**Physiol-04A13** Describe the concept of renal clearance and its use to estimate glomerular filtration rate.

**Definitions**

*Renal clearance of substance* = hypothetical volume of plasma from which a substance is completely removed by the kidney in unit time

Renal clearance involves:

(a) glomerular filtration  
(b) tubular secretion (usu. active)  
(c) tubular reabsorption (usu. passive)  
(d) rarely tubular metabolism (insulin)

Renal clearance of substance Y could be estimated by:

\[ \text{Urinary } [Y] \times \text{urinary flow rate} / \text{plasma } [Y] \]

*Glomerular filtration rate* = volume of ultrafiltrate produced by the kidneys at the glomerulus per unit time

Normally, GFR ≈ 125 mL/min or 180 L/day

Theoretically, GFR would equal to renal clearance of a substance if it is freely filtered at the glomerulus and not:

(a) secreted  
(b) reabsorbed  
(c) metabolised  
(d) affect function of kidney

*Inulin* is a naturally occurring polysaccharide that closely fits above criteria  
∴ inulin clearance can be used to approximate GFR

Typical regime:

1. Infuse inulin (single shot methods also exist)  
2. Wait for steady state then measure plasma inulin concentration  
3. Catheterise bladder and measure urine output and urine inulin concentration  
4. Use equation to calculate inulin clearance, which approximates GFR

Rate of inulin filtered at glomerulus = \([\text{inulin}]_{\text{plasma}} \times \text{GFR}\)  
Rate of inulin excreted in urine = \([\text{inulin}]_{\text{urine}} \times \text{urine flow rate}\)  
By conservation of mass and assuming no tubular excretion, reabsorption or metabolism \(\rightarrow\) above must be equal

Solving for GFR = \([\text{inulin}]_{\text{urine}} \times \text{urine flow rate} / [\text{inulin}]_{\text{plasma}}\)

Inulin clearance is laborious to perform as well as being invasive
Creatinine is a product of muscle creatine breakdown → naturally occurring

Creatinine clearance is often used to approximate GFR as it is freely filtered at glomerulus but small fraction also actively secreted by the proximal tubules
∴ CrCl overestimates GFR

**Examiner’s comments** – 69% of candidates passed this question.

Candidates were expected to provide some **definition of clearance**, with some detail on how the elements of function of the kidney relate to clearance. These include **filtration** and **tubular reabsorption** and **secretion**.

The inclusion of any discussion about **glomerular filtration** and **tubular function** was a common omission in a number of answers. In a number of cases, extensive detail was provided on the mechanisms of filtration at the glomerulus, but this did not attract significant additional marks.

Inclusion of some **basic formula** about **how clearance relates to plasma concentration and urinary volume and concentration** was an important inclusion in the answer. Quite a number of candidates included an extensive derivation of this formula, but omitted more important facts.

The properties required of a marker, ideal for use in the measurement of glomerular filtration rate was well described by the majority of candidates, and was an important part of the answer. Most candidates included discussion of specific examples which can be used, such as inulin and creatinine. Whilst this was generally done well, an understanding of the relationship between creatinine concentrations, creatinine clearance, and glomerular filtration rate was not always apparent.