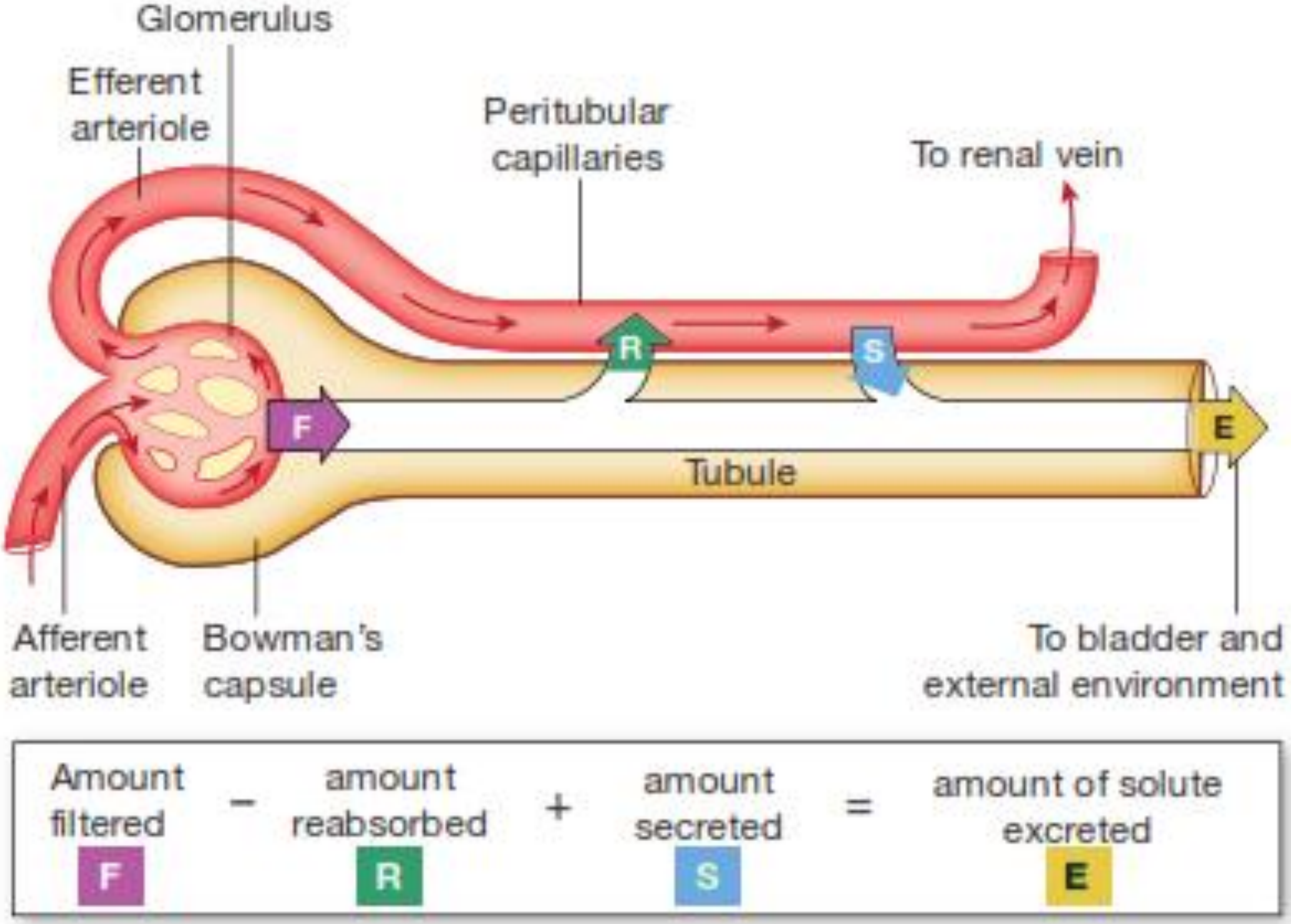
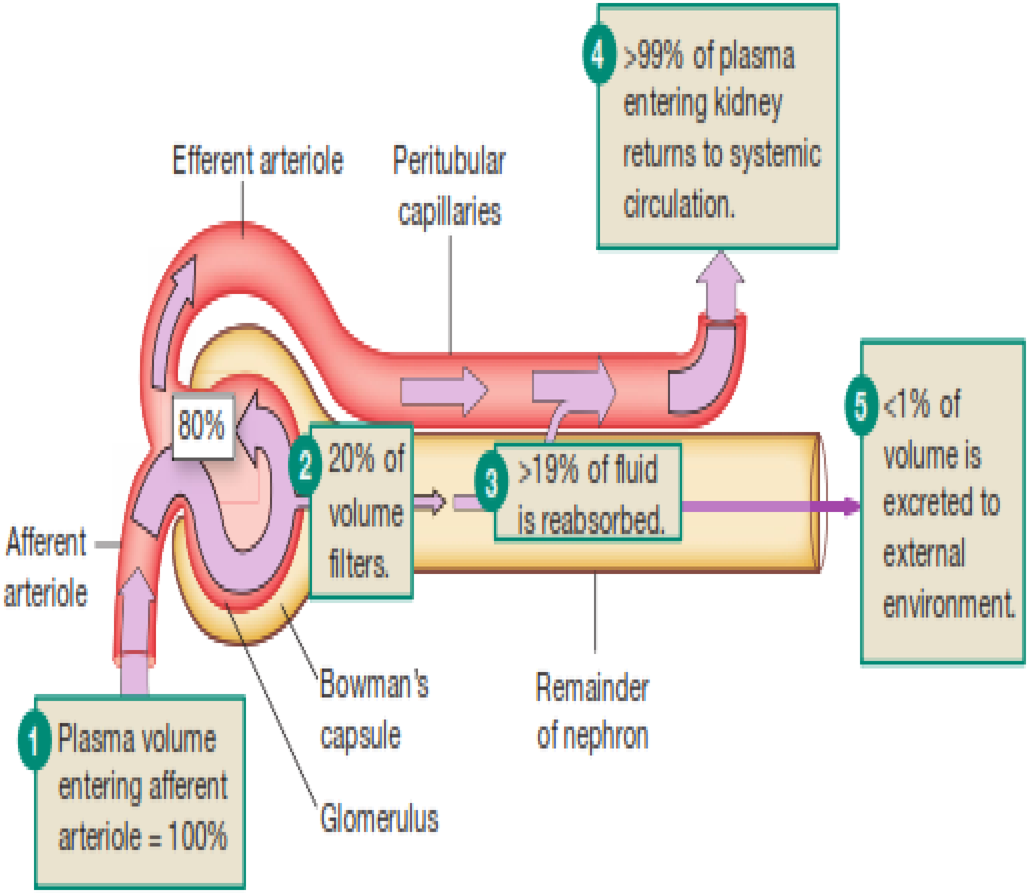
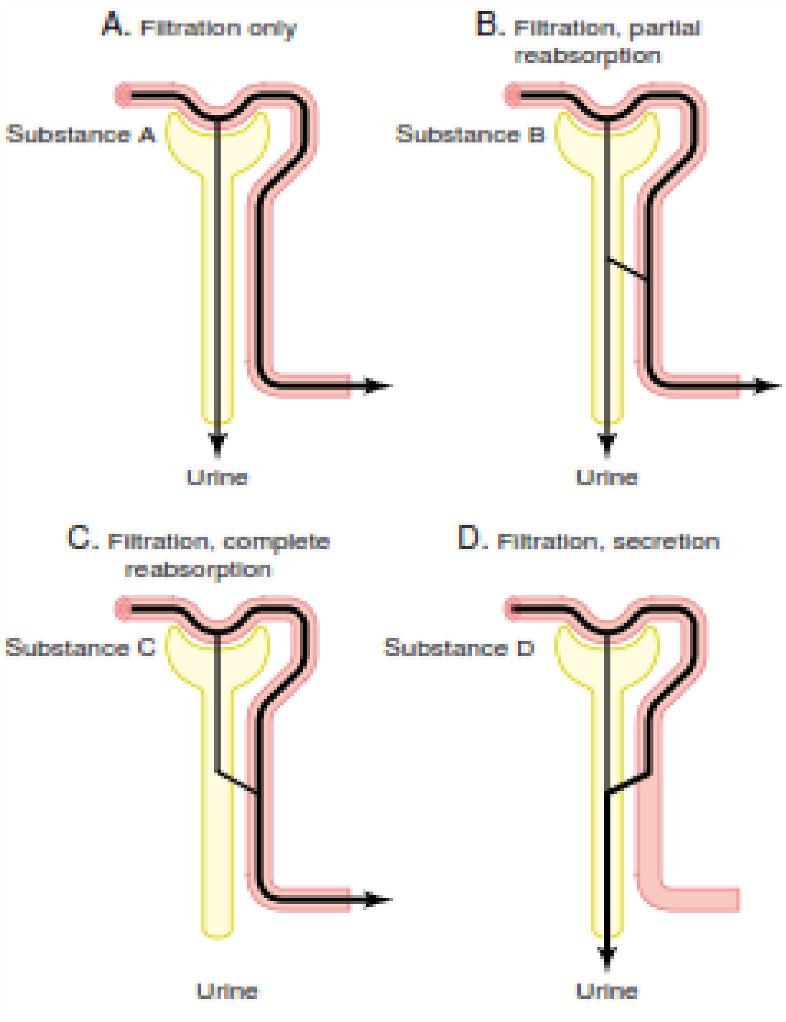


