Renal physiology I

Urinary and non-urinary functions
Functional anatomy

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Urinary functions

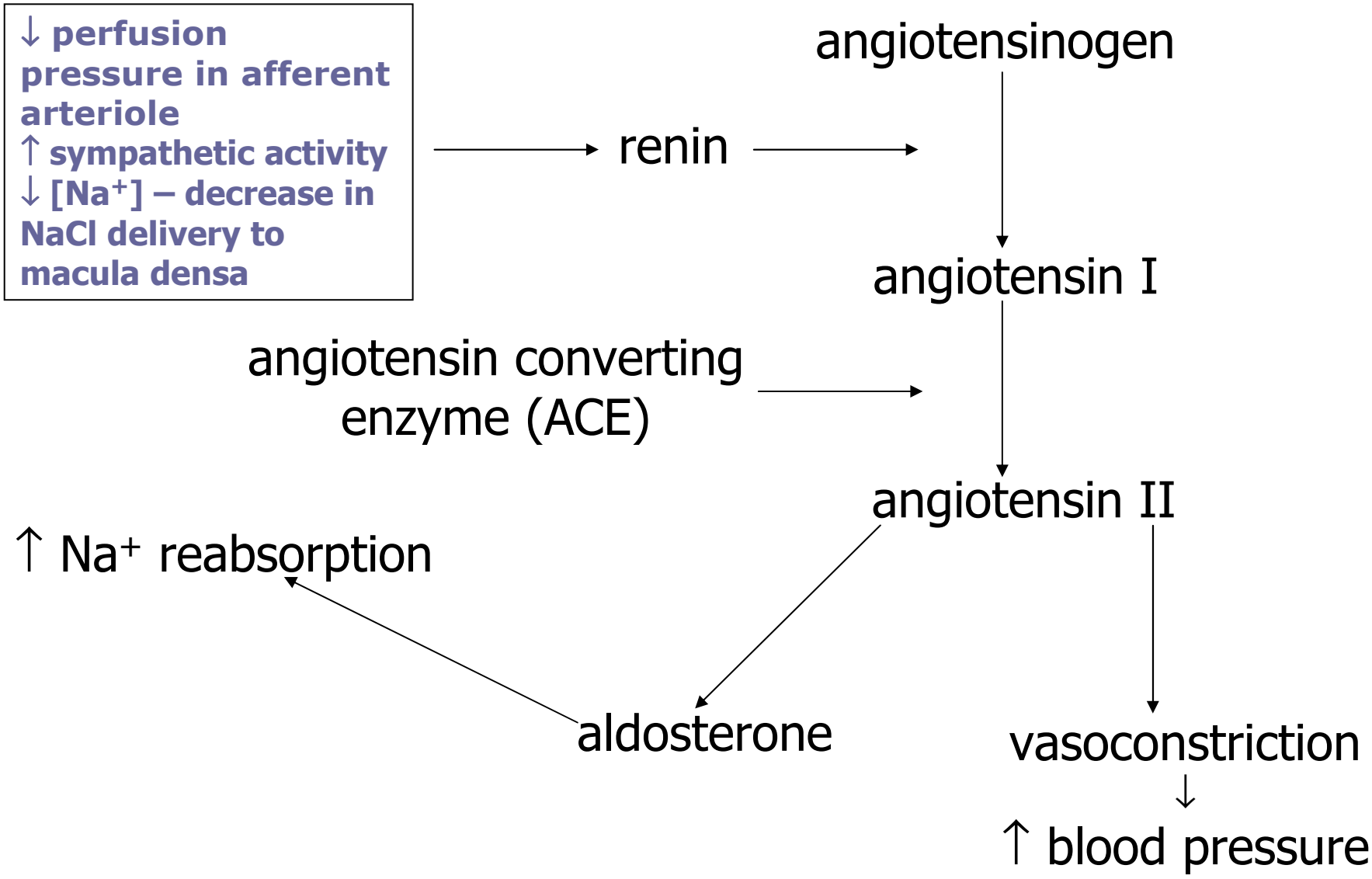
AIM: Homeostasis in body fluids

- regulation of ECF volume, osmolarity & electrolyte balance by handling water and electrolytes
- regulation of acid-base balance by balancing H^+ and HCO_3^- levels
- excretion of metabolic end-products and foreign substances like urea, uric acid and creatinine
- adequate amounts of essential substances retained

