CHAPTER 15

HOMEOSTASIS

EXERCISE

SECTION I: Multiple Choice Questions

Select the correct answer from the following choices

1. **Excretion of hypotonic urine in humans is associated best with the:**
   (a) glomerular capsule
   (b) proximal convoluted tubule
   (c) loop of the Henle
   (d) distal convoluted tubule

2. **The walls of the _________ are made more or less permeable to water, depending on the need to conserve water:**
   (a) ureter
   (b) urethra
   (c) fibrous capsule
   (d) collecting duct

3. **Which of the following will cause a decrease in ADH production?**
   (a) dehydration
   (b) an increase in osmotic pressure of blood
   (c) drinking water
   (d) abnormally low blood pressure

4. **The function of glomerulus and Bowmen's Capsule of the nephron is to:**
   (a) reabsorb water into the blood
   (b) eliminate ammonia from the body
   (c) reabsorb salts and amino acids
   (d) filter the blood and capture the filtrate

5. **In man, glucose is present in blood plasma but not in urine. This is because glucose molecules are:**
   (a) actively transported from the proximal convoluted tubule to blood capillaries
   (b) oxidised to supply energy for ultrafiltration
   (c) stored in the kidney
   (d) too large to enter Bowmen's Capsule

6. **Evidence for glomerular filtration in the kidney could be obtained by comparing the sizes of the molecules present in Bowmen's Capsule with those in the:**
   (a) afferent blood vessel
   (b) collecting duct
   (c) loop of Henle
   (d) proximal tubule

7. **The site and principal mechanism for the passage of glucose into the blood stream in the human kidney is the:**
   (a) collecting duct, by active secretion
   (b) glomerulus, by selective reabsorption
   (c) glomerulus, by ultrafiltration
   (d) proximal concoluted tubule, by selective reabsorption

8. **A drug reduces mitochondrial activity in kidney nephrons. Which chemical will be present in increased amounts in the urine?**
   (a) ammonia (b) glucose (c) uric acid (d) urea

9. **The main difference between endotherms and ectotherms is:**

(a) how they conserve water
(b) where from they get most of their body heat
(c) whether they are warm or cold blooded
(d) whether they live on land or in the water

10. The water content of human blood is regulated by ADH. In which part of the nephron does regulation occur?

(a) ascending limb of loop of Henle (b) descending limb of loop of Henle
(c) Bowmen's Capsule (d) proximal convoluted tubule

Answer

1	(c)	2	(d)	3	(c)	4	(d)	5	(a)
6	(a)	7	(d)	8	(b)	9	(b)	10	(b)

SECTION II: Short Questions

Give short answers of the following questions.

Q1. Define the term homeostasis, variable and set points.

Answer

a) Homeostasis

Homeostasis is the tendency of an organism or cell to regulate its internal environmental conditions, such as the chemical composition of its body fluids, so as to maintain health and functioning regardless of outside conditions.

OR

It is the ability of an organism to maintain the internal environment constant or near to constant level against the harms of external fluctuations (temperature, water, heat etc.).

b) Variable

The internal factors which are influenced by external environment are called variables e.g body temperature, water and solute concentrations etc..

c) Set point

Set point is the ideal or normal value of variable that is previously set or stored in memory.

Q2. Differentiate between osmoconformers and osmoregulators

Answer

Animals cells require more critical balance of water and solutes in body as they cannot survive a net water gain or loss. Water continuously leaves and enters the cells; however, the quantity of the water and the solutes is kept in balance. There are two approaches in maintaining this balance.

1) Osmoconformers

Animal body fluids are kept isotonic to the external environment even for marine saltwater environment. These animals thus do not require actively to adjust their internal osmotic state, so are known as osmoconformers.

2) Osmoregulators

In the animals whose body fluid concentration differs noticeably with outside environment actively regulate to discharge excess water and excrete salts in hypotonic and hypertonic conditions respectively, therefore are called as osmoregulators.

Q3. How negative feedback mechanisms are helpful?

Answer

Feedback mechanism consists of cycle of events which provide information about the changes to regulate the set points for temperature, water and solute concentrations etc..

Negative feedback mechanism is mainly, how homeostasis is maintained.

This feedback results in a several of the directions of change. Negative feedback tends to stabilize a system, correcting, mechanism from the set point.

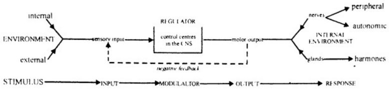


Fig. Homeostatic mechanisms for the control of the internal environment

Q4. Why positive feedback are often harmful?

Answer

Harmful Positive Feedback

Although Positive Feedback is needed within homeostasis, it also can be harmful at times. When you have a high fever it causes a metabolic change that can push the fever higher and higher. In rare case the body temperature reaches 113°F and the cellular proteins stop working and the metabolism stops, resulting in death. If a person breathes air that has very high carbon dioxide content, this produces a high concentration of carbon dioxide in blood.

This is his sensed by carbon dioxide receptors, which cause the breathing rate to increase. So the person breathes faster, taking in more carbon dioxide, which stimulates the receptors even more, so they breathe faster and faster.

Q5. What are the problems faced by osmoregualtors?

Answer

1) **Fresh water animals** live in hypotonic environment, therefore water constantly enters the body and they also face deficiency of salts, so they have to lose excess water and maintain high salt concentration than their environment.
2) Most of marine teleosis (bony fishes) are hypotonic to sea water so these fishes have tendency to lose water to environment, specially across the gill epithelium. They also have problems of excess of salts in the body due to drinking of sea water.
3) Terrestrial animals also have hypotonic internal environment. Evaporation of water leads to the dehydration which is a life threatening problem for them.

Q6. Name the organs of urinary system and write their major functions.

Answer

Major organs of urinary system are:

i) Kidneys ii) Ureter
iii) Urinary bladder iv) Tubular urethra

i) Kidneys

Major organs which separate nitrogeneous substances from blood.

ii) Ureter

Tubular organ which transports urine from kidney to urinary bladder.

iii) Urinary Bladder

Hollow, distensible, muscular organ It is located in pelvic cavity. It serves as a urine reservoir.

iv) Urethra

It is a tube that carries urine from urinary bladder to outside of the body.

Q7. Name the parts of nephron and trace the blood supply to the nephron.

Answer

Nephron

It is the structural and functional unit of kidney. A nephron is arranged along two distinct regions cortex and medulla. The nephrons which are arranged along the cortex are called cortical and those nephrons which are arranged along the border of cortex and medulla with their tubular system loping deep in inner medulla are called juxtamedullary nephrons. Juxtamedullary nephrons play an important role in the production of concentrated urine.

Structure of Nephron

Nephron is divided into two main portions:

i) Renal corpuscle ii) Renal tubule

i) Renal Corpuscle

Renal corpuscle is further divided into two parts:

a) Bowman's capsule and b) Glomerulus

The inner end of each nephron forms a cup shaped swelling which is called Bowman's capsule. The capsule surrounds a ball of capillaries called glomerulus. The blood enters the glomerulus through afferent arteriole and leave it through efferent arteriole. The blood vessels divides further to form the network of capillaries called peritubular capillaries.

ii) Renal Tubule:

The second part of the nephron is a long and narrow tube called loop of Henle. Bowman capsule continues as proximal tubule loop of Henle and the distal tubule called collecting tubule. Loop of Henle has three parts, first part is coiled, second is U shaped and third is also coiled.

