or countertransport (antipor

A. About 25% of Na+ is reabsorbed using the Na/Cl symport mechanism
B. About 25% of Na+ is reabsorbed using specialized Na channels
* C. About 25% of Na+ is reabsorbed using the Na/K/2Cl symport mechanism
D. About 25% of Na+ is reabsorbed using the Na/K/ATPase mechanism

Na+ is absorbed in various components of a nephron as follows :
Proximal convoluted tubule - about 60 % - Using the electro-chemical gradient created by the Na/K/ATPase pump in the basolateral membrane, Na is pulled in as follows
Na-H exchange
Na cotransport with AA & organic solutes (early PCT)
Na/H along with Cl anion exchange (late PCT) Paracellular (?)
Loop of Henle (thick ascending limb, mainly) - about 25% - Na/K/2Cl symport (flow dependent)
Distal tubule - about 4% - Na/Cl symport (flow dependent)
Late distal tubule and Collecting duct - about 3% - Na channels using electrochemical gradient created by Na/K/ATPase on basolateral membrane - through upregulating effect of Aldosterone countered by down-regulating effect of Atrial natriuretic peptide. This cotransporter is inhibited by the thiazide diuretics.
<p> The Na+-K+-2Cl- cotransporter in the Loop of Henle's thick ascending limb is the site of action of the loop diur

A. The dilution of the tubular fluid by the proximal convoluted tubule, which allows the formation of dilute urine
* B. The variability in water permeability of the collecting duct in response to ADH.
* C. The dilution of the tubular fluid by the thick ascending limb (Henle’s loop) and distal convoluted tubule, which allows the formation of dilute urine
D. The variability in water permeability of the distal convoluted tubule in response to ADH.
* E. The generation of a hypertonic medullary interstitium, which allows the formation of a concentrated urine

Dilute urine : There are two basic steps required for the generation of dilute urine:
NaCl reabsorption without water in the ascending limb of the loop of Henle decreases the osmolality of the tubular fluid. This process is continued by NaCl reabsorption in the distal and collecting ducts. The urine remains dilute if water reabsorption in the collecting ducts is minimized by keeping the cells relatively impermeable to water, i.e. the absence of ADH.
Concentrated urine : This happens as follows :
NaCl reabsorption without water in the medullary ascending limb makes the medullary interstitium hyperosmotic at the same time that it makes the tubular fluid dilute (as high as 2800 mOsm/kg at the tip of Henle’s loop in dogs).
The urine entering the cortical collecting duct has an osmolality of approximately 100 mOsm/kg. This dilute urine equilibrates osmotically with the isosmotic cortical interstitium (290-300 mOsm/kg), resulting in the reabsorption of almo

43) Diabetes Insipidus occurs when there is a malfunction in

* A. ADH production by the hypothalamus or ADH response in nephrons
  B. the response of the kidney to ANP
  C. the response of the kidney to Angiotensin II
  D. the response of the kidney to Aldosterone
  E. the Na/K/ATPase pump in the basolateral membrane of the nephron

  Diabetes Insipidus is a condition characterized by an inability to concentrate urine - either central diabetes insipidus in which there is a partial or complete lack of ADH production and release from the neurohypophysis OR nephrogenic diabetes insipidus, a diverse group of disorders in which structural or functional abnormalities interfere with the action of ADH. <p>It follows that animals with central diabetes insipidus can be treated successfully with ADH analogues (e.g. desmopressin), whereas these drugs are ineffective in animals with nephrogenic diabetes insipidus. <p>The modified water deprivation test can be used to distinguish between the two : in this test, maximal urine solute concentration is defined whenever less than 5% increase in urine osmolality occurs on sequential determinations. In normal dogs, this maximal urine concentration occurs at a urine osmolality of
1414 mOsm/kg after 24 h of water deprivation. At this point exogenous vasopressin (antidiuretic hormone) is administered (2 to 3 U subcutaneously) and urine osmolality is measured again at 1 and 2 h after injection.
In normal dogs, there should be minimal further increase (<10%) in urine osmolality after injection.
In central diabetes insipidus, there will be a marked increase in urine osmolality In animals with nephrogenic diabetes insipidus, there will be minimal change in urine osmolality

44) Which respect to chronic renal failure

  A. PUPD occurs when more than 75% of function is lost, whereas Azotemia (high BUN, Creatinine) occurs when more than 66% of renal function is lost
  B. PUPD occurs when more than 50% of function is lost, whereas Azotemia (high BUN, Creatinine) occurs when more than 66% of renal function is lost
* C. PUPD occurs when more than 66% of function is lost, whereas Azotemia (high BUN, Creatinine) occurs when more than 75% of renal function is lost
  D. PUPD occurs when more than 66% of function is lost, whereas Azotemia (high BUN, Creatinine) occurs when more than 66% of renal function is lost