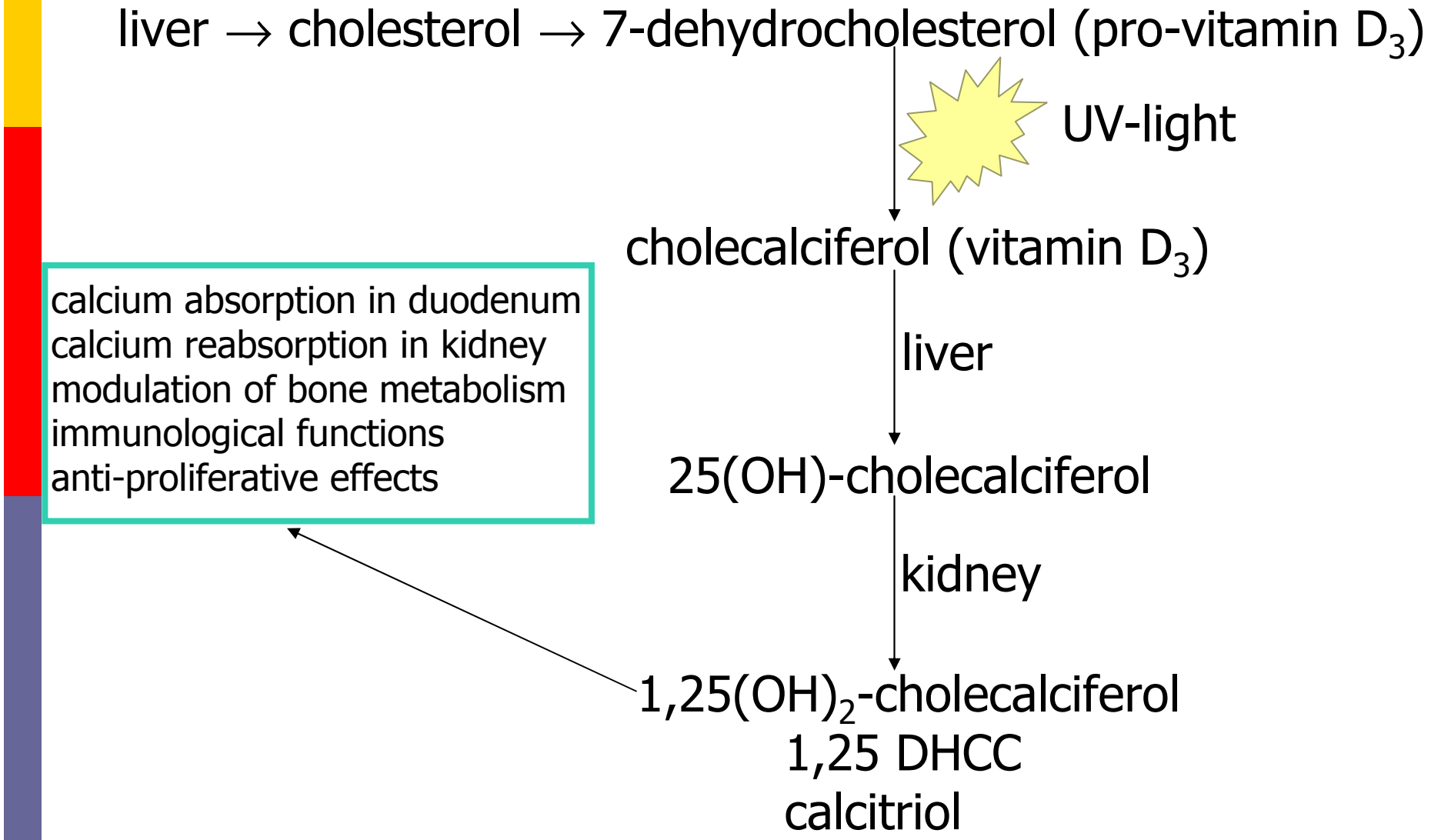
Non-urinary functions of the kidneys

- renin production
- calcitriol = $1,25(OH)_2D_3$ production
- erythropoietin production
- prostaglandin production
- bradykinin production
- gluconeogenesis
- dopamine production
- catabolism of substances such as lysozymes in the renal epithelial cells