FIGURE 19-3 ***The urinary excretion of a substance depends on its filtration, reabsorption, and secretion.***



● **FIGURE 19-4** ***The filtration fraction.*** Only 20% of the plasma that passes through the glomerulus is filtered. Less than 1% of filtered fluid is eventually excreted.

Perlakuan ginjal terhadap empat jenis zat hipotetis.



A. Zat yang difiltrasi secara bebas tetapi tidak direabsorpsi.→ kreatinin

B. Zat difiltrasi secara bebas, tetapi sebagian hasil fitrasi direabsorpsi. Kembali ke darah→ Na, Cl

C. Zat difiltrasi secara bebas tetapi tidak diekskresikan ke dalam urine karena semua zat yang direabsorpsi dari tubulus ke dalam darah.→ asam amino dan glukosa

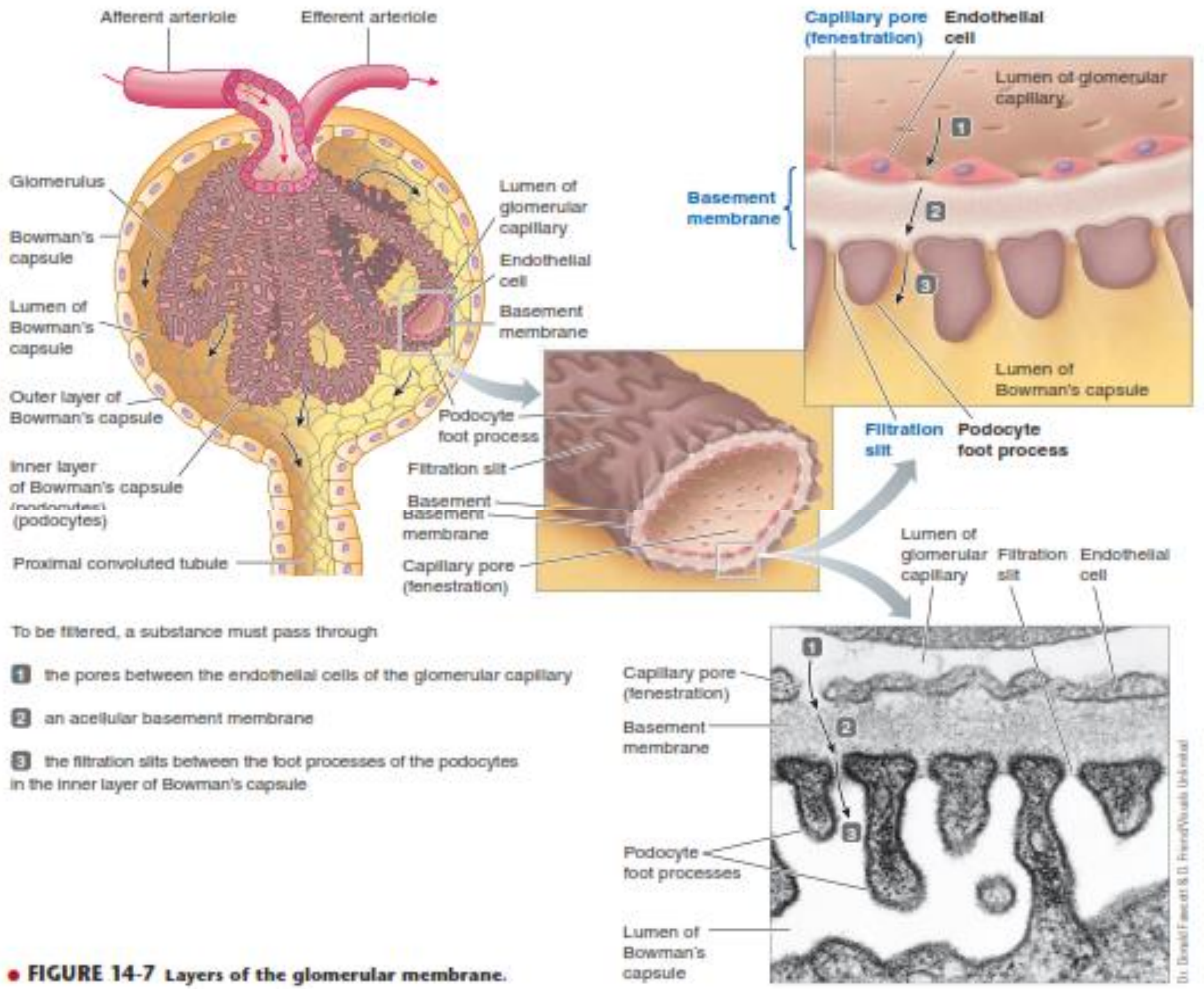
D. Zat difiltrasi secara bebas dan tidak direabsorpsi tetapi disekresikan dari kapiler peritubulus ke dalam tubulus ginjal.