Blood Circulation to Nephron

Renal artery brings impure blood within kidney which gives rise to branches called inter lobular artries which enter in the cortex region of kidney and give rise to afferent artrides. The afferent arterioles supply blood to the glomerular capillaries of the renal capsule.

Efferent artreides arise from the glomeruli, which comes out of nephorn and such capillaries surround the upper portion of nephron such plexus of capillaries called peritubular capillaries.

Some capillaries come down and surround the henle loop called Vesa recta.

Q8. What general processes are involved in urine formation?

Answer

Ultrafiltration (Glomerular Filtration)

Blood passing through glomerulus is filtered into Bowman's capsule. It is specifically filtered here, unlike at the other parts of the vessels, because glomerulus walls are porous, and the fraction of the blood pressure reaching here provides the **filtration pressure**. The filtrate appearing in glomerulus is called as **glomerular filtrate**, which contains numerous useful substances such as glucose, amino acids, salts etc. in aqueous solution.

ii) Reabsorption

All the useful constituents of the glomerular filtrate are reabsorbed. When filtrate reaches the first part of the renal tubules, 2/3 of the filtrate which containing useful materials like glucose and amino acids, is reabsorbed in the blood. The waste materials are not absorbed from the filtrate which becomes dense. Thus when filtrate leaves proximal tubules in mostly contains nitrogenous wastes.

iii) Secretion

The tubular epithelium also secrete substances into the human, this secretion is very selective and is mainly of hydrogen ions to balance pH value of the filtrate passing through tubule.

Urine Formation

Passing through the middle part the filtrate is diluted or concentrated according to the need. When the filtrate is passed through the last part of the duct it takes the form of urine.

Q9. How reabsorption is a selective process?

Answer

Reabsorptoin is also called tubular reabsorption is a process where certain substances have been filtered out of the blood during ultrafilteration are reabsorbed back. These substances include glucose, amino acid, vitamins, inorganic salts and some water.

Q10.Name three urinary tract infection (UTI) and bacteria responsible.

Answer

i) Urethrits – Infection of urethra
ii) Cystitis – Infection of urninary baldder
iii) Pyelonephritis – Infection of kidney

Names of Bacteria Involved in UTI

1) Escherichia coli
2) Proteus Vugaris
3) Klebsiella pneumoniae
4) Neisseeria gonorrhoea

Q11. What are causes of kidney failure?

Answer

Kidney failure called as renal failure is caused by:

i) bacterial infection

ii) Nephritis (inflammation of glomeruli) due to high blood pressure and diabetes millitus
iii) Multiple factors causing acute renal failure are:
Haemorrhage due to trauma, vomiting, diarrhoea, Diuresis, sweating, obstruction of the ureter, urinary bladder or urethra, kidney stone and sever nephritis.

Q12.Why it is suggested that protein intake needs to be limited in kidney failure patients?

Answer

Kidneys separate nitrogenous wastes from blood. Nitrogenous wastes are derived from protein breakdown.

Kidney failure patients are advised not to take in proteins because their kidneys are not working, so nitrogenous wastes due to protein breakdown is poisonous which bring kidney failure patient at risk of their life.

Q13.By what physical processes do solutes enter or leave blood during dialysis?

Answer

During dialysis, the blood of kidney failure patient is brought out of body. This blood is then sent into an external filter called dialyzer, which consists of tubes of semipermeable membrane. In the machine the concentration of substances- minerals, electrolytes are kept in low concentration as compared to the concentration of such substances of patient's blood, so that when blood would pass through the dialyzer (machine) the nitrogenous substances should come out from blood into the machine due to osmosis.

Q14.Why do the blood and dialysate flow in opposite direction?

Answer

As blood flows in opposite direction through dialyzer the flow of blood and dialysate (fluid used in dialysis) is kept in opposite direction.

So as the dialysate attracts certain substances-minerals, electrolytes and waste by producers cross the membrane from the blood. The dialysate absorbs these substances.

Q15.Suggest two problems that might occur if the dialysate was pure water.

Answer

i) There will be no establishment of concentration gradient between blood & dialysate if it would be pure water, so no movement of nitrogenous waste would occur between blood and dialysate.

ii) Water from dialyzer machine would enter into the blood and would change the composition of blood which may be fatal for patient.

Q16.What is a main problem with a kidney transplant once it has been carried out?

Answer

Tissue rejection and toxic effects of cyclosporine (Immune system suppressive medicines).

Q17.Compare peritoneal dialysis with haemodialysis and suggest which one is advantageous.

Answer

Haemodialysis

Removes wastes and water by circulating blood outside the body through an external filter, called dialyzer, which consist, of tubes of semipermeable membrane.

Peritoneal Dialysis

Peritoneal dialysis involves the use of natural membrane in the body, the peritoneum, which enclose the abdominal cavity. In this process two catheters are surgically insented into the abdominal cavity that serve as the portals through which dialysate (dialysis fluid) enters and leaves the cavity.

Primary Advantage

Primary advantage of peritoneal dialysis is the mobility. Most of people are able to participate in regular activities including work, while peritoneal dialysis can also be performed at home.

Q18.How animals can be classified on the bases of the ability to thermoregulation?

Answer

Temperature Classification of Animals

1) Classification scheme based on temperature fluctuation in the environment

Animals deal with variation to the thermal characteristics of their environment. So animals can be divided into two categories:

Poikilotherms (cold-blooded): These are animals in which body temperature tends to fluctuate more or less as the air or water temperature change. All invertebrates, amphibians and reptiles are considered in this category.

Homeotherms (warm-blooded)

These animals when exposed to charging air or water temperature, maintain their body temperature. These include birds and mammals.

Several difficulties arise with this terminology. It is observed that deep sea fishes maintain their body temperature due to the constant natural surroundings and lizards regulate their body temperature; and in contrast numerous birds and mammals vary their body temperature.

Classification Scheme Based on the Source of Heat Production

It is more widely applicable temperature classification scheme. So animals are divided into three categories:

1) Endotherms

The animals that generate their own body heat through heat production as by-product during metabolism are called Endotherms, such as mammals, birds, some fishes and flying insects.

2) Ectotherms

These are the animals which produce metabolic heat at low level and that is exchanged quickly with the environment, however, absorb heat from their surroundings. Most invertebrates, fish amphibians and reptiles are in the category.

3) Heterotherms

Those animals who are capable of varying degrees of endothermic heat production but generally do not, regulate their body temperature within a narrow range e.g. bats, humming bird etc., are called heterotherms.

Q19.How do blood vessels deep into the skin help to regulate body temperature during hot and cold external conditions?

Answer

Physiological Responses to Hotness

Hyperthermia is the body temperature above 37°C. There are two main physiological response of heat, vasodilation and sweating. Vasodilation is the expansion of blood capillaries which lie beneath,the epidermis of the skin. So there is more flow of the blood in blood capillaries of the skin. Sweat glands spread sweat over the skin. Evaporation of sweat from the skin carries heat from the blood thus produces cooling effect.

Phsysiological Responses to Cold

Spasmodic contraction of the muscles is called **shivering**. This contraction produces heat which helps to raise the body temperature. **Vasconstriciton** reduces blood flow to the skin. Piloerection literally means erection of skin hair. It traps air in the erected hair which is insulator for the heat. Increased metabolic rate is also.a physiological response to cold.