Renin production



Calcitriol production



Erythropoietin

↓ tissue oxygenation

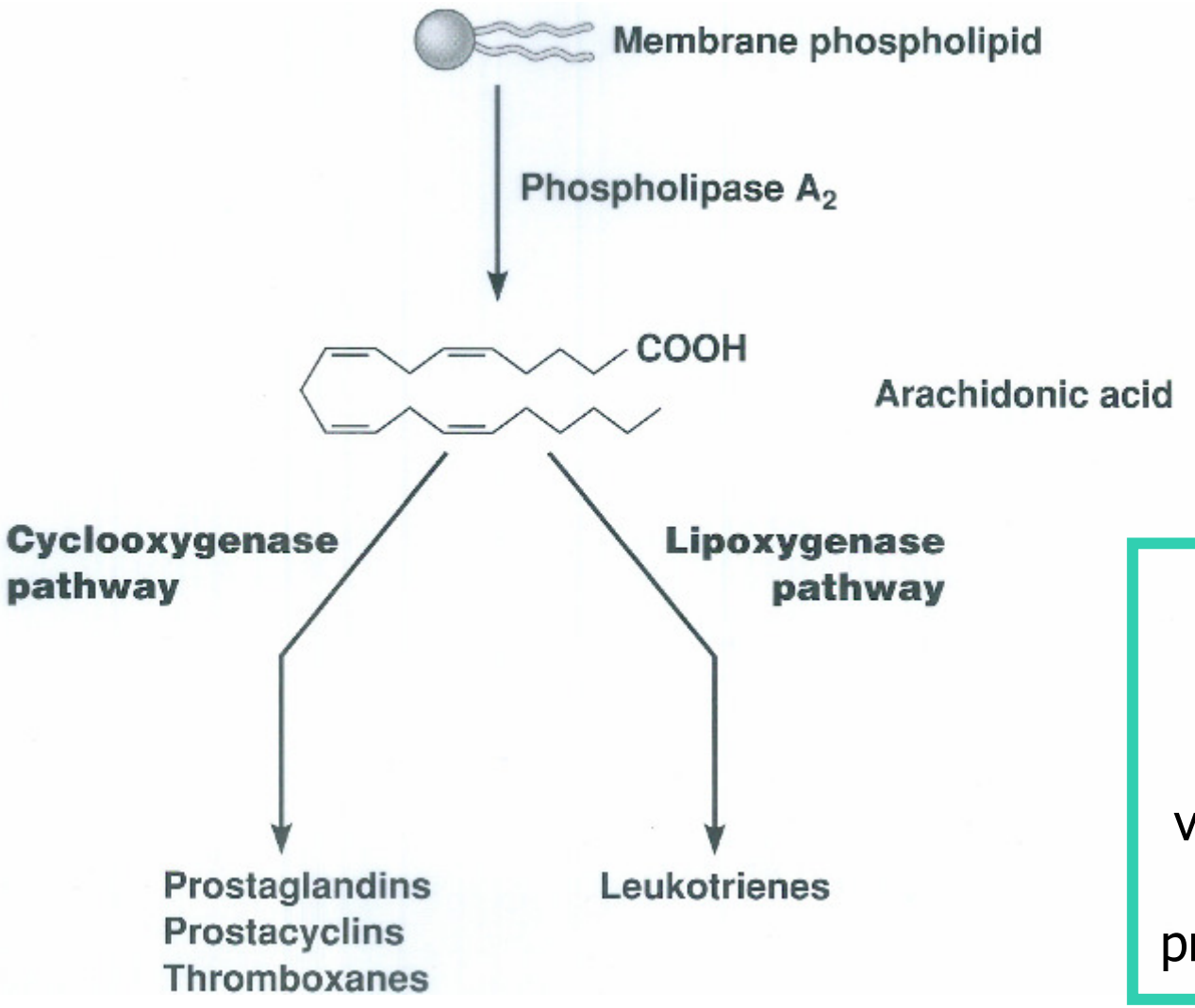
↓

erythropoietin production by kidneys

↓

↑ red blood cell production

Prostaglandin synthesis



prostaglandins
↓
increase RBF by dampening vasoconstrictor effects
↓
prevents renal ischemia