FILTRASI GLOMERULUS (PROTEIN PLASMA)

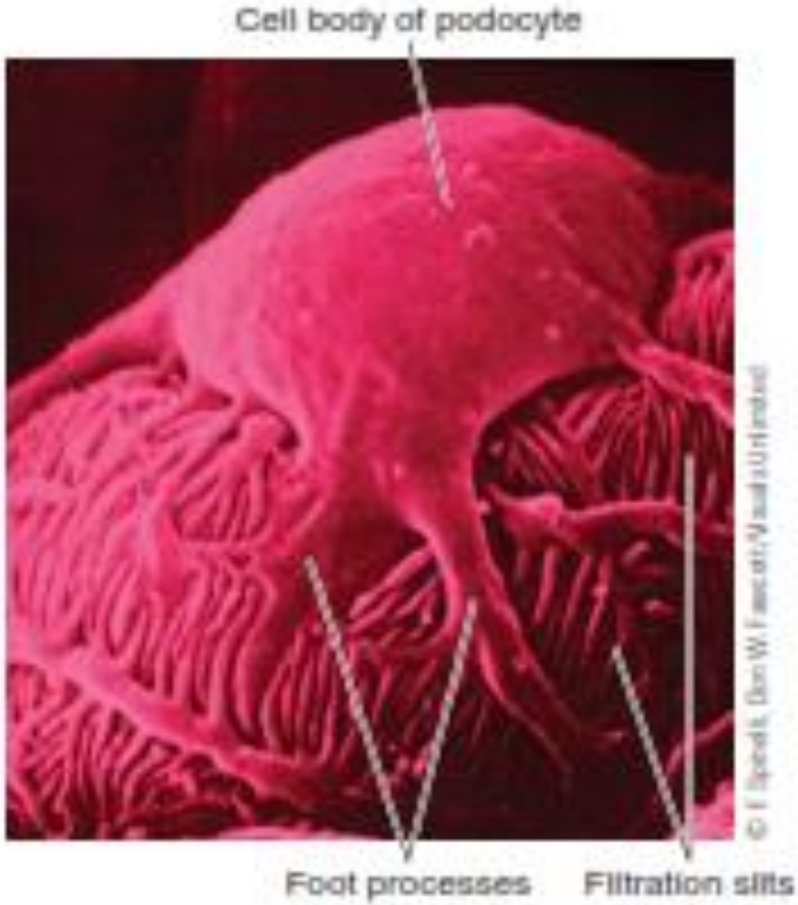
- **Membran glomerulus**
  - **Dinding kapiler glomerulus**
    - 1 Lapis endotel
    - Pori besar/ fenestra bermuatan (-)
  - **Membran basalis**
    - Lapisan gelatinosa aseluler
    - Kolagen→ kekuatan struktur
    - Glikoprotein (-) → menghambat filtrasi protein plasma yg kecil dan protein bermuatan negatif ex: albumin
  - **Lapisan dalam kapsul Bowman**
    - Podosit (-) , terdapat foot process yg saling menjalin dgn foot process podosit sekitar→ celah filtrasi

• **FIGURE 14-8 Bowman's capsule podocytes with foot processes and filtration slits.** Note the filtration slits between adjacent foot processes on this scanning electron micrograph. The podocytes and their foot processes encircle the glomerular

LAPISAN-LAPISAN DI MEMBRAN GLOMERULUS



● **FIGURE 14-7** **Layers of the glomerular membrane.**



• **FIGURE 14-8 Bowman's capsule podocytes with foot processes and filtration slits.** Note the filtration slits between adjacent foot processes on this scanning electron micrograph. The podocytes and their foot processes encircle the glomerular capillaries.

KEMAMPUAN KAPILER GLOMERULUS MEMFILTRASI BERBAGAI ZAT OLEH BERDASARKAN BERAT MOLEKULNYA

Table 26–1

Filterability of Substances by Glomerular Capillaries Based on Molecular Weight

Substance	Molecular Weight	Filterability
Water	18	1.0
Sodium	23	1.0
Glucose	180	1.0
Inulin	5,500	1.0
Myoglobin	17,000	0.75
Albumin	69,000	0.005

MOLEKUL BESAR YANG BERMUATAN NEGATIF LEBIH SUKAR DIFILTRASI DIBANDINGKAN DENGAN MOLEKUL BERMUATAN POSITIF DENJGAN UKURAN YANG SAMA

