

# Kidney function: Optimization of nephrovascular network

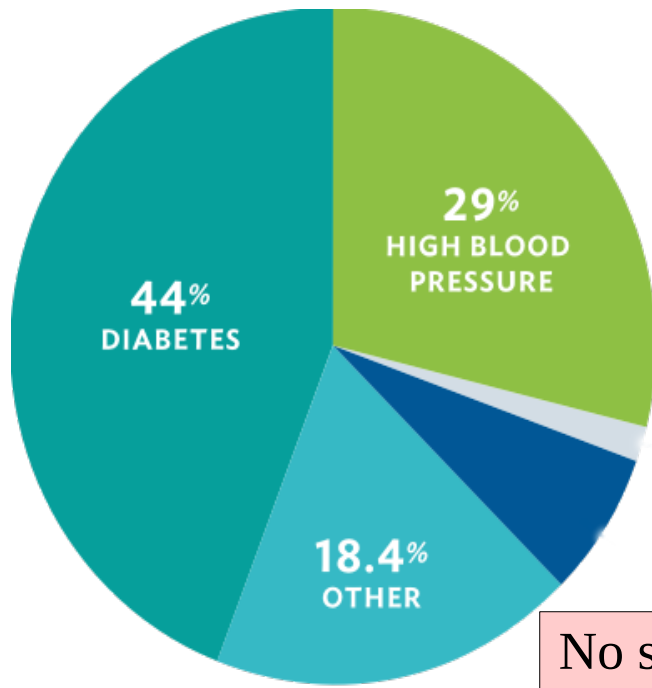
*Olga Sosnovtseva*  
*Associate Professor*

UNIVERSITY OF COPENHAGEN



**SCARY TRUTH**

# Chronic Kidney Disease: A silent killer?



9 in 10 adults with CKD do not know they have it;

1 of 3 adults with diabetes has it;

Every 24 hours, 160 people with diabetes begin treatment for kidney failure;

Nearly 10% of global adult population) suffer from some kind of kidney problem/damage.

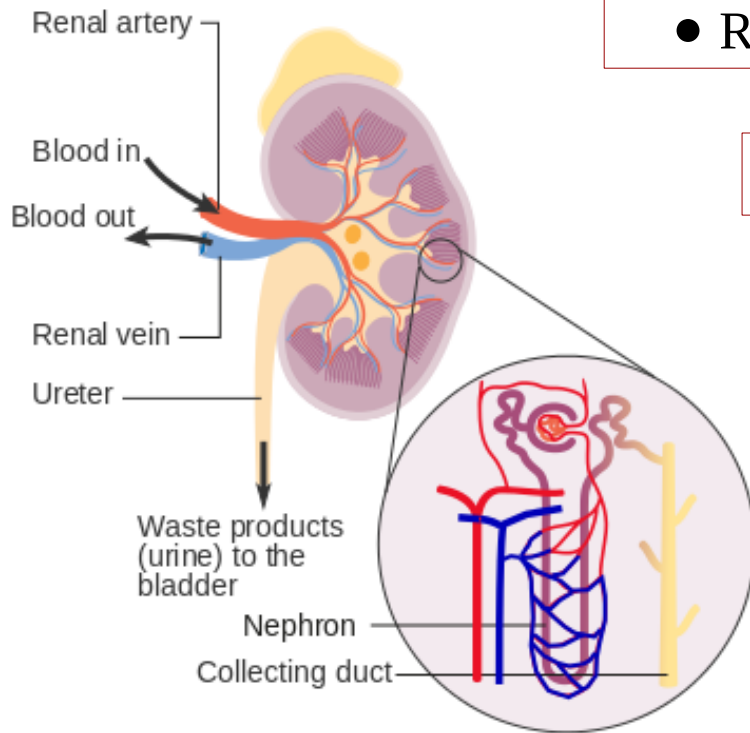
No signs or symptoms until >70% of kidney function is lost.

GPs screen only 20% of their diabetic patients for kidney disease.

Standard blood test: serum creatinin rises only if > 50% of renal function is already lost.