Bradykinin

kallikrein – proteolytic enzyme produced in kidneys

↓

cleaves circulating kininogens

↓

bradykinin

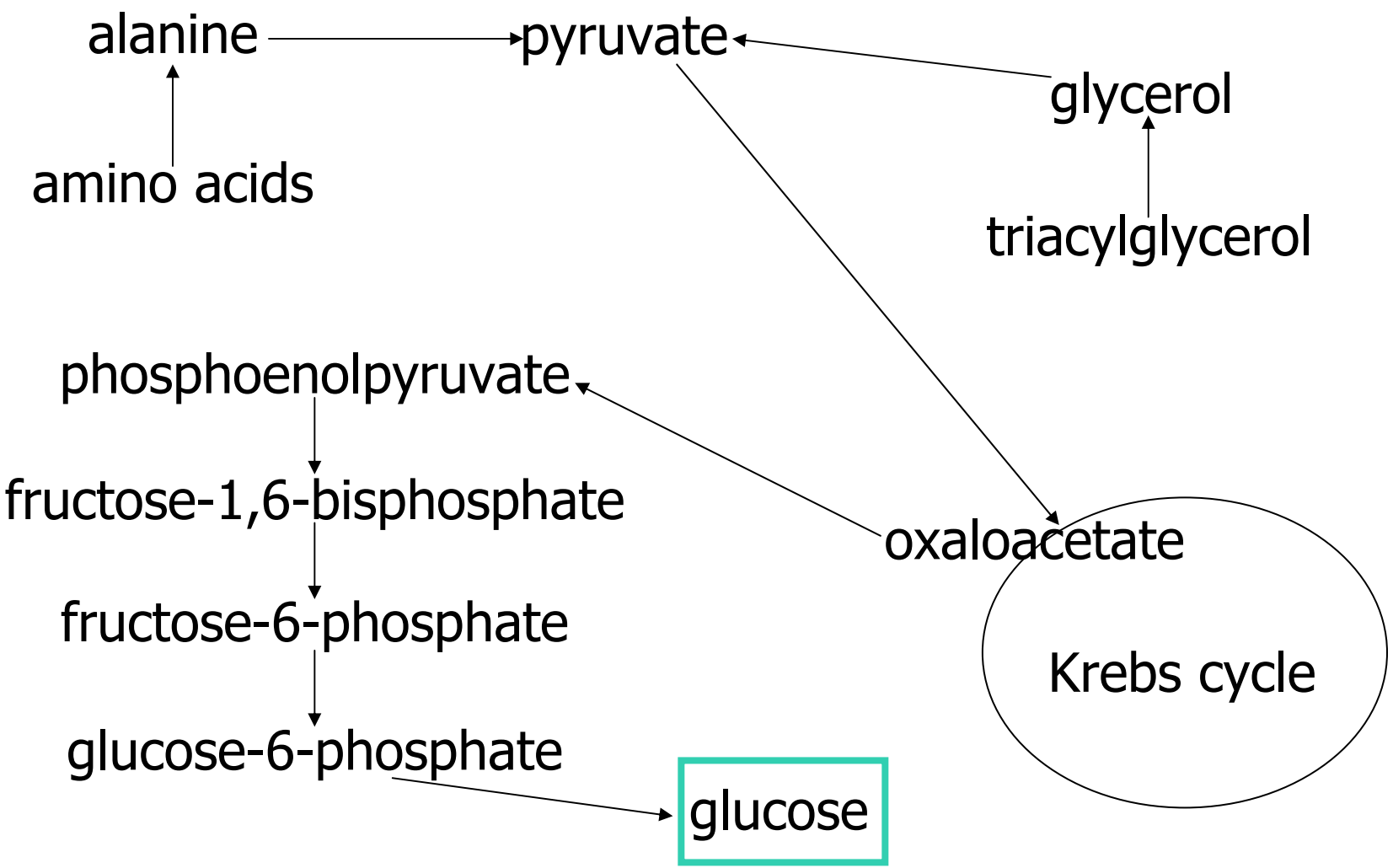
↓

causes vasodilation by stimulating the release of NO and prostaglandins

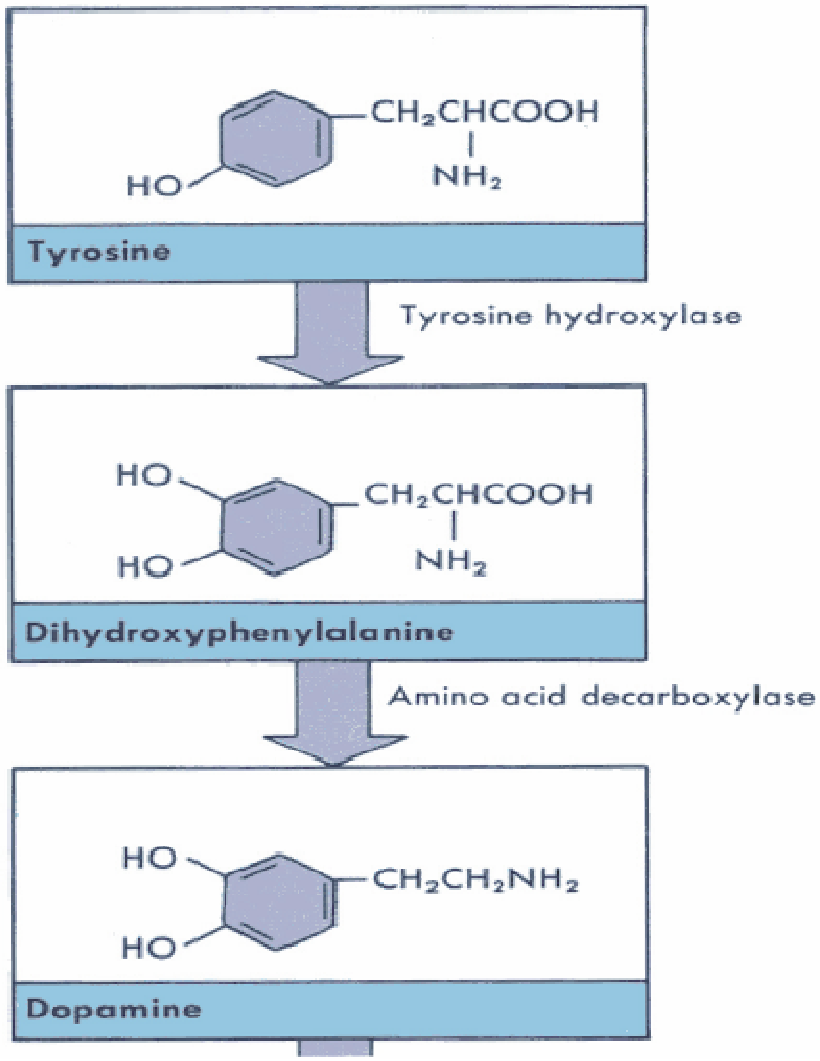
↓

increases RBF and GFR

Gluconeogenesis