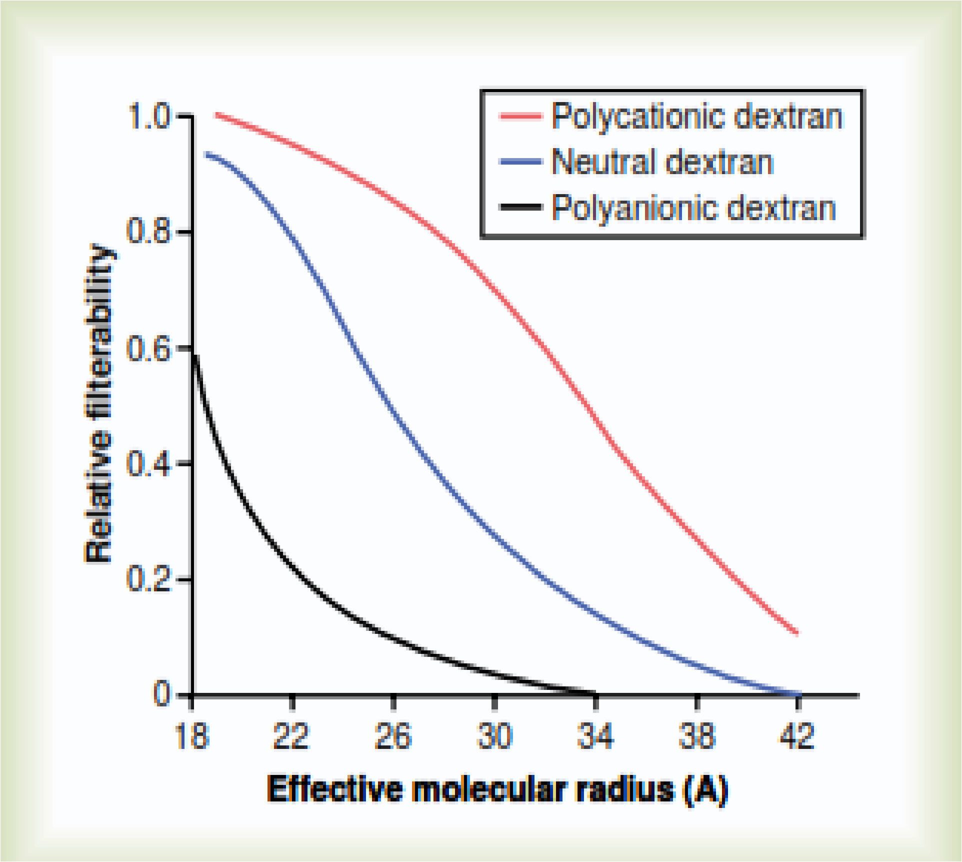


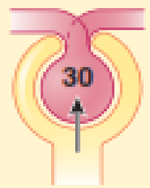
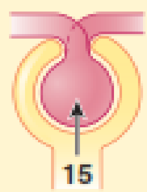
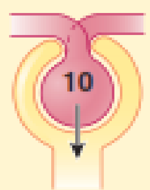
Figure 26–11

Effect of size and electrical charge of dextran on its filterability by the glomerular capillaries. A value of 1.0 indicates that the substance is filtered as freely as water, whereas a value of 0 indicates that it is not filtered. Dextrans are polysaccharides that can be manufactured as neutral molecules or with negative or positive charges and with varying molecular weights.

Proteinuria?
Albuminuria?

GAYA-GAYA YANG BERPERAN DALAM FILTRASI GLOMERULUS

TABLE 14-1 Forces Involved in Glomerular Filtration

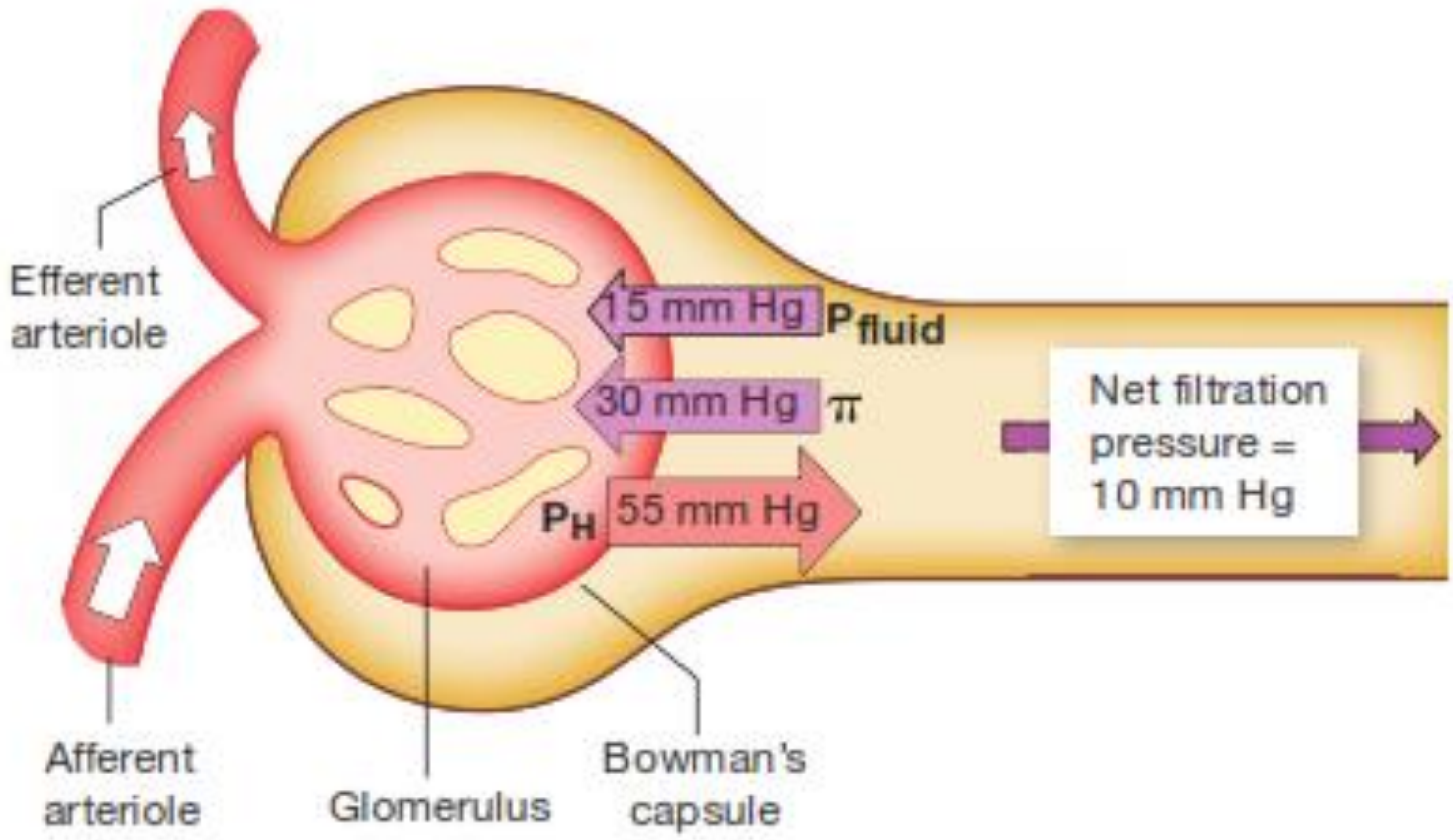
Force	Effect	Magnitude (mm Hg)
Glomerular Capillary Blood Pressure	Favors filtration	 55
Plasma-Colloid Osmotic Pressure	Opposes filtration	 30
Bowman's Capsule Hydrostatic Pressure	Opposes filtration	 15
Net Filtration Pressure (Difference between Force Favoring Filtration and Forces Opposing Filtration)	Favors filtration	 10 55 − (30 + 15) = 10