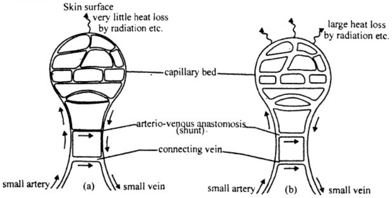

Skin surface
very little heat loss by radiation etc.
large heat loss by radiation etc.
capillary bed
arterio-venous anastomosis (shunt)
connecting vein
small artery
(a)
small vein
small artery
(b)
small vein

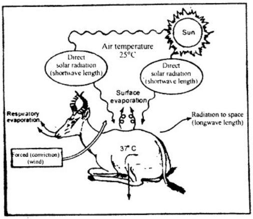
Fig. Mechanism of regulation fo blood flow through the skin.
a) Vasoconstriction, b) Vasodilation.

Q20.List some behavioural responses of the animals to maintain homeostasis.

Answer

Behavioural Adaptations

These include moving of the animal to an environment where heat exchange between these is minimal e.g., ground squirrels move to burrows in midday heat and lizards bask (lie around or relax) in sun to gain heat. Animals also control the amount of surface area available for heat exchange by adjusting their postures.


Sun
Air temperature 25°C
Direct solar radiation (shortwave length)
Direct solar radiation (shortwave length)
Surface evaporation
Respiratory evaporation
Radiation to space (longwave length)
37°C
Forced (conviction) (wind)

Q21.Investigate why positive feedback mechanism in humans are sometimes associated with severe health problem?

Answer

Positive Feedback

In contrast to negative feedback, positive-feedback involves a change in some variable that triggers mechanisms that amplify rather than reverse the change. During childbirth, for instance, the pressure of the baby's head against sensors near the opening of the uterus stimulates; uterine contractions, which cause greater pressure against the uterine opening, heightening the contractions which causes still greater pressure. Positive feedback brings childbirth to completion, a very different sort of process from maintaining a physiological steady state.

Harmful Positive Feedback

Although Positive Feedback is needed within homeostasis, it also can be harmful at times. When you have a high fever it causes a metabolic change that can push the fever higher and higher. In rare cases the body temperature reaches 113° F and the cellular proteins stop working and the metabolism stops, resulting in death. If person breathes air that has very high carbon dioxide content, this produces a high concentration of carbon dioxide in blood.

This is sensed by carbon dioxide receptors, which cause the breathing rate to increase. So the person breathes faster; taking in more carbon dioxide, which simulates the receptors even more, so they breathe faster and faster.

Q22.Draw flow chart to show negative feedback of homeostatic mechanism by taking an example of hormone.

Answer

A flow chart to show negative feedback of homestatic mechanism by taking an example of hormone.

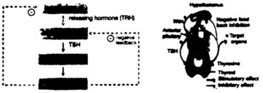


Fig. Negative feedback of homestatic mechanism

Flow chart showing negative feedback in the regulation of the hypothalamus, anterior pituitary and thyroid:

1) Low body temperature or stress stimulates neurosecretory cells of hypothalamus.
2) The releasing hormones of hypothalamus trigger the release of thyroid stimulating hormone (TSH) in the anterior Pituitary.
3) The TSH then stimulates the thyroid gland to release thyroxin.
4) Thyroxin causes an increase in the metabolic activity of most body cells, generating ATP energy and heat. 5)Both the raised body temperature and higher thyroxin levels in the body inhibit the releasing hormone cells of hypothalamus and the TSH producing cells.

Q23.Why women are more likely to acquire UTI as compared to men?

Answer

Although male can get a urinary tract infection, the condition is 50 time more common in women.

In general, the higher risk in women in mostly due to the shortness of the female urethra, which is 1.5 inches as compared to 8 inches in men. Bacteria from faecal matter at anal opening can be easily transferred to the opening of urethra.

Q24.Describe the importance of kidney donation for the benefit of kidney failure patients.

Answer

Kidney denotation is a relatively safe operation, and many donors will never feel the loss of their second kidney. It is the most expendable organ. So giving up a kidney causes no disadvantage to your long term health. In fact, studies here shown, that kidney donors actually live longer than the general population, because donors come

from a pool of people in good health.

Just think people have no problems having only one kidney.

SECTION III: Extensive Questions

Q1. Describe the elements which operate homeostatic mechanism.

Answer

Concepts In Homeostasis

Definition

The protection of internal environment from the harms of fluctuations in external environment is termed **as homeostasis**.

Explanation

Each organism of a species has assumed, in evolutionary history a specific set up (internal environment) at various levels of organization suitable to its surroundings i.e., external environment. External environment and its components fluctuate continuously, however, the organism resists and manages these changes by making adjustments to keep its own internal fluctuations within a narrow range thus protect internal environment from the harms of the fluctuations. The homeostasis keeps the internal fluctuations in a narrow range with various control systems compared to wider external fluctuations.

Components Effected by Fluctuations

Most susceptible components of internal environment that may be effected by fluctuations in external environments are water solutes and temperature.

Mechnisms to Maintain Homeostasis

The mechanism an organism has adapted to eliminate harmful nitrogenous wastes depends upon the availability of water.

1) **Osmoregulation:** The mechanism of regulation, generally between organism and its environment of solute and the gain and loss of water is osmoregulation.

2) **Excretion:** The mechanism which eliminates nitrogenous waste is referred to as excretion.

3) **Thermoregulation:** The maintenance of internal temperature within a tolerable range is designated as thermoregulation.
Homeostasis is the central requirement in the maintenance of an; organism which compels the adaptations in the constant changing conditions and contribute in evolutionary process.

Mechanism of Homeostasis

Homeostatic mechanism operates just like physical control system having three components; receptors, control center and effectors.

Receptor (sensor) detects changes in variable and feeds that information back to the **Control center (integrator)** integrates (puts together) data from sensor and stored "set point" data.

Effector is the mechanism (heating coil in this example) that has an "effect" on the variable.

In a common lab incubator if temperature is decreased from set point, the thermometer (receptor) detects the change in temperature and signals the thermostat (control center), which in turn activates the heating coil (effector). Similarly if temperature is increased from the set point again thermometer detects the change and signals the thermostat to switch off heating. Likewise in human body thermoreceptors are involved in the detection of temperature change. Hypothalamus in fore brain is a body thermostat.

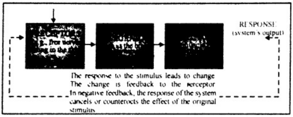

RESPONSE
(system's output)
The response to the stimulus leads to change
The change is feedback to the receptor
In negative feedback, the response of the system cancels or counteracts the effect of the original stimulus

Fig. Mechanism of homeostatsis

Stimulated once, hypothalamus acts on effectors for cooling (e.g. sweat glands) or heating (e.g. muscles) the body to reverse the change to the set point. After receiving the signal, a change occurs to correct the deviation either by depressing it with negative feedback or enhancing it with positive feedback.

Q2. How does homeostatic mechanism work?

Answer

Mechanism of Homeostasis

The internal factors which are influenced by external environment are called variables e.g., body temperature, water concentration, solute composition etc.. **Set point** is the "ideal" or "normal" value of the variable that is previously "set" or "stored" in memory.

Homeostatic mechanism operates just like physical control system in having three components; receptors, control centre and effectors.