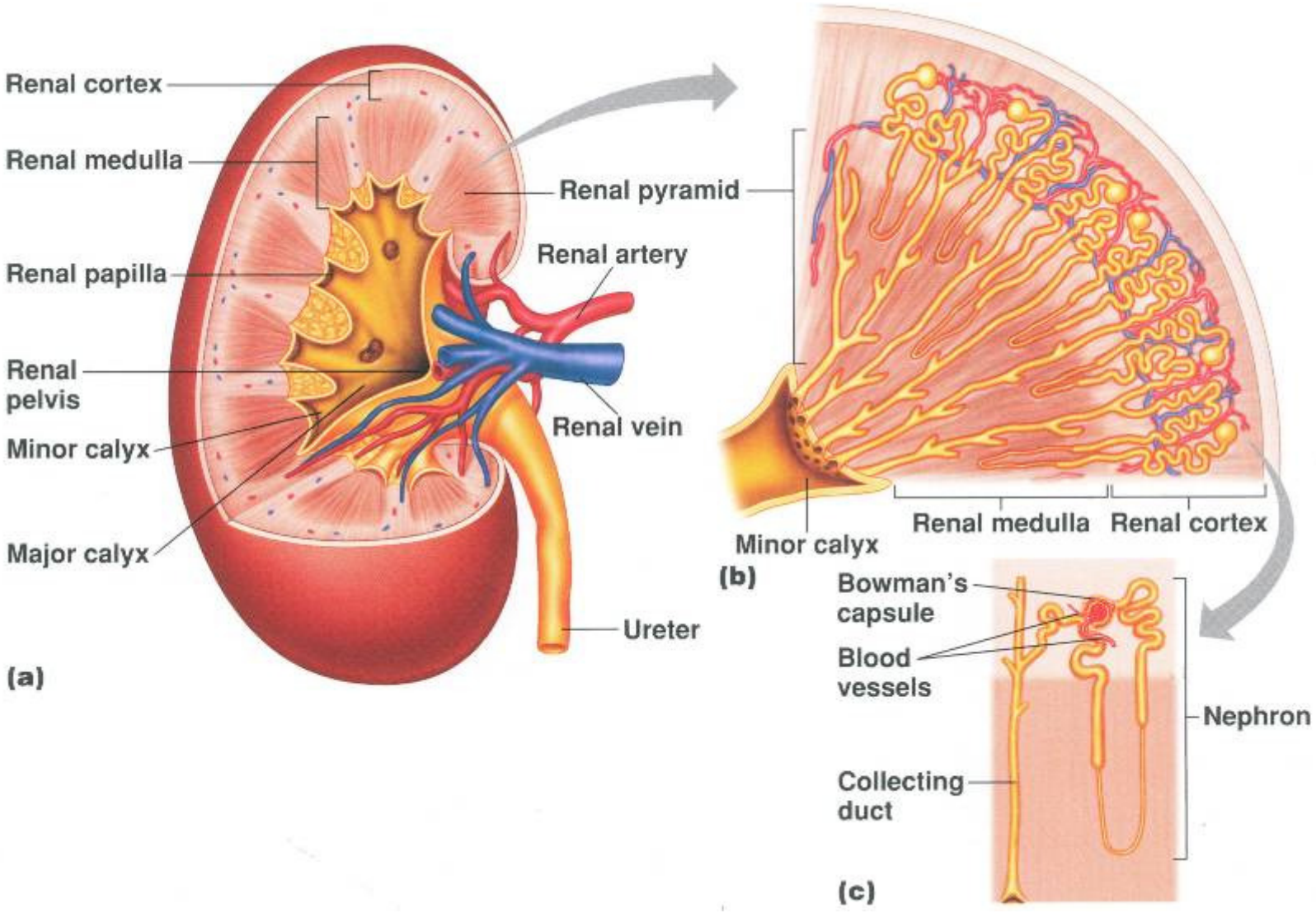


Dopamine synthesis

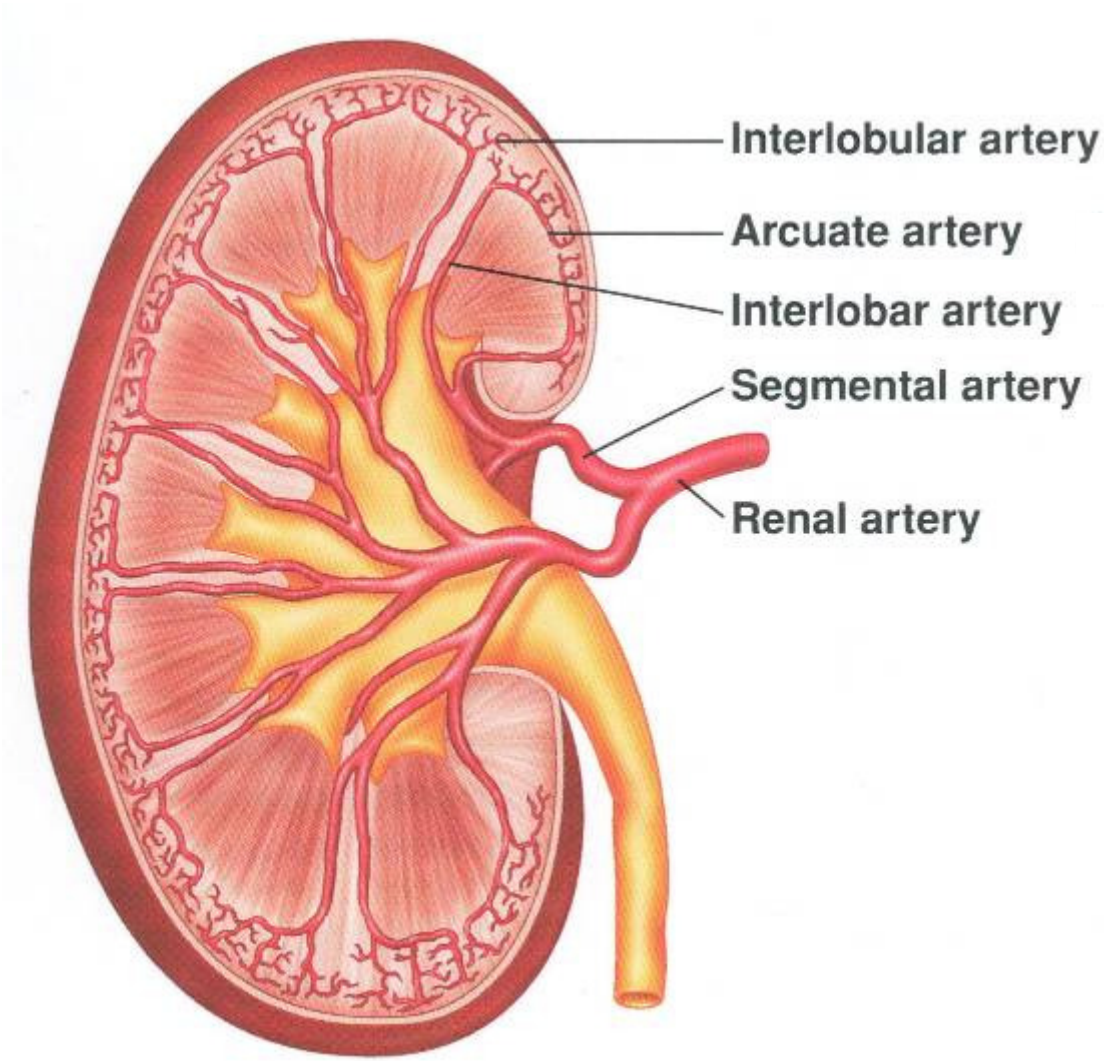


Dopamine is a vasodilator substance – increases RBF and inhibits renin secretion

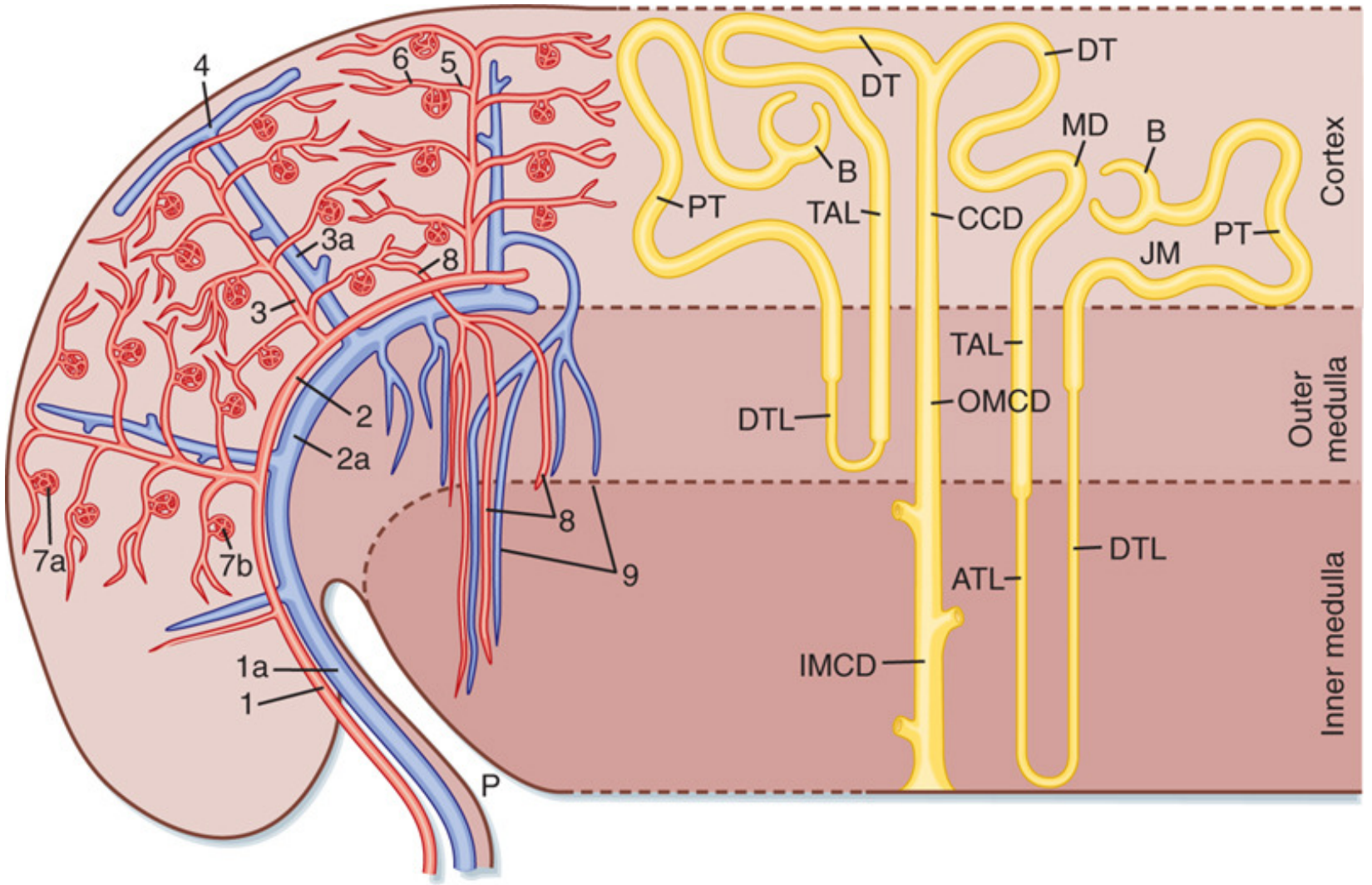
Functional anatomy of the kidney



Blood supply of the kidneys



Organization of the vascular system and nephron of the kidney