Tekanan darah kapiler glomerulus

- Bergantung pd kontraksi jantung
- Resistensi thdp aliran darah yg ditimbulkan arteriol aferen dan eferen. (55 mmHg)

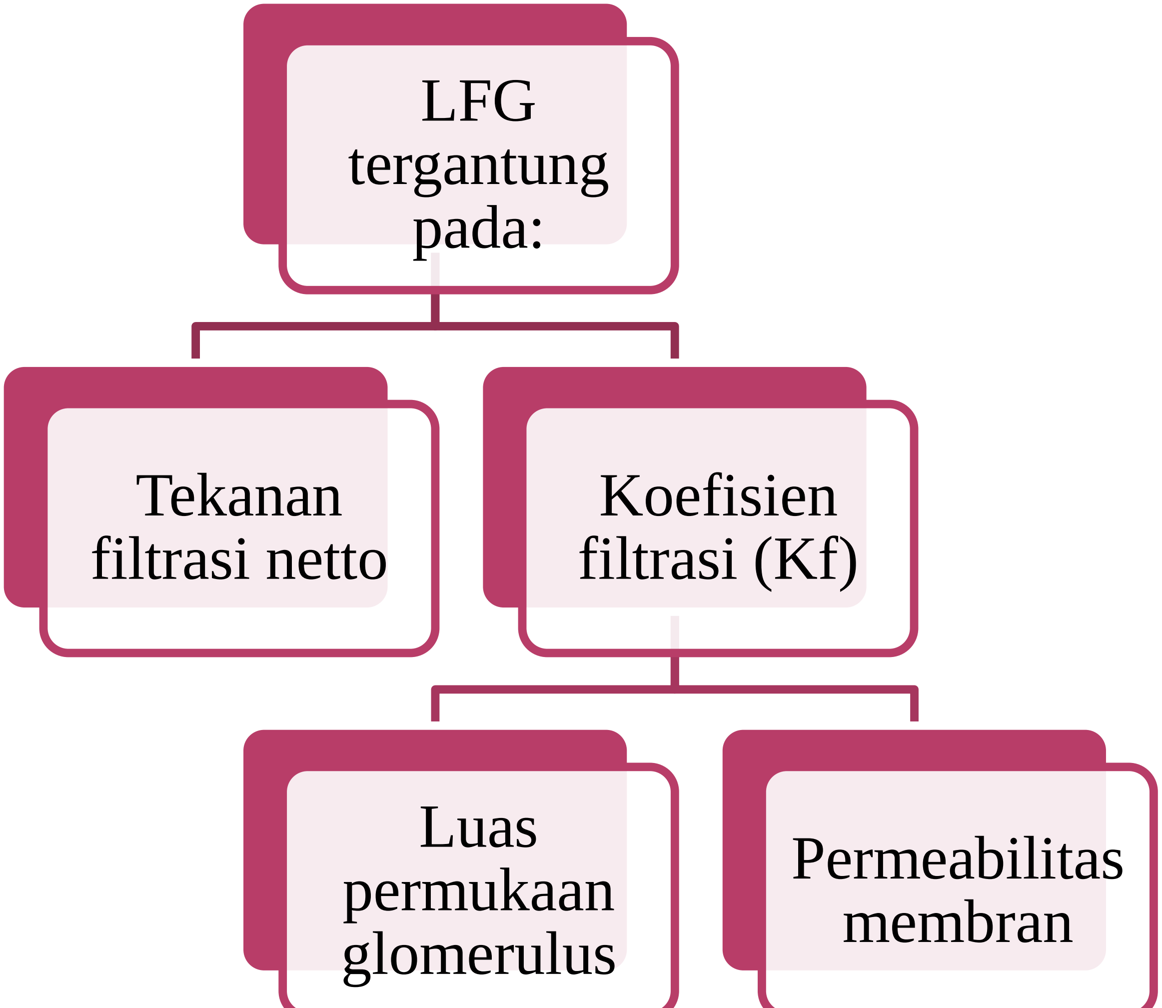
↓

- Diameter arteriol aferen > besar dan diameter arteriol eferen> kecil.
- Tekanan darah glomerulus yg tinggi dan tdk menurun akan mendorong cairan keluar glomerulus menuju kapsula bowman.



Efferent arteriole
15 mm Hg
Pfluid
30 mm Hg
π
Net filtration pressure = 10 mm Hg
PH
55 mm Hg
Afferent arteriole
Glomerulus
Bowman's capsule

LAJU FILTRASI GLOMERULUS



LFG rerata pria : 125 ml/mnt

Wanita : 115 ml/mnt

LFG meningkat→ pasien luka bakar (protein plasma menurun)

LFG menurun→ dehidrasi

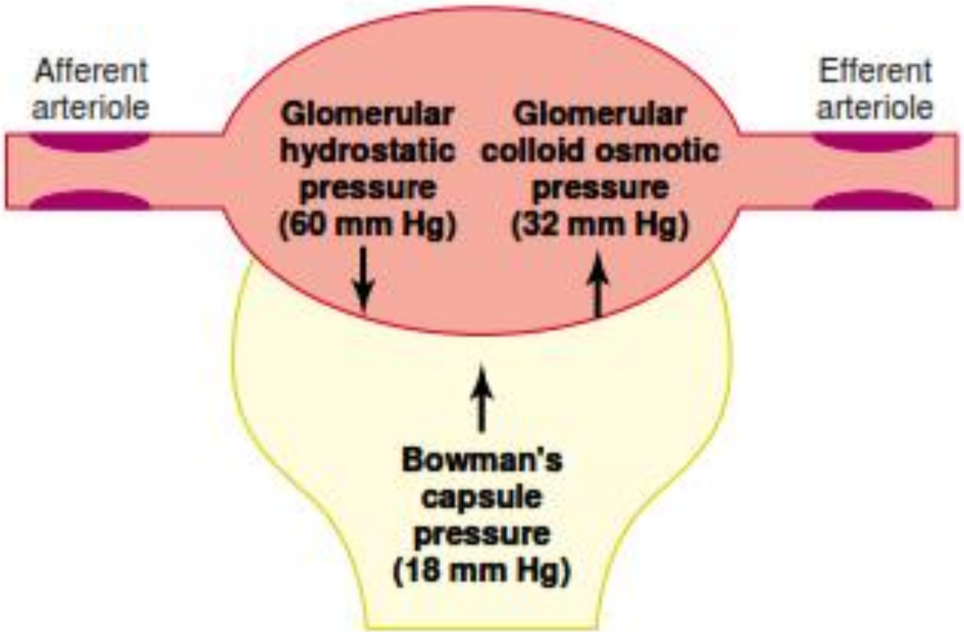
Tekanan hidrostatik kapsul bowman meningkat→ batu ginjal dan prostat.