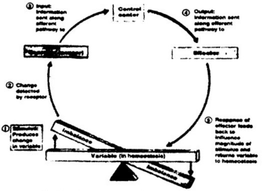

③ Input: Information sent along afferent pathway to
Control center
④ Output: Information sent along efferent pathway to
Effector
② Change detected by receptor
① Stimulus: Produces change in variable
Imbalance
Variable (in homeostasis)
Imbalance
⑤ Response of effector feeds back to influence magnitude of stimulus and returns variable to homeostasis

Fig. Basic component of a control system

Receptor (sensor)

It detects changes in variable and feeds that information back to the control centre (integrator) thermometer in following example).

Control Centre (integrator)

It integrates (puts together) data from sensor and stored "set point" data (thermostat in following example).

Effector

It is the mechanism that has an "effect" on the variable (heating coil in this example).

Example In a common laboratory incubator, if temperature is decreased from set point, the thermometer (receptor) detects the change in temperature and signals the thermostat (control centre), which in turn activates the heating coil (effector). Similarly, if temperature is increased from the set point again thermometer detects the change and signals the thermostat to switch OFF heating.

Likewise, in human body; thermoreceptors are involved in the detection of temperature change. **Hypothalamus** in forebrain is thermotostat of the body. Stimulated once, it acts on effectors for cooling (e.g. sweat glands) or healing (e.g. muscles) the body to reverse the change to the set point.

After receiving the signal from receptor, the control centre causes a change to correct the deviation by depressing it with negative feedback or enhancing it with positive feedback.

Concept of Feedback Mechanism in Homeostasis

Feedback system consists of a cycle of events in which information about a change (e.g., a change in temperature) is fed back into the system so that the regulator (the temperature regulating centre in the brain) can control the process (temperature regulation). There are two types of feedback: negative feedback and positive feedback.

Negative Feedback

Negative feedback is mainly, how homeostasis is maintained. This feedback results in a reversal of the direction of change. Negative feedback tends to stabilize a system, correcting deviations from the set point.

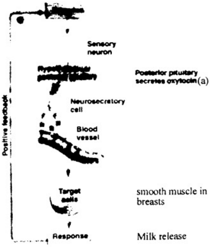


Fig. Positive feedback (sucking)

For example feedback mechanism is applied to control water content in the body. When body is deficient in water, hypothalamus stimulates posterior pituitary lobe to release antidiuretic hormone ADH. ADH makes, collecting tubules and distal convoluted tubules permeable to water thus more water is absorbed and maximum amount of water is retained in the body.

The blood water content rises which is sensed by hypothalamus. So ADH secretion slows down.

Positive Feedback

Positive feedback response is, mainly responsible for amplification of the change in variable. This has a destabilizing effect, so does not result in homestatsis. Positive feedback is less common in naturally occurring systems than negative feedback, but it has its applications. For example, a baby suckling at the nipple sends nerve signals to sensory neurouns in the hypothalamus. Oxytocin is made by neruosecretroy cells and stored in the posterior pituitary. When oxytocin circulates to target cells in the breast, it triggers smooth muscle contraction and release of milk. The milk encourages more suckling at the nipple.

Q3. Explain the problems faced by osmoregulators and discuss how they manage them?

Answer

Osmoregulation

The maintenance of constant osmotic conditions (water and solute concentration) in the body is called **osmoregulatoon**. Animals may be either osmoregulators or osmoconformers with respect to their external environment.

Osmoregulators and Osmoconformers

Osmoregulators

Those animals that can maintain internal osmotic concentrations different from medium are called osmoregulators. Such animals are hypotonic or hypertonic to their environment. Almost all of the freshwater animals and most of the marine vertebrates are osmoregulators.

Osmoconformers

Those animals that change the osmotic concentrations of the body fluids according to that of surrounding medium are called osmeeonformers. These are isotonic to their external environment. These include all marine invertebrates, some freshwater invertebrates and some marine vertebrates like *Myxine* (hag fishes) and elammobranches (sharks and rays).

The unusual higher osmotic concentration than other vertebrates of marine habitat is maintained by high levels of urea and trimethylamine oxide (TMAO) in the blood. These organic substances are celled **osmolytes** because they increase the osmotic (solutes) concentration.

Problems Faced by Osmoregulators

Since, freshwater animals live in hypotonic environment, therefore, water constantly

enters the body and they also face deficiency of salts, so they have to lose excess water and maintain higher salt concentration than their environment.

On the other hand, most of the marine teleosts (bony fishes) are hypotonic to sea water. So these fishes have tendency to lose water to the environment, especially across the gill epithelium. They also have problem of excess of salts in the body due to drinking of sea water.

Terrestrial animals are also hypotonic to the outer environment. Evaporation of water that leads to the dehydration is the major problem faced by these animals.

Q4. Describe the different methods of osmoregualtion found in fresh water, marine water and terrestrial habitats.

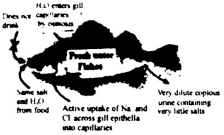
Answer

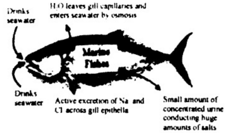
Osmoregualtion Adaption in Animals

1) Freshwater Animals

Almost all of the freshwater animals are osmoregulators. These animals are generally hypertonic to their outer environment.

These animals deal with these problems by producing large volume of diluted urine. Their kidney absorbs the salts that are required. Salts are also obtained from the food they eat. These animals also actively transport salts from the external dilute medium with the help of special salt cells called ionocytes. Ionocytes are found in the amphibian skin and gills of fishes.


H₂O enters gill capillaries by osmosis
Does not drink
Fresh water Fishes
Same salt and H₂O from food
Active uptake of Na and Cl across gill epithelia into capillaries
Very dilute copious urine containing very little salts


Drinks seawater
H₂O leaves gill capillaries and enters seawater by osmosis
Marine Fishes
Drinks seawater
Active excretion of Na and Cl across gill epithelia
Small amount of concentrated urine conducting huge amounts of salts

2) Marine Animals

Teleosts (bony fishes) are osmoregulators in marine environment which are hypotonic to their environment. So these fishes have tendency to lose water to the environment, especially across the gill epithelium. In order to replace the water loss, these fishes usually drink large amount of water unlike freshwater fishes. (Fig. 15.5)

They also have problem of excess of salts in.

3) Terrestrial Animals

In terrestrial animals evaporation of water leads to the dehydration which is the major problem faced by these animals. The successful groups of land animals are arthropods among the invertebrates and reptiles, birds and mammals among the vertebrates. The presence of chitinous exoskeleton in arthropods and dead keratinized skin in vertebrates are adaptation to reduce water loss by their bodies.

Fig. Kangroo rat; master of water conservaton in the desert.

Desert mammals are very much resistant in this regard. They can tolerate against strong degree of dehydration by special metabolic and behavioral adaptation. This characteristic is called anhydrobiosis. Actually these animals feed upon seeds of desert plants in which large amount of carbohydrate is stored, during the breakdown of these compounds, water is produced as by-product that is utilized by these animals. Best example of such animals is Kangaroo rat. Desert animals avoid day time heat, and emerge at night. 90% of the water that they use is metabolic water derived from cellular oxidation.

Q5 Describe different organs of urinary system.

Answer

Organs of urinary system of humans are follows:

1) Kidney
2) Ureters
3) Urinary bladder
4) Urethra

1) Kidneys

The kidneys are dark-red, slightly flattened, bean shaped organs about 12 cm long, 6cm wide and 4cm thick each weighing about 150 gms. They are placed against the back wall of the abdominal cavity just below the diaphragm, one on either side of the vertebral column, between the last thoracic vertebra and the third lumbar vertebra.