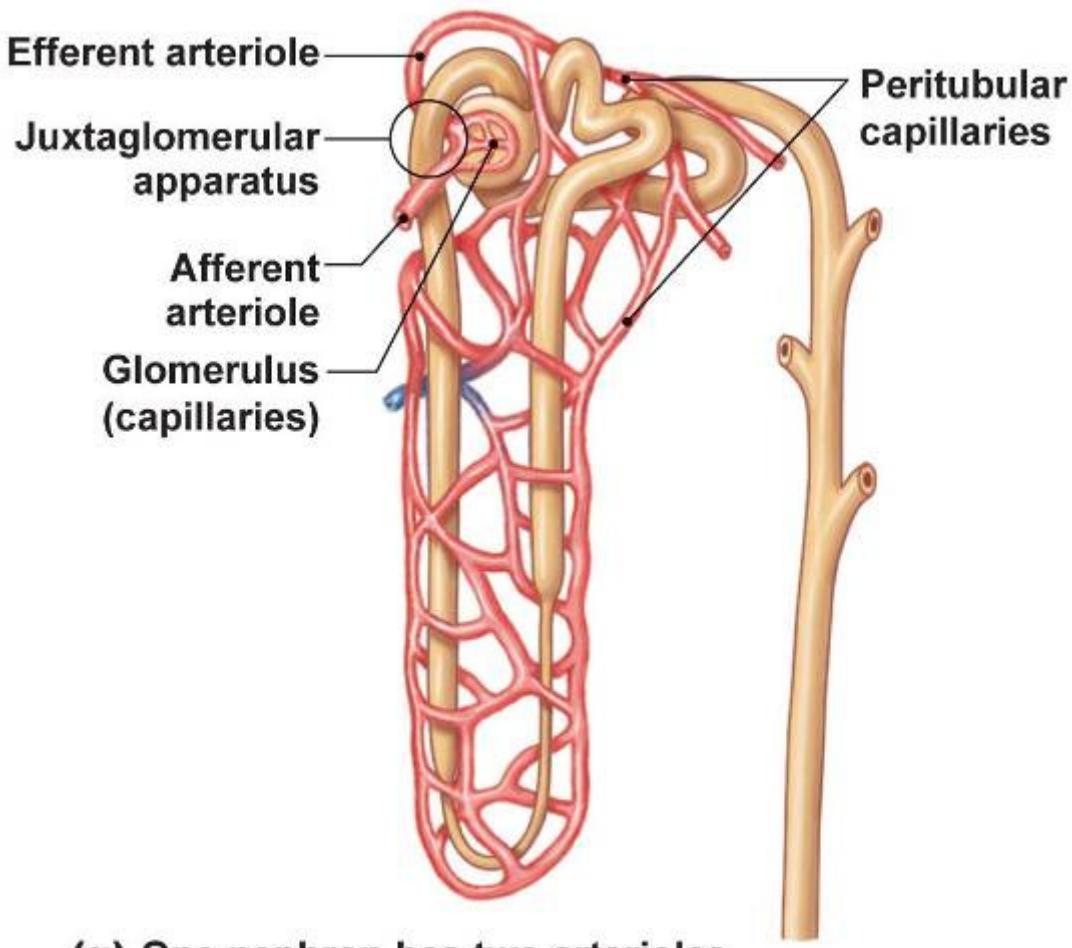
LEFT

1 – interlobar arteries, 1a – interlobar veins
2 – arcuate arteries, 2a – arcuate veins
3 – interlobular arteries, 3a – interlobular veins
4 – stellate veins
5 – afferent arterioles
6 – efferent arterioles
7a, 7b – glomerular capillary networks
8 – descending vasa recta
9 – ascending vasa recta