KOEFISIEN FILTRASI

Koefisien filtrasi tergantung pada:

- Luas permukaan (filtrasi permukaan dlm kapiler glomerulus yg berkontak dengan darah)
  - Sel mesangium (mengandung elemen kontraktil) → dpt menutup sebagian kapiler filtrasi saat berkontraksi dgn stimulus simpatis→ mengurangi luas permukaan
  - Podosit (mengandung filamen kontraktil)
- Permeabilitas membran glomerulus
  - Semakin banyak celah yg terbuka, > permeabilitas membran

GFR = KF -NET fiLTRATION PRESSURE



Net filtration pressure (10 mm Hg) = Glomerular hydrostatic pressure (60 mm Hg) − Bowman's capsule pressure (18 mm Hg) − Glomerular oncotic pressure (32 mm Hg)

PENINGKATAN LFG AKIBAT PENINGKATAN KOEFISIEN FILTRASI KAPILER GLOMERULUS

Kf= LFG/ Tekanan filtrasi netto

- LFG: 125 ml
- Tekanan filtasi netto: 10 mmHg
- Kf: 12,5 ml/ menit/ mmHg

- Kf kapiler glomerulus yg tinggi ini sangat mempengaruhi laju filtrasi cairannya yg cepat.

- Peningkatan Kf akan meningkatkan LFG, begitu juga sebaliknya.

- Diabetes dan hipertensi tidak terkontrol akan menurunkan Kf.

PENURUNAN LFG AKIBAT PENINGKATAN TEKANAN HIDROSTATIK DI KAPSULA BOWMAN

- Dalam keadaan patologis tertentu→ obstruksi traktus urinarius, tekanan kapsula bowman dapat meningkat secara nyata→ penurunan LFG

- Pengencdapan kalsium atau asam urat→ “batu” pada traktus urinarius (sering di ureter)→ menghambat aliran traktus urinarius dan meningkatkan tek.kapsula bowman→ LFG menurun dan hidronefrosis.

PENURUNAN LFG AKIBAT PENINGKATAN TEKANAN OSMOTIK KOLOID DI KAPILER GLOMERULUS

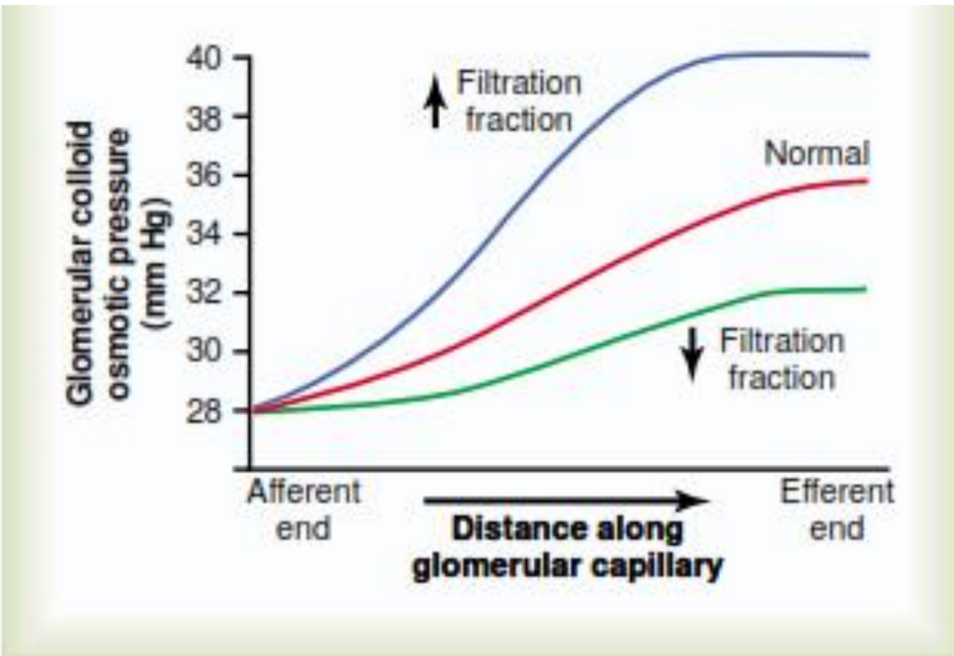
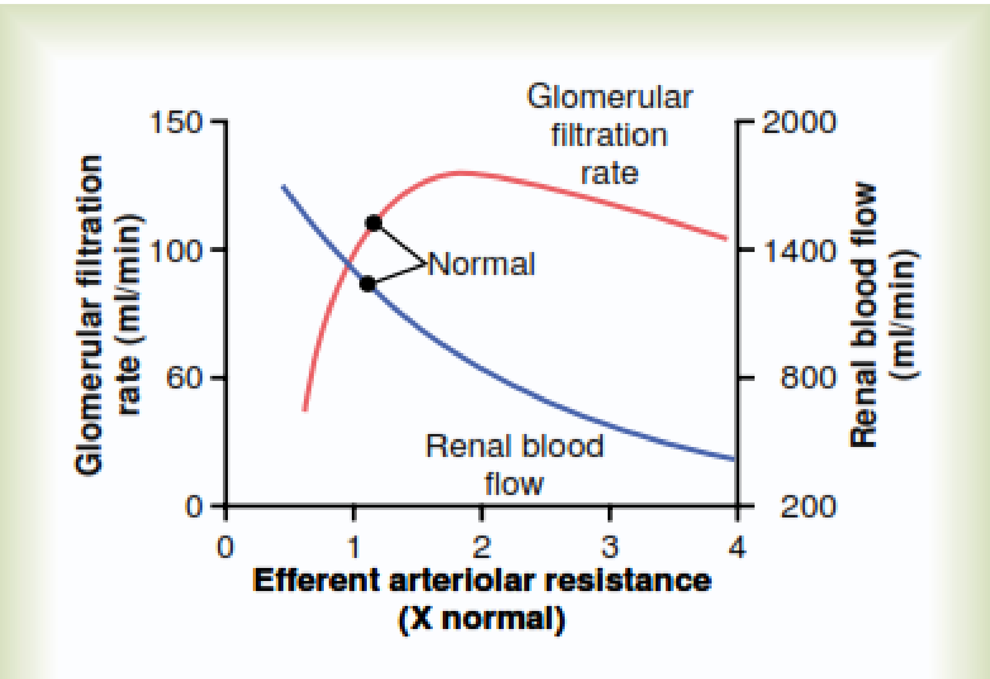


