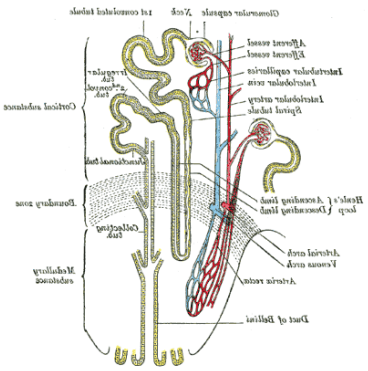
生物策略格式

KJC, 2019/10/21

類別	生物策略 (Strategy)
生物策略 STRATEGY	腎元分離及循環物資 (Nephrons separate and recycle resources)
生物系統 LIVING SYSTEM	人類 *Homo sapiens* (Human)
功能類別 FUNCTIONS	#獲取、吸收、或過濾化學物質 #改變濃度（離子、溶質等） #Capture, absorb, or filter chemical entities #Modify concentration (of ions, solutes, etc.)
作用機制標題	人類的腎單元，藉由腎臟中不同鹽分的百分率，可分離及吸收重要的離子、碳水化合物、蛋白質和水選透膜小管 (The human kidney element separates and absorbs important ions, carbohydrates, proteins, and water-selective permeable membrane tubules through different salt fractions in the kidney.)
生物系統/作用機制示意圖	

作用機制摘要說明 (SUMMARY OF FUNCTIONING MECHANISMS)

工業化學物質的製造過程，通常牽涉了物資密集型的分離步驟。大多數生化合成方法本身並不需分離步驟，然而其他生理過程卻需要。舉例來說，血液的過濾，將移除有潛在危害的有機或無機物質。水以及有用的礦物質、葡萄糖、蛋白質，都會和有害物質分離，並返回至血流中再循環。如果水和有用的化合物隨著有害化合物一起排泄，基於經常性的每日基礎，生物體就必須消耗幾加侖的水和許多公克的礦物質，以恢復流失量。

在腎臟過濾方面，可視為由數十萬到超過百萬個獨立裝配線的集合，並執行相同的複雜任務。此處的裝配線就是腎元，是一管狀構造，沿著其長度，具有特殊的區域。大量有用水分的排泄，在腎元第一次下降至腎臟深層組織時，會再吸收而回到血液中。此部分的腎元即是亨氏環 (loop of Henle) 的下降支 (descending limb)。下降支的內襯細胞，可通透水分，但對離子不通透。當分支下降通過腎臟漸鹹的 (高張的) 區域時，相對不鹹的 (低張的) 濾液中之水分，則被動流出腎元的內腔 (內部空間)，並經由滲透作用進入至周圍較鹹的組織裡。接著濃縮的濾液沿著亨氏環的上升支 (ascending limb) 向上行進，通過逐漸

不鹹的 (增加高張的) 的間隙區域，上升回到腎臟的表面。與下降支相反，上升支內腔的內襯細胞可通透離子，但不透水。濾液中有用的離子，當其濃度梯度下降時，會經由蛋白質通道流至周圍腎組織裡而被再吸收，而水則被排除掉。沿著腎元，蛋白質泵在內腔和腎細胞間更進一步主動運輸有用的離子和物質，反之亦然。主動運輸需要耗盡 ATP 分子來輸入能量。更多的水分也被吸收，因此當濾液作為完全形成的尿液而抵達膀胱時，它僅含有初期濾液體積的百分之一。