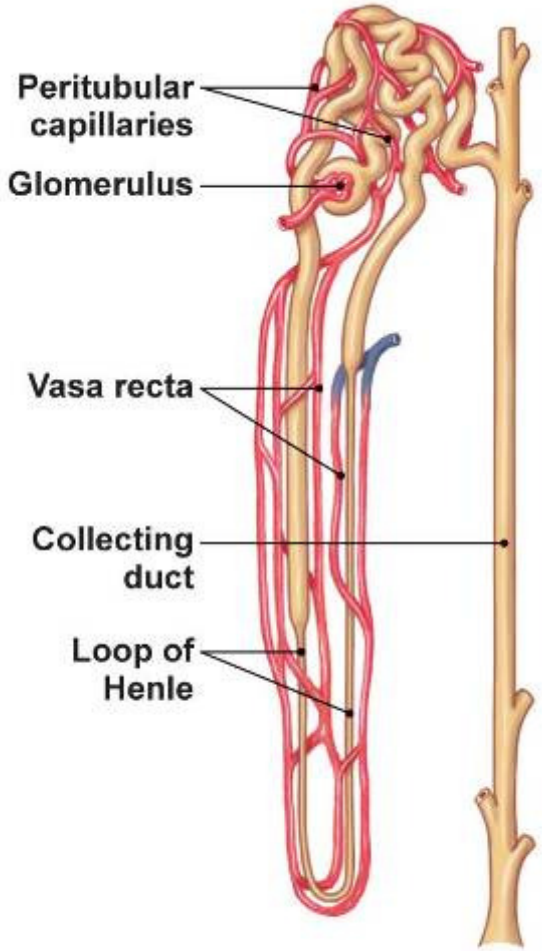
RIGHT

B – Bowman's capsule
PT – proximal tubule
DTL – descending thin limb
ATL – ascending thin limb
TAL – thick ascending limb
MD – macula densa
DT – distal tubule
CCD – cortical collecting duct
IMCD – inner medullary collecting duct
OMCD – outer medullary collecting duct
P – pelvis