Figure 26–13

Increase in colloid osmotic pressure in plasma flowing through the glomerular capillary. Normally, about one fifth of the fluid in the glomerular capillaries filters into Bowman's capsule, thereby concentrating the plasma proteins that are not filtered. Increases in the filtration fraction (glomerular filtration rate/renal plasma flow) increase the rate at which the plasma colloid osmotic pressure rises along the glomerular capillary; decreases in the filtration fraction have the opposite effect.

- Osmotik koloid rata-rata dari protein plasma kapiler glomerulus merupakan nilai pertengahan antara **28 dan 36 mmHg** atau kira-kira 32 mmHg

PENINGKATAN LFG AKIBAT PENINGKATAN TEKANAN HIDROSTATIK DI KAPILER GLOMERULUS



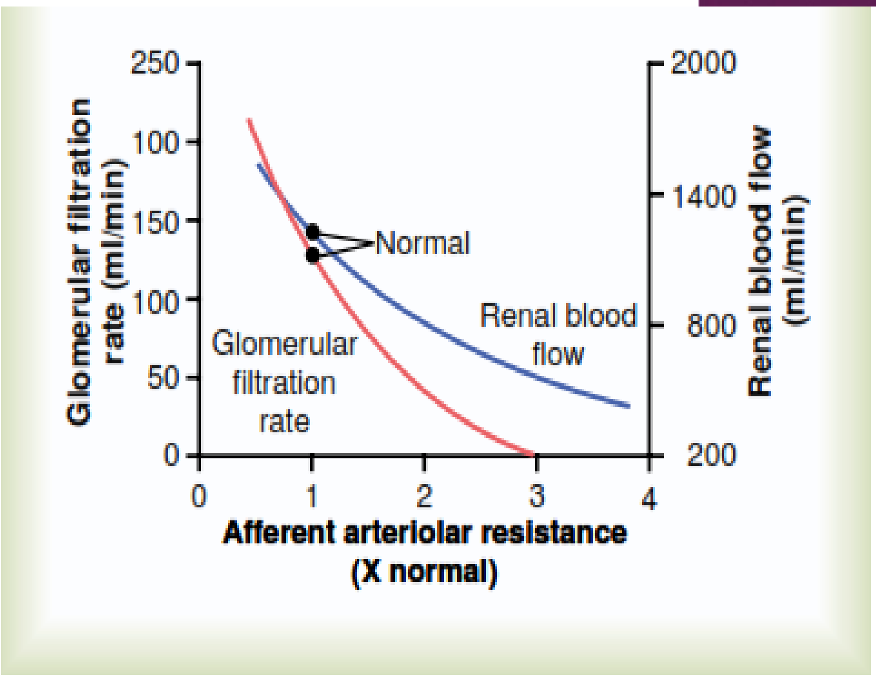
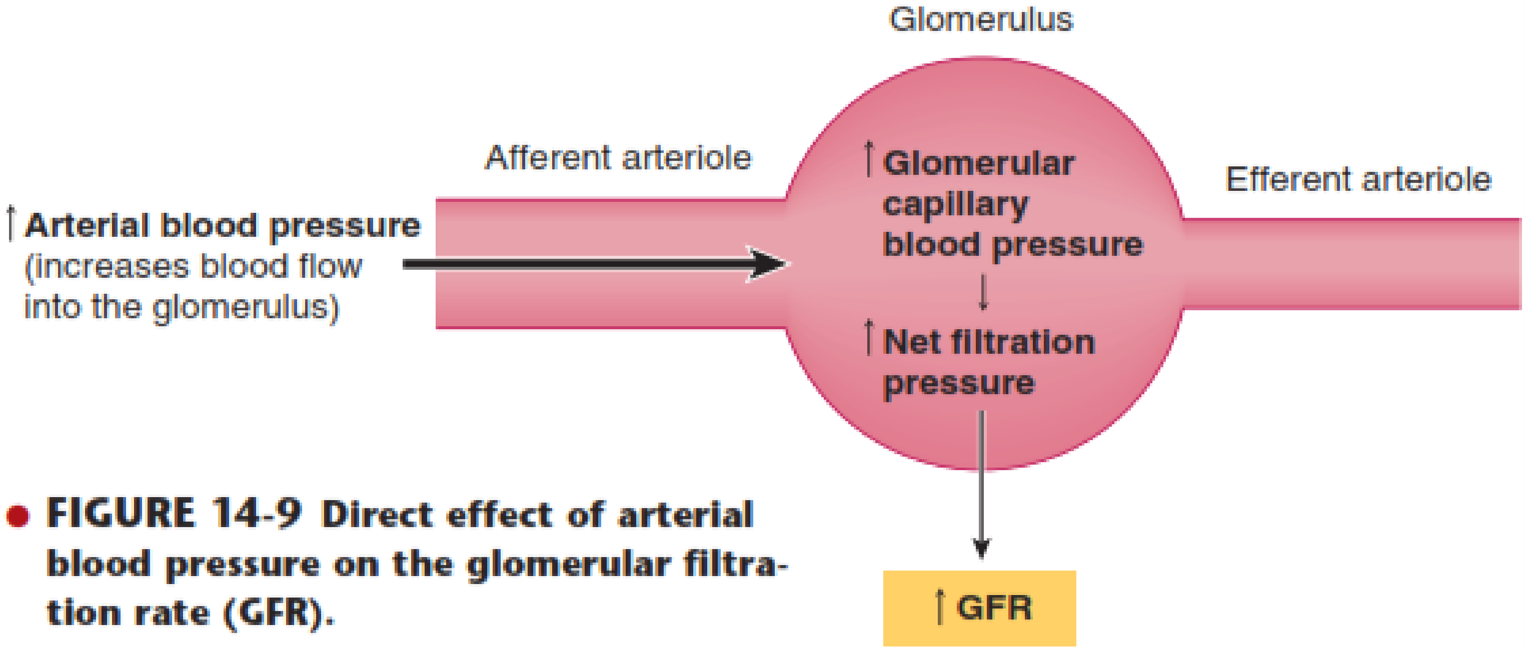


Figure 26–14

Effect of change in afferent arteriolar resistance or efferent arteriolar resistance on glomerular filtration rate and renal blood flow.