The upper parts of the kidneys are partially protected by the eleventh and twelfth ribs. Their position is slightly asymmetrical, the right kidney being a little lower than the left one because of a liver lobe above it. The kidney has a bean-shaped structure. The outer surface is convex and the inner surface is concave. The inner surface has a deep notch called hilus. The renal artery and nerves enter the kidney, and the renal vein and ureter leave the kidney through hilus. The kidney is surrounded by tough membrane, tissue, the renal pritonium.

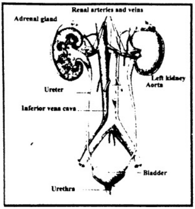


Fig. Human urinary system

Transverse section of kidney shows two distinct regions, an outer cortex and an medulla. The cortex contains renal corpuscles and convoluted tubules of nephorns. The medulla contains conical structures called pyramids. All the pyramids project into the pelvis. The pelvis leads into the ureter.

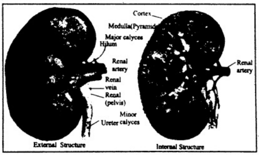


Fig. Human Kidney

2) Ureters

Ureters are about 28 cm long. They are a pair of narrow, muscular, tubular structures which arise from the hilus of the kidney, run backward along the dorsal body wall and open on the dorsal wall of the urinary bladder. Theses pass urine from the kidneys to the urinary baldder.

3) Urinary Bladder

It is a pear shaped sac situated in the pelvic region of the abdominal cavity. It has thick muscular distensible wall that allow its expansion. It can store about 0.5 to 1 litre of urine. It receives the ureters through the lower part of its back wall. The lower part or neck of the bladder is guarded by 2 rings of muscle fibres called sphincters. Both the

sphincters must relax to let urine pass out from the bladder. The act of emptying the bladder is called micturition.

4) Urethra

The urethra starts from the neck of the urinary bladder and leads to the exterior. In females it is about 2-3 cm long and carries only urine. It opens by the urethral orifice or urinary aperture in the vulva in front of the vaginal aperture.

In male, urethra is about 20 cm long and carries urine as well as the spermatic fluid. It passes through the penis and opens out at the tip of the penis by a urinogenital aperture.

Q6. Describe the structure of kidney and relate it with its function.

Answer

Structure and Function of Kidney

A kidney is reddish brown, bean shaped organ with small surface. A fibrous connective tissue layer called fibrous capsule, enclosed with kidney. The lateral surface of each kidney is convex but its medial side is deeply concave. The resulting medial depression leads into a hollow chamber called renal sinus. The entrance to this sinus is termed hilum (hilus) where the renal artery and nerves enter and the renal vein and ureter exit. The kidney is divided into an outer renal cortex and inner renal an medulla that surrounds the renal sinus.

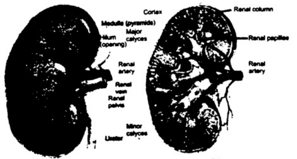


Fig. Human kidney:
(a) external sturcture

Internal structure
(longitudinal section)

The base of each pyramid is located at the boundary between renal cortex and renal medulla. The tips of the pyramids the renal pipillae are pointed towards the centre of the kidney. The parts of cortex which are projected between the renal pyramids, towards the centre of the kidney are called renal columns. The spaces between any two renal columns are called minor calyces. Each renal papilla is pierced by tiny opening that lead into the minor calyx. The minor calyces from several pyramids join together to form larger funnel shaped spaces called major calyces. The major calyces converge to from an enlarged channel called renal pelvis. Urine formed within the kidneys passes from renal papillae into the minor calyces then into the major calyces. From the major calyces, urine is collected in the renal pelvis and exit the kidney through ureter.

Q7. Describe the structure of nephron in detail.

Answer

Structure of Nephron

The nephron is the functional unit of kidney. A nephron consists of a renal corpuscle and a renal tubule. A renal corpuscle is composed of a network of capillaries called glomeruluis which is surrounded by a thin double-walled, structure called Bowman's **capsule**. The **Bowmen's Capsule** is an expansion at the closed end of a renal tubule. The **renal tubule** leads away from the Bowmen's Capsule and becomes highly coiled. This coiled portion of the tubule is called proximal convoluted tubule. The proximal convoluted tubule dips toward the renal pelvis into the medulla forming a sharp loop called loop of Henle. The loop of Henle consists of a descending limb and an ascending limb. The ascending limb returns to the region of the renal corpuscle, where it becomes highly coiled again, and is called the distal convoluted tubule which is connected to the collecting duct. The collecting duct receives many nephrons. Many collecting ducts combine together to form larger collecting ducts which empty into minor calyces through an opening in a renal papilla.

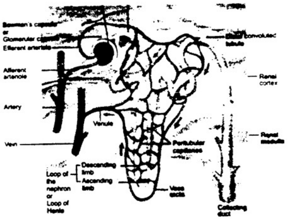


Fig. 15.8 Structure of nephron

Q8. Explain the process of glomerular filteration, selective reabsorption and tubular secretion.

Answer

The human kidneys perform a variety of functions; nearly all are carried out by nephrons. The nephrons filter blood; remove wastes which are passed out as urine. Formation of urine involve three key processes, ultrafiltration, selective reabsorption and tubular secretion.

Ultrafiltration

It is filtration under pressure. The diameter of efferent arteriole is half as compared to

the afferent arteriole. It results in a high blood pressure in glomerulus. About 20% of the plasma is filtered into Bowman's capsule. This filtered fluid is called glomerular filtrate.

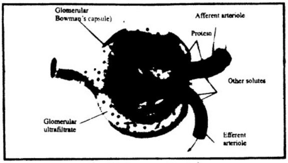


Fig. 15.8 Structure of nephron

This filtrate has to cross endothelium of the glomerular capillaries, basement membrane of capillaries, and endothelium of Bowman's capsule.

It has chemical composition similar to that of blood plasma. It contains glucose, amino acids vitamins, ions, nitrogenous wastes, some hormones and water.

Selective Reabsorption

Ultrafiltration produces about 125 ml of glomerular filtrate per minute in humans. This is equivalent to about 180 liters per day. In fact, of the 125 ml of filtrate produced per minute 124 ml is reabsorbed on average. The reabsorption process in the nephron is very selective. The useful substances for the body are reabsorbed.

Over 80% of the glomerular filtrate is reabsorbed in proximal convoluted tubules. Here all of the glucose, amino acids, vitamins, hormones and about 80% of the sodium chloride and water are reabsorbed.

The function of loop of Henle is to conserve water. The wall of ascending limb is impermeable to water, however, sodium, chloride, potassium and other ions are absorbed actively here. The plasma becomes concentrated and fluid in the ascending limb becomes very dilute. The descending limb is highly permeable to water. The counter current multiplier system here results in reabsorption of a lot of water and solutes.

The distal convoluted tubules have osmoregulatory role and also control blood pH by secreting hydrogen ions. The collecting ducts are impermeable in nature. ADH opens water channels in collecting ducts to allow water to move out of the filtrate. It reduces the volume of urine making it more concentrated.

Tubular Secretion

Tubular secretion is the transfer of materials from peritubular capillaries to renal tabular lumen. Tubular secretion is caused mainly by active transport.