  The water deprivation test is indicated in evaluation of animals with confirmed polyuria and polydipsia (PU/PD), but for which the cause remains undetermined - most commonly animals suspected to have nephrogenic or central diabetes insipidus or psychogenic polydipsia (when urine specific gravity is usually <1.007). The withholding of water should stimulate release of endogenous ADH from the neurohypophysis, and thus allow assessment of the ability of the kidneys to concentrate urine. Maximal stimulation of ADH release is present after loss of 5% of body weight. In normal dogs, this level of dehydration develops after a mean of 42 h (range 30 - 90 h). However, dogs with polyuria may become dehydrated within 6-12 h.
Clinically, normal concentrating ability is assumed if SG is >1.025 in dogs and >1.030 in cats although it can go as high as 1.075 and beyond.

45) When referring to concentration, equivalence

  A. is used when referring to large proteins or colloids
  B. is used when referring to a solute that does not fully dissociate
* C. is used when referring to a solute that dissociates into more than one particle
  D. is used when referring to a weak acid

  The concentration of solutes that normally dissociate into more than one particle when dissolved in solution (e.g. NaCl) is usually expressed in terms of equivalence. Ions in biologic solutions combine according to their valence (charge) and the number of cations (positively charged ions e.g. Na+) in solutions is always equal to the number of anions (negatively charged ions e.g. Cl-) - electroneutrality is maintained. <p>By expressing the concentrations of solutes in equivalents per liter (Eq/L), the charge or valence of the solute is reflected.
The equivalent weight of a substance is the atomic or molecular weight divided by the valence.
The mEq weight of Na+ is equal to its atomic weight because the valence of this ion is +1. Thus, each millimole of Na+ provides 1 mEq. However, the mEq weight of Ca2+ is half its atomic weight because its valence is +2, and each millimole of Ca2+ provides 2 mEq. To convert concentrations mEq/L = mmol/L X valence

46) Normal plasma has a specific gravity (SG) of about

* A. 1.008 to 1.010 g/ml
  B. 1.003 to 1.005 g/ml
  C. 1.080 to 1.100 g/ml
  D. 1.800 to 1.900 g/ml

  This corresponds to an osmolality of about 300 mOsm/Kg. Clinically, SG is measured by a refractometer - most often for measurement of urine SG. In a dehydrated patient with normal renal function, more concentrated urine will be produced. In this situation, urine osmolality and SG are higher than normal (e.g. SG greater than 1.030 g/ml). On the other hand, a patient with renal failure wherein the ability to concentrate urine is lost, may continue to have a urine SG between 1.008 and 1.010 even when dehydrated. Thus, measurement of urine SG is useful in the assessment of renal function.

47) About how much water exists in a healthy adult animal?

  A. 30-40%
* B. 50-70%
  C. 70-80%
  D. 40-50%

  The most common estimate of total body water (TBW) is 60% of body weight. However, TBW can range between 50-70% of body weight. Also, Values are higher in neonates Values are lower in obese animals because the water content of adipose tissue is lower when compared to lean tissue. These differences are of some clinical relevance e.g. estimates of fluid needs for correction of dehydration will be more conservative for obese animals to avoid overhydration.

48) Total body water (TBW) is about 60% of body weight. What proportion of TBW is within intra-cellular fluid (ICF)?

  A. 50%
  B. 40%
* C. 66%
  D. 33%

  Thumb rule estimates of volumes of various compartments:
TBW = 0.6 x body weight ICF = 0.4 x body weight ECF = 0.2 x body weight Interstitial fluid = 0.70 x ECF Plasma = 0.25 x ECF <p><img src="Total-Body-Water-dis

49) ANP, or Atrial natriuretic peptide, has an action

  A. that works independent of hormones involved in the RAAS system
* B. that opposes the RAAS system
  C. that enhances the RAAS system
  D. is produced in the mesengial cells of the kidney

  Atrial natriuretic peptide (ANP) (also called atriopeptin or Atrial natriuretic factor (ANF)), is a polypeptide hormone involved in the homeostatic control of body water,sodium, and adiposity. It is released by atrial myocytes, cells in the atria of the heart, in response to signals of raised blood pressure and acts to reduce the water, sodium and adipose loads on the circulatory system, thereby returning blood pressure to more normal levels. <p>Kidney : In the kidney, ANP does the following : Dilates the afferent glomerular arteriole, constricts the efferent glomerular arteriole, and relaxes the mesangial cells. This increases the glomerular filtration rate, resulting in greater excretion of sodium and water.
Decreases sodium resorption in the renal distal convoluted tubule and cortical collecting duct (antagonistic to aldosterone).
Inhibits renin secretion.
Adrenal Gland : In the adrenal gland, ANP reduces aldosterone secretion by the adrenal cortex.