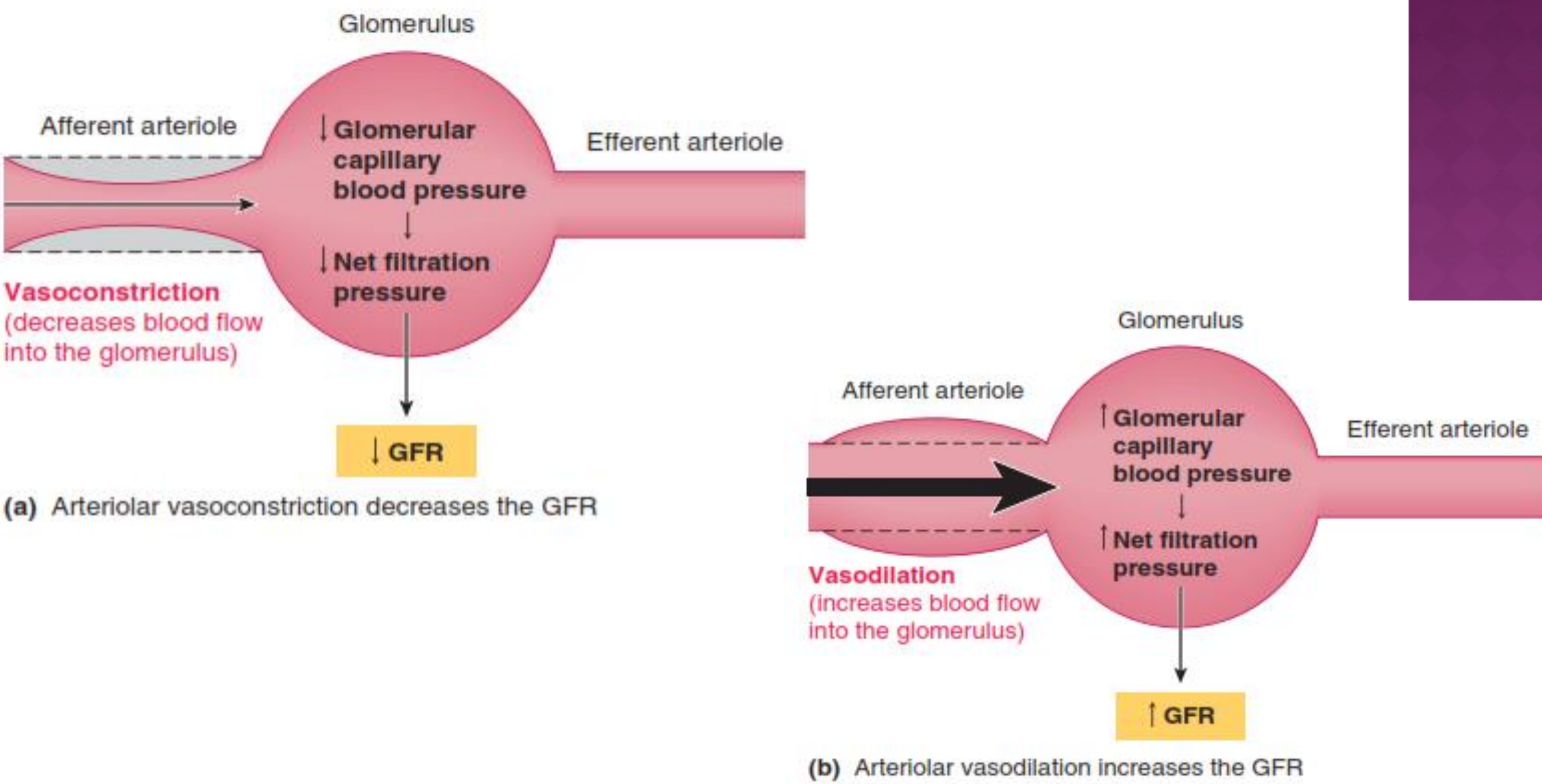
- Konstriksi arteriol aferen menurunkan LFG
- Efek konstriksi arteriol eferen bergantung pada beratnya konstriksi→ konstriksi aferen yg berat (> 3x lipat kenaikan tahanan) cenderung akan menurunkan LFG.

EFEK LANGSUNG TEKANAN DARAH ARTERI TERHADAP LAJU FILTRASI GLOMERULUS (LFG)



● **FIGURE 14-9 Direct effect of arterial blood pressure on the glomerular filtration rate (GFR).**

PENYESUAIAN KALIBER ARTERIOL AFEREN MENGUBAH LFG



● **FIGURE 14-10 Adjustments of afferent arteriole caliber to alter the GFR.**

BERBAGAI FAKTOR YANG DAPAT MENURUNKAN LAJU FILTRASI GLOMERULUS

Factors That Can Decrease the Glomerular Filtration Rate (GFR)

Physical Determinants*	Physiologic/Pathophysiologic Causes
$\downarrow K_f \rightarrow \downarrow GFR$	Renal disease, diabetes mellitus, hypertension
$\uparrow P_B \rightarrow \downarrow GFR$	Urinary tract obstruction (e.g., kidney stones)
$\uparrow \pi_G \rightarrow \downarrow GFR$	↓ Renal blood flow, increased plasma proteins
$\downarrow P_G \rightarrow \downarrow GFR$	
$\downarrow A_P \rightarrow \downarrow P_G$	↓ Arterial pressure (has only small effect due to autoregulation)
$\downarrow R_E \rightarrow \downarrow P_G$	↓ Angiotensin II (drugs that block angiotensin II formation)
$\uparrow R_A \rightarrow \downarrow P_G$	↑ Sympathetic activity, vasoconstrictor hormones (e.g., norepinephrine, endothelin)