Usually only a few substances are secreted. These substances are present in great

excess, or are natural poisons.

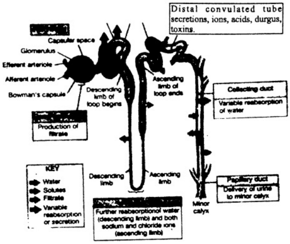

Distal convulated tube secretions, ions, acids, durgus, toxins.
Capsular space
Glomerulus
Efferent arteriole
Afferent arteriole
Bowman's capsule
Descending limb of loop begins
Ascending limb of loop ends
Production of filtrate
Collecting duct
Variable reabsorption of water
KEY
Water
Solutes
Filtrate
Variable reabsorption or secretion
Descending limb
Ascending limb
Further reabsorptionof water (descending limb) and both sodium and chloride ions (ascending limb)
Minor calyx
Papillary duct
Delivery of urine to minor calyx

Fig. Urine formation

Q9. How concentration of urine is regulated by counter current and hormonal mechanism.

Answer

Mechanism of Urine Concentration

In restricted supply of water, the conservation of water is the principal function of the body. This is done by concentration of the filtrate by counter current and hormonal menchanisms. In the sufficient of excess supply of water, reabsorption of water from the filtrate is reduced, specifically due to inhibition of releases of ADH (Antidiuretic Hormone) in the presence of hyposomotic body fluids. The reduction in reabsorption causes large volumes of diluted urine. Mammallian kidney including human is adapted to conserve water by over 99.5% reabsorption of glomerular filtrate.

Counter Current Mechanism

The interstitial fluid of the kidney is gradually concentrated from cortical to medullary part, thus inner medulla is highly concentrated with the presence of urea and through a mechanism of counter-current multiplier. This mechanism causes gradual osmotic outflow of water from the filtrate back to kidney as it passes downward in the descending loop of Henle. Furthermore, ascending loop of Henle does not allow outflow of water from its filtrate, instead actively transport Na^+ into kidney interstitum to sustain its high concentration.

Gradually increasing osmotic concentration from cortex to inner medulla is a main factor for the production of hypertonic (concentrated) urine in mammals including humans. Due to counter current, filtrate moving in limbs of loop of henle and the blood

moving in the capillaries of vesa reacta, water is greatly (approx. 99.5%) reabsorbed.

Hormone Function

As fluid travels up the descending limb, sodium chloride is transported actively out of the limb into the surrounding area. This movement is controlled by aldasternone (adrenal cortical hormone). This cause increase in concentration of water in filtrate and decrease in concentration of water in kidney intersitium. As a result, water passes out the descending limb by osmosis. This movement of water is also promoted by anti-diuretic hormone (ADH) which is secreted from posterior lobe of pituitary gland.

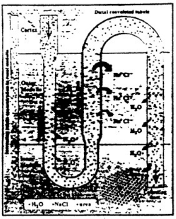


Fig. The counter current mechanism in kidney

Q10. Justify the functioning of kidney as both organ of excretion and osmoregulation.

Answer

Kidney as Omsoregulatory Organ

Control of Water Level

Body maintains the solute potential of blood at an approximately steady state. It is done by balancing water uptake from the diet with water lost in evaporation, sweating, egestion and urine. The solute potential is primarily achieved by the effect of antiduretic hormone.

ADH is secreted by the posterior lobe of pituitary gland. When body is deficient in water, hypothalamus detects a fall in blood solute potential and directs pituitary to release ADH. This hormone increases the permeability of the distal convoluted tubules and collecting ducts to water. More water is absorbed, reducing the volume of urine and making it more concentrated.

When there is a high intake of water ADH release is inhibited. Less water is absorbed and a large volume of dilute urine is excreted.

Control of Blood Sodium Level

The maintenance of sodium level at a steady state is controlled by the steroid hormone aldosterone. It is secreted by adrenal cortex. Aldosterone activates sodium-potassium pumps in the distal convoluted tubules. Sodium is pumped back to blood from filtrate actively.

Q11. Compare the function of two major capillary beds in kidneys.

Answer

There are two types of nephorn, cortical nephorns and juxtamedullary nephrons. Cortical nephrosns are found in the cortex. They have their renal corpuscle in the

superficial renal cortex and have relatively short loops of Henle. 70 to 80% nephrons in human kidney are cortical. Under normal conditions of water availability, the cortical nephrons deal with the control of blood volume by forming diluted urine. Juxtamedullary nephrons, have their renal corpuscle close to the junction of the cortex and medulla. They have long loop of Henle which extends deep into the medulla. These types of nephrons are relatively rare and only comprise 20-30% of the nephrons in the human kidney. When water is in short supply, increased water retention occurs through juxtamedullary nepheroms.

The renal artery within kidney gives rise to branches called interlobular arteries which project into the cortex and give rise to the afferent arterioles. The afferent arterioles supply blood to the glomerular capillaries of the renal capsule. Efferent arterioles (rather than a venule) arise from the glomeruli give rise to a plexus of capillaries called the peritubular capillaries around the proximal and distal tubules. Specialized part of the peritubular capillaries called vasa recta course into the medulla along with the loops of Henle and then back toward the cortex. The peritubular capillaries drain into interlobular veins, which drain into renal vein. The renal vein exits the kidney and connects to the inferior vena cava.

Q12. Explain causes and treatments of kidney stone.

Answer

Urinary Stones

Urinary stones are hard, crystalline mineral materials that stick together to from small "pebbles" within the kidney or urinary tract. They may stay in kidneys or travel out of the body through the urinary tract.

Symptoms/Indications

Kidney stones often cause no pain while they are in the kidneys, but they can cause sudden, serve pain as they travel from the kidneys to the bladder. Usually pain appears at side belly or groin and the colour of urine becomes pinkish or reddish. These are common indication of kidney stones.

Anyone may develop a kidney stone, but people with certain diseases and conditions or those who are taking certain medications are more susceptible to the stone development. Kidney stones form when there is decrease in urine volume and/or an excess of stone-forming substances in the urine.

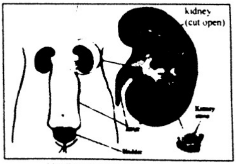


Fig. Formation of Kidney stones in various places in the urinary system

Chemical Nature of Stone

The most common type of kidney stone contains calcium in combination with either oxalate or phosphate (70% of all stones). Other chemical compounds that can form

stones in the urinary tract include uric acid (5-10% of all stones) and the amino acid cystine (1-3% of all stones). Kidney stones can also result from infection in the urinary tract, these are known as struvite or infection stones (1520% of all stones).

Causes

A number of different medical and environmental conditions can lead to an increased risk for developing kidney stones.

- **Hypercalcemia** It is characterized by increased calcium level in the blood that in turn causes hypercalciuria (high calcium in the urine). These conditions may also arise in case of Hyperparathyroidism, which is the over secretion of parathormone from parathyroid gland.

  In this condition, too much calcium is absorbed from food and excreted into the urine, where it may form calcium phosphate or calcium oxalate stones.
- **Hyperoxaluria:** It is characterized by increased oxalate level in the urine. The condition is usually associated with over use of tomato and other green leafy vegetables in the diet.
- **Hyperuricemia:** It is characterized by increased amount of uric acid in the blood that can lead to the formation of uric acid stones. The level of uric acid may arise in gout(genetic disorder) or due to high intake of protein in the form of meat products.

