BIOLOGY

Kidney Functioning and Renal Dialysis

Process	Kidney Function	Renal Dialysis

What it Does	• Kidneys regulate the chemical composition of the blood by removing metabolic wastes from the body.
	• Filter poisonous nitrogenous wastes (urea-made by the liver from excess amino acids in protein food) from the blood, maintaining blood pH.
	• Remove excess fluids.
	• Maintain salt and mineral levels (regulate ion concentration).
	• Release 3 hormones:
	  • Erythropoietin: Stimulates bone marrow to make red blood cells
	  • Rennin: Regulates blood pressure
	  • Calcitriol: Active form of vitamin D maintaining calcium for bones and chemical balance in the body.
		• Dialysis replaces kidney function when they are less than 15% of normal functioning level.
		• Regulate the chemical composition of the blood by removing metabolic wastes.
		• Filter poisonous nitrogenous wastes, maintaining blood pH.
		• Remove excess fluids.
		• Maintain salt and mineral levels
		• Two types:
		  • Peritoneal Dialysis
		  • Haemodialysis

How it Does it	• Blood vessels head towards the renal cortex in the nephrons of the kidney. • They continue to the Bomens capsule where they intertwine with a tubule in the Glomerulus. This forces fluid and nutrients out of the vessel (it doesn't take cellular blood components) this is known as glomerular filtrate. • The glomerular filtrate then travel towards the proximal tubule where blood vessel wrap around to re absorb the needed nutrients (glucose, salt ions, amino acids etc.) known as tubular reabsorption. • The left waste products reach the distal tubule after passing the loop of Henle. Here it passes into a series of collecting tubules where it is sent to the bladder via the ureter (known as tubular secretion) and then excreted via the urethra.	• **Peritoneal Dialysis:** A fluid is run into the abdominal cavity. It is left for several hours and 'bonds' with waste products. The fluid is then drawn out and discarded. • **Haemodialysis:** This is the common form of dialysis. With temporary dialysis (e.g. before transplantation) a set of catheters is placed in the vein. Blood passes through one catheter, through a machine which removes toxins and back to the body through the other catheter. In permanent dialysis, surgery is needed to connect an artery to a vein in the arm (either by an artificial tube-shunt- or direct connection-fistula). This allows better access for the dialysis. During the dialysis, the needle is placed in the shunt or vein and retrieves and returns the blood here

Active/Passive Transport Used	Glucose, amino acids and sodium ions are reabsorbed by active transport. Passive transport is used in the Bowmans capsule when the non-cellular components of the blood are filtered out of the vessel and the larger cellular particles are kept in.	Dialysis cannot carry out active transport because it does not have a supply of energy. Instead it undergoes passive transport via diffusion where the smaller urea molecules can diffuse out of the tubing and the larger cellular molecules are kept in. Levels of vitamin and mineral intake must be closely monitored because some of these important components may diffuse out during the dialysis process.
Speed with Which Blood is Filtered	Approximately 150 L per day ($104\frac{1}{6}$ mL per minute)	4 hours 3 sessions per week ($20\frac{5}{6} mL$ per minute). All the blood in the body each session.
How Regulated	• The kidneys are regulated by hormones. • A decrease in ions in the blood stimulates the adrenal gland to secrete the hormone Aldosterone. When this reaches the kidney it increases the permeability of the nephrons to the ions, resulting in retention of the ions. (Diuretic: causes water loss). • When a decrease in water concentration is detected, the hypothalamus in the brain stimulates the posterior pituitary gland to release Anti-diuretic hormone (ADH). This increases the permeability of cell membranes in the distal tubule and collecting tubule to absorb water. (Anti-diuretic: reduces water loss). • These are negative feedback loops maintaining homeostasis by Osmoregulation.	• In dialysis the level of toxin and water re-absorption is regulated based on concentration gradient. The dialysate (dialysis fluid) flows in the opposite direction to the blood in order to collect maximal waste products (like the gills retrieving oxygen in a fish). • Dialysate has the same concentration of waste free blood plasma so that they easily diffuse from the blood to the dialysate along a concentration gradient. For example, bicarbonates in the dialysate to counteract the pH as it increases with acidity. This fluid must constantly be replaced so that the higher concentration of wastes in the blood continually diffuses out. If the concentration of wastes in the dialysate gets too high the concentration gradient will reverse and wastes will go back into the blood.
Outcome	• Blood clean of toxins such as urea (ammonia). • Erythropoietin stimulating the making of red blood cells • Calcitriol: maintaining calcium for strong bones. • Osmoregulation (control of water and salt levels in blood).	• Dialysis is not painful and patients can read, watch television, sleep or even eat while the process is happening. • After dialysis you can go about your normal daily activities without any restrictions. • Some of the consequences of kidney failure (such as hardening of the arteries) cannot be reversed by dialysis. The best option is a transplant but these have their own set-backs such as major surgery or taking anti-rejection drugs for life.

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