Industrial chemical processes often involve resource intensive separation steps. While most biochemical synthetic methods themselves do not need separation steps, other physiological processes do. One example is the filtering of blood which removes potentially harmful organic and inorganic materials. Water, as well as useful minerals, glucose, and proteins are separated from the harmful materials and recycled back into the blood stream. If the water and useful compounds were excreted along with the harmful compounds, the organism would have to consume gallons of water and many grams of minerals on a constant, daily basis to recover the loss. The filtration aspect of the kidney can be thought of as a collection of hundreds of thousands to over a million independent assembly lines carrying out the same intricate task. The assembly line here is the nephron, a tubular structure with specialized regions along its length. The great quantity of useful water that is excreted is reabsorbed back into the blood as the nephron first descends into the deeper tissues of the kidney. This part of the nephron is the descending limb of its “loop of Henle.” The cells lining the descending limb are permeable to water and impermeable to ions. As the limb descends through progressively saltier (hypertonic) regions of the kidney, water in the relatively un-salty (hypotonic) filtrate passively flows out of the nephron’s lumen (interior space) and into the surrounding salty tissues via osmosis. The concentrated filtrate then travels up the ascending limb of the loop of Henle, which ascends back towards the surface of the kidney through progressively less salty (increasingly hypotonic) interstitial regions. In contrast with the descending limb, the cells that line the lumen of the ascending limb are permeable to ions and impermeable to water. Useful ions in the filtrate are reabsorbed as they flow down their concentration gradient into the surrounding kidney tissues through protein channels, while water is excluded. Further along the nephron, protein pumps actively transport useful ions and substances between the lumen and the kidney cells and vice versa. Active transport requires an energy input by depleting ATP molecules. More water is also absorbed, so that by the time the filtrate reaches the bladder as fully formed urine, it contains only one percent of the volume of the early filtrate.

文獻引用 (REFERENCES)

「管狀再吸收，指的是液體和溶質從管狀系統進入管周微血管的運動。此過程使得身體得以保留液體和所需的溶質。在腎絲球過濾率為 125 毫升/分鐘時，腎臟每天產生 180 升的濾液。然而，尿液平均輸出量僅為 1,000 至 1,500 毫升。經由再吸收，99%的腎絲球濾液可返回血流。近端小管是管狀系統中再吸收的主要部位...它將過濾的溶質再吸收，並因此有高達 100%的比例返回血漿，這些都是身體通常不希望丟棄的，例如葡萄糖、氨基酸和碳

酸氫鹽；且再吸收大部分的溶質，例如鈉、鉀、氯、鈣和鎂，以及水分.....再吸收牽涉到被動和主動的運輸機制。被動運輸包括滲透和擴散，而主要和二次運輸和吞噬作用等主動轉運機制，則需要使用能量來移動抵抗電化學梯度的物質。調節液體和溶質的再吸收，可達到身體的生理需要。」(Chmielewski 2003: 187-188)

"Tubular reabsorption is the movement of fluid and solutes from the tubular system into the peritubular capillaries. This process allows the body to retain fluid and desired solutes. At a glomerular filtration rate of 125 ml/min., the kidneys produce 180 liters of filtrate daily. Yet the average urine output is only 1,000 to 1,500 ml. Through reabsorption, 99% of the glomerular filtrate is returned to the bloodstream. The proximal tubule is the major site of reabsorption in the tubular system… it reabsorbs, and thus, returns to the plasma, up to 100% of the filtered solutes that the body does not routinely wish to discard, such as glucose, amino acids, and bicarbonate and reabsorbs a large percentage of solutes, such as sodium, potassium, chloride, calcium, and magnesium, and water…reabsorption involves both passive and active transport mechanisms. Passive transport includes osmosis and diffusion while active transport mechanisms, such as primary and secondary transport and endocytosis, require the use of energy to move substances against an electrochemical gradient. Reabsorption of fluid and solutes is regulated to meet the body's physiological needs." (Chmielewski 2003: 187-188)

參考文獻清單與連結 (REFERENCE LIST)

Chmielewski, C. (2003). Renal anatomy and overview of nephron function. *Nephrology nursing journal: journal of the American Nephrology Nurses' Association* 30: 185-90. (https://www.researchgate.net/publication/10768828_Renal_anatomy_and_overview_of_nephron_function)

延伸閱讀:

生物系統延伸資訊連結 (LEARN MORE ABOUT THE LIVING SYSTEM/S)

https://en.wikipedia.org/wiki/homo_sapiens

文章貢獻/編修者與日期:

陳敬喜翻譯 (2019/04/26)；朱天愛編修 (2019/12/19)；吳晧編修 (2020/01/04)；譚國鎏編修 (2020/05/26)；紀凱容編修 (2020/11/26)；施習德編修 (2020/12/28)

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