Kidney stones

Most stones smaller 0.5cm can spontaneously pass from the kidney but most stones greater than 1 cm cannot pass. If the stone must be removed two commonly employed methods are percutaneous nephrolithotrypsy (PCNL) and extracorporeal shock wave lithotripsy (ESWL). The type of procedure depends on the type of stone and its size. Typically, small stones can be treated with ESWL, while larger stones require PCNL. ESWL uses sound waves to break the stone. A PCNL procedure is more commonly used when ESWL is not successful. First a tube is inserted into the patient's back into the kidney to create a tract. A scope is run through the tract to directly see the stone inside the kidney.

Fig. Staghorn stone

Ultrasound equipment can then be inserted to break up the stone. While watching the stone through the scope, the stone: fragments can be grasped with special equipment and pulled through the tract out from the kidney. Before the advent of PCNL and ESWL, open surgical procedures were performed. This is less often necessary now, but sometimes is still performed especially for large complicated staghorn (branched) stones.

Q13. Explain in detail the mechanism and problems related to dialysis.

Answer

Problems Related to Dialysis

Renal dialysis could sustain life indefinitely, but in practice most people experience a steady .decline of overall health with long-term dialysis because there are several problems involved in procedure.

The life span of catheters is limited due to thrombosis or infection. Anticoagulation is required to prevent clotting of the extra corporeal circuit. Poor filtration rates and clotting of the filter may result from low arterial pressure and or elevated central venous pressure. Plasma urea and creatine are lowered by each treatment of haemodialysis but do not return to normal.

Dialysis distributes the electrolyte imbalance. Kidney machines do not perform regulatory control of body fluid volume and acid-base balance. Kidney machines do not perform endocrine production of erythropoietin, renin and prostaglandin and metabolic activation of vitamin D.

Q14. What are regulatory strategies in man for thermo regulation? Also classify the animals on the basis of temperature.

Answer

Thermoregulation

Thermoregulation is defined as the maintenance of internal temperature within a range that allows cells to function efficiently. The body works to balance the amount of heat loss to maintain a stable internal temperance. Temperature colder or warmer than the enzymes optimum range, changes the shape of the active site and causing chemical reaction to stop.

Classification of Animals on the Basis of Temperature

Animals can be classified based upon to maintain constant body temperature as poikilotherms and homeotherms. Poikilotherms are all non-vertebrates, fishes, amphibian and reptiles. These are unable to maintain their body temperature within narrow limits using physiological mechanisms. Homeotherms are birds and mammals which are able to maintain a fairly constant body temperature by using physiological mechanisms.

Animals are also classified on the basis of source of body's heat as ectotherms and endotherms. Ectotherms animals produce metabolic heat at low level and that is also exchanged quickly with environment. They rely more on heat derived from the environment to raise their body temperature. Examples are most invertebrates, fishes, amphibians and reptiles. Endotherms animals produce their own body heat through heat production as by-product during metabolism in muscles, or by the action of hormones that increase metabolic rate. The examples of endotherms are birds and mammals.

Thermoregulatory Strategies in Man

Thermoregulatory centre in human body is located in the hypothalamus which acts as thermostat. It can detect the temperature of the blood that passes through it and, if the temperature increases or decreases even slightly, the hypothalamus initiates corrective responses such as sweating or shivering. When we encounter a particularly warm or

cold environment, temperature receptors in the skin inform the hypothalamus. They also stimulate the higher, voluntary centres of the brain. This means that we feel changing our clothing or turning the heating up or down. Often, this behavioural response corrects the situation without the need for any physiological response.

Hyperthermia is the body temperature above 37°C. There are two main physiological responses to heat, vasodilation and sweating. Vasodilation is the expansion of blood capillaries which lie just beneath the epidermis of the skin. So there is more flow of the blood in blood capillaries of the skin. Sweat glands spread sweat over the skin. Evaporation of sweat from the skin carries heat from the blood thus produces cooling effect.

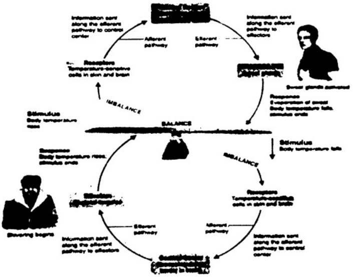

Information sent along the afferent pathway to control center
Afferent pathway
Efferent pathway
Information sent along the efferent pathway to effectors
Receptors
Temperature-sensitive cells in skin and brain
Sweat glands activated
IMBALANCE
Response
Evaporation of sweat
Body temperature falls;
stimulus ends
Stimulus
Body temperature rises
BALANCE
Stimulus
Body temperature falls
Response
Body temperature rises;
stimulus ends
IMBALANCE
Receptors
Temperature-sensitive cells in skin and brain
Shivering begins
Efferent pathway
Afferent pathway
Information sent along the efferent pathway to effectors
Information sent along the afferent pathway to control center

Fig. Thermoregulation in human

Physiological Responses to Cold

Spasmodic contraction of the muscles is called shivering. This contraction produces heat which helps to raise the body temperature. Vasoconstriction reduces blood flow to the skin. Piloerection literally means erection of skin hair. It traps air in the erected hair which is insulator for the heat. Increased metabolic rate is also a physiological response to cold.

Q15. Define how excretion osmoregulation takes place in different habitats?

Answer

Excretion

Metabolism produces a number of toxic by-products, particularly the nitrogen containing compound. The excretion is the removal of chemical waste from the body which are produced by the metabolic processes within cells. The nitrogenous excretory products of animals are ammonia, urea and uric acid.

Relationship between Excretory Products and Habitats

The exact nature of excretory product is determined mainly by the availability of water to the organism which is based upon its habitat. The correlation with habitat is: (a) ammonia aquatic (b) urea aquatic and terrestrial (c) uric acid terrestrial.

Ammonia

Ammonia is highly toxic because it tends to raise the pH of body fluids and interfere with membrane transport functions. It is highly soluble in water and diffuses rapidly across cell membrane. It is therefore excreted rapidly. One gram of nitrogen, in the form of ammonia, requires five hundred ml of water to dissolve it to nontoxic level. Such plenty of water can only be afforded by many aquatic organisms, particularly those in freshwater e.g., most fishes, protozoans, sponges, coelenterates. Animals which excrete ammonia as their major nitrogenous waste product are called ammonotelic.

Urea

Organisms with less freshwater available, such as some marine organisms and all terrestrial organisms remove their most of the nitrogenous waste in the form of urea. They will often invest some energy to convert the ammonia into urea, which is 100,000 times less toxic than urea. One gram of nitrogen, in the form of urea, requires 50 ml of water to dilute it to nontoxic level. Animals which excrete urea as their major nitrogenous waste product are called ureotelic.

Uric acid

Uric acid is a purine even less toxic than urea, and it precipitates from solution, allowing the 4 nitrogen atoms per uric acid molecule to be excreted with just enough water so that the crystals do not scratch on the way out. One gram of nitrogen, in the form of uric acid, requires just 1 ml of water for its excretion. It has evolved in two groups with major water loss problems, terrestrial invertebrates and egg-lying vertebrates. These animals are called uricotelics.

ADDITIONAL QUESTIONS

Q16. What are disorders of urinary tract infection (UTI)? Also write down the names of microbes which cause UTI.

Answer

Disorders of Urinary Tract

The normal aging process in humans affects kidney function in various ways. Urinary tract infections (UTI) are fairly common.