Blood supply of the superficial and juxtamedullary nephrons

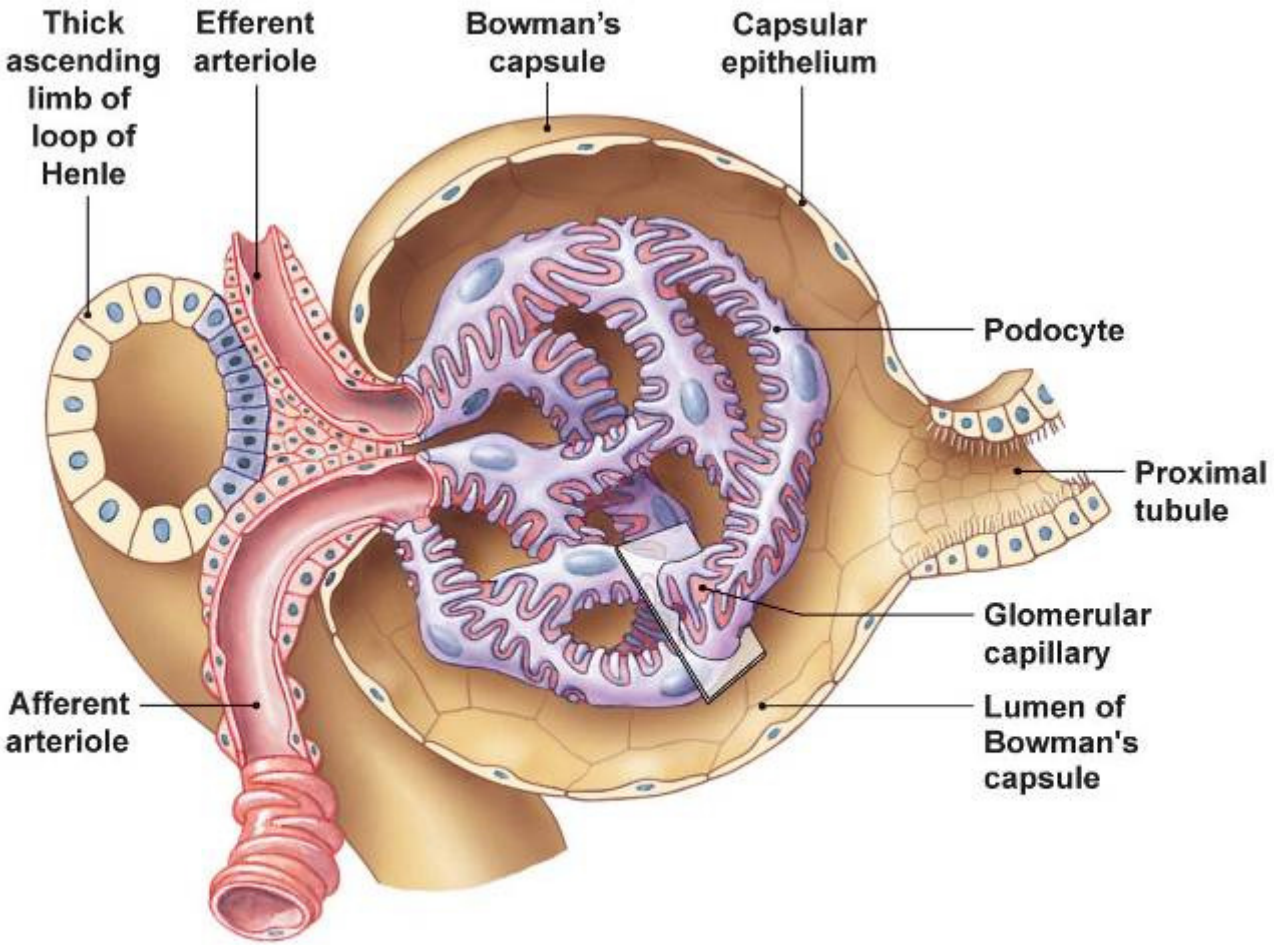


(g) One nephron has two arterioles and two sets of capillaries.



(h) Juxtamedullary nephron with vasa recta

The renal corpuscle (body of Malpighi)

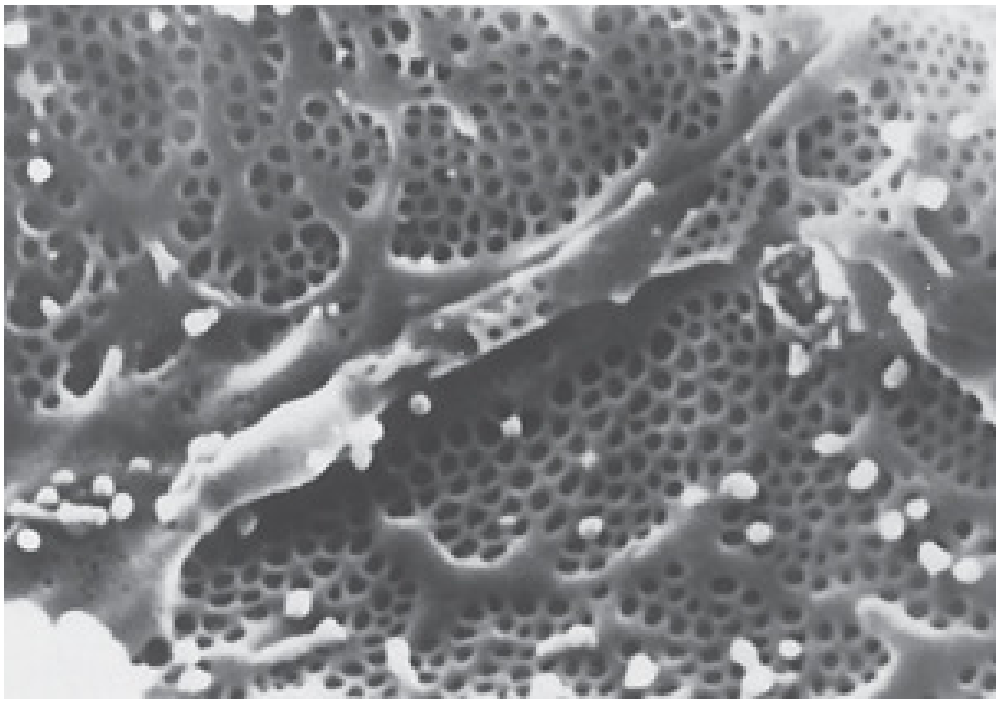


(a) The epithelium around glomerular capillaries is modified into podocytes.

Mesangial cells between basal lamina and endothelium contract to decrease filtering surface

LEFT
Micrograph showing podocyte foot processes around glomerular capillaries

RIGHT
Fenestrations (small holes) of endothelial cells from inside of glomerular capillary



Renal perfusion

- 1250 ml/min (20-25% of cardiac output)
- thus renal plasma flow: 650 ml/min
- renorenal reflex: a spinal reflex that compensates for a decrease in perfusion in one kidney with an increase in perfusion in the other kidney

Mechanisms of kidney function