Urinary Tract Infection

Although males can get a urinary tract infection, the condition is fifty times more common in women. In general, the higher risk in women is mostly due to the shortness of the female urethra, which is 1.5 inches as compared to 8 inches in men. Bacteria from faecal matter at the anal opening can be easily transferred to the opening of the urethra. Almost all parts of the urinary tract are affected by the infection except ureters which are rarely the site of infection. The types of UTIs depending upon the site are: urethritis is an infection of urethra, cystitis involves the bladder and if the kidneys are infected the infection is called pyelonephritis.

Since the infection is caused by bacteria, it is curable by antibiotic therapy. For prevention, one should drink lot of water to flush out bacteria. Personal hygiene is especially important too.

Causes

The bacterial and fungal strains that cause most common type of UTIs include:

- Escherichia coli
- Staphylococcus saprophyticus
- Klebsiella, Enterocooci bacteria, and Proteus mirabilis
- Fungal organisms, such as Candida albicans that also causes the infections in mouth, digestive tract, and vagina.
- Neisseeria gonorrhoea-causes
  Urethritis, Gonorrhoea
- Treponema palladium- causes syphilis

Q17. What are the causes of kidney failure and its types?

Answer

Kidney Failure

A general term for a decline kidney function particularly the efficiency of the filtering process is called kidney failure or renal failure. Chronic renal failure is the irreversible deterioration in renal function. It is a gradual, slowly progressive and occurs over a period of years.

Chronic renal failure may be caused by: Bacterial infection of the pelvis and surrounding tissue. Nephritis (inflammation of glomeruli). Damage due to high blood pressure. Diabetes mellitus.

Acute renal failure may be caused by: Haemorrhage due to trauma, vomiting, diarrhoea. Diuresis (excess excretion of urine) sweating, obstruction of the ureters, bladder or urethra e.g., kidney stone.

Q18. What is a dialysis? Why it is required? Write a note on types of dialysis.

Answer

Dialysis Mechanism

A procedure to filter toxins from the blood by artifical methods when the kidneys are unable to perform this function is called renal dialysis. Dialysis works on the principal of kidneys although it is not as effective, efficient, or thorough as the natural processes performed by the kidneys. There are two general types of renal dialysis: haemodialysis and peritoneal dialysis.

Haemodialysis

Haemodialysis removes wastes and water by circulating blood outside the body through an external filter, called a dialyzer, which consists of tubes of semipermeable membrane. In this process, a catheter is inserted into a blood vessel, usually in the arm, it routes the blood circulation externally through a machine that removes wastes. The cleansed blood then returns to the body through a second catheter. The haemodialysis machine consists of a pump and a container in which a network of synthetic tubes made up of cellophane membrane, called the dialyzer, is situated. The blood moves into the tubes of dialyzes from the top through blood pump. After circulating through the dialyzer, blood leaves the machine from the bottom and transfuse back to the body. On the other hand, dialysate (dialysis fluid) pour into the machine from bottom, which after circulating around the membranous tube, leaves the machine from the top. The dialysate attracts certain substances-minerals, electrolytes, and waste by-products to cross the membrane from the blood. The dialysate absorbs these substances.

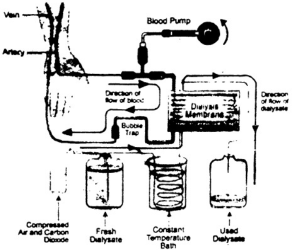

Vein
Artery
Blood Pump
Direction of flow of blood
Bubble Trap
Dialysis Membrane
Direction of flow of dialysate
Compressed Air and Carbon Dioxide
Fresh Dialysate
Constant Temperature Bath
Used Dialysate

Fig. Haemodialysis

Peritoneal Dialysis

Peritoneal dialysis involves the use of a natural membrane in the body, the peritoneum. which encloses the abdominal cavity. In this process, two catheters are surgically inserted into the abdominal cavity that serve as the portals through which dialysate (dialysis fluid) enters and leaves the cavity. The molecules of the dialysate are too large to pass through the peritoneum so the solution remains contained in the abdominal cavity. During circulation, when blood passes through the blood vessels (capillary networks) within the peritoneum, the dialysate attracts certain molecules to cross the membrane into the dialysate. A second catheter carries dialysate out of the abdominal cavity.

Q19. How does kidney transplantation is done and what are problems related to the process?

Answer

Kidney Transplant: Process and Problems

Kidney transplantation is the surgical procedure of placing a fully functioning kidney into a person with chronic kidney failure.

Principles of Kidney Transplant

Kidney graft is taken from a deceased (cadaver) donor or from a related or unrelated person. ABO blood group compatibility between donor and recipient is essential. It is usual to select donor kidneys on the basis of human leucocytes antigen (HLA) matching as this improves graft survival. A person can live normally with just one kidney.

When a donor kidney becomes available, it is relatively simple operation to transplant it into another body. The old kidneys are left in place and they do not harm. The existing kidneys are removed only if they cause persistent infection or high blood pressure. The new kidney is placed in the lower abdomen. Surgeon chooses the site because the new kidney can be attached easily to a large artery (femoral artery) and is usually right next to the bladder.

As soon as the transplanted kidney is connected to the -blood vessels, it will begin purifying the blood of waste products.

Problems associated with kidney transplant

The two problems are rejection and toxic effects of cyclosporine. These problems are

usually treated simultaneously by adding extra doses of steroids. Patients are required to take medications such as cyclosporine etc. to suppress their immune system in order to prevent rejection of the transplanted kidney. If at any point a recipient stops taking the medications, transplant rejection can occur even ten or fifteen years after the transplant.

KEY POINTS

- Homeostasis is the tendency of an organism or cell to regulate its internal conditions, such as the chemical composition of its body fluids, so as to maintain health and functioning, regardless of outside conditions.
- Homeostatic mechanism operates just like physical control system having three components; receptors, control center and effectors.
- Negative feedback results in a reversal of the direction of change. Negative feedback tends to stabilize a system, correcting deviations from the normal state.
- Positive-feedback involves a change in some variable that triggers mechanisms that amplify rather than reverse the change.
- A type of homeostasis in which water and ions (electrolytes) concentration is maintained in the cells and in the intercellular fluids is called osmoregulation.
- Aquatic animals that live in the sea have the body fluids with a solute concentration equal to that of external environment so that animal body fluids are kept isotonic. Such animals are called osmoconformers.
- Desert mammals are very much resistant in this regard. They can tolerate against strong degree of dehydration by special metabolic and behavioral adaptation. This characteristic is called anhydrobiosis.
- The primary nitrogenous waste product is ammonia. Some animals excrete their ammonia directly; others fast convert it to less toxic wastes such as urea or uric acid and then excrete it.
- Animals which excrete ammonia as their major nitrogenous waste product are called ammonotelic.
- Animals which excrete urea as their major nitrogenous waste product are called ureotelic.
- Animals which excrete uric acid as their major nitrogenous to are called uricotelic.
- Skin, lungs, liver and kidneys work to dispose of metabolic wastes.
- The act of emptying the bladder is called micturition.
- Formation of urine involves three key processes ultrafiltration, selective reabsorption and tubular secretion.
- A urinary tract infection can happen anywhere along the urinary tract. Types of UTIs depending upon the site include: pyelonephritis (kidney infection), cystitis (bladder infection) and urethritis (urethral infection).