# KIDNEY FUNCTION

# Kidney function



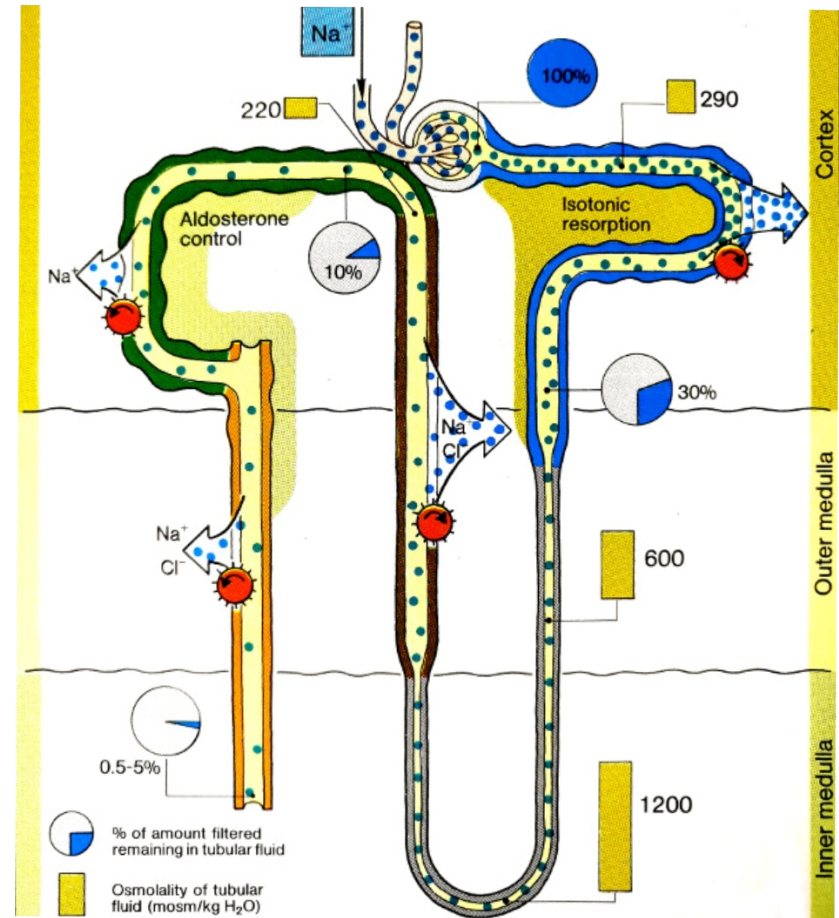
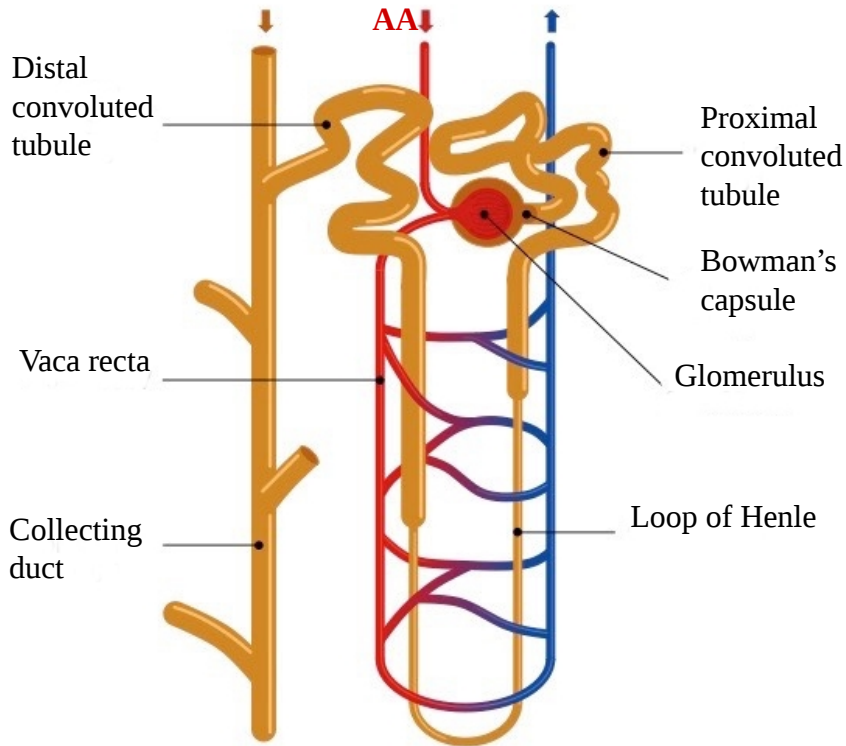
- Regulation of water and electrolyte balance

- Excretion of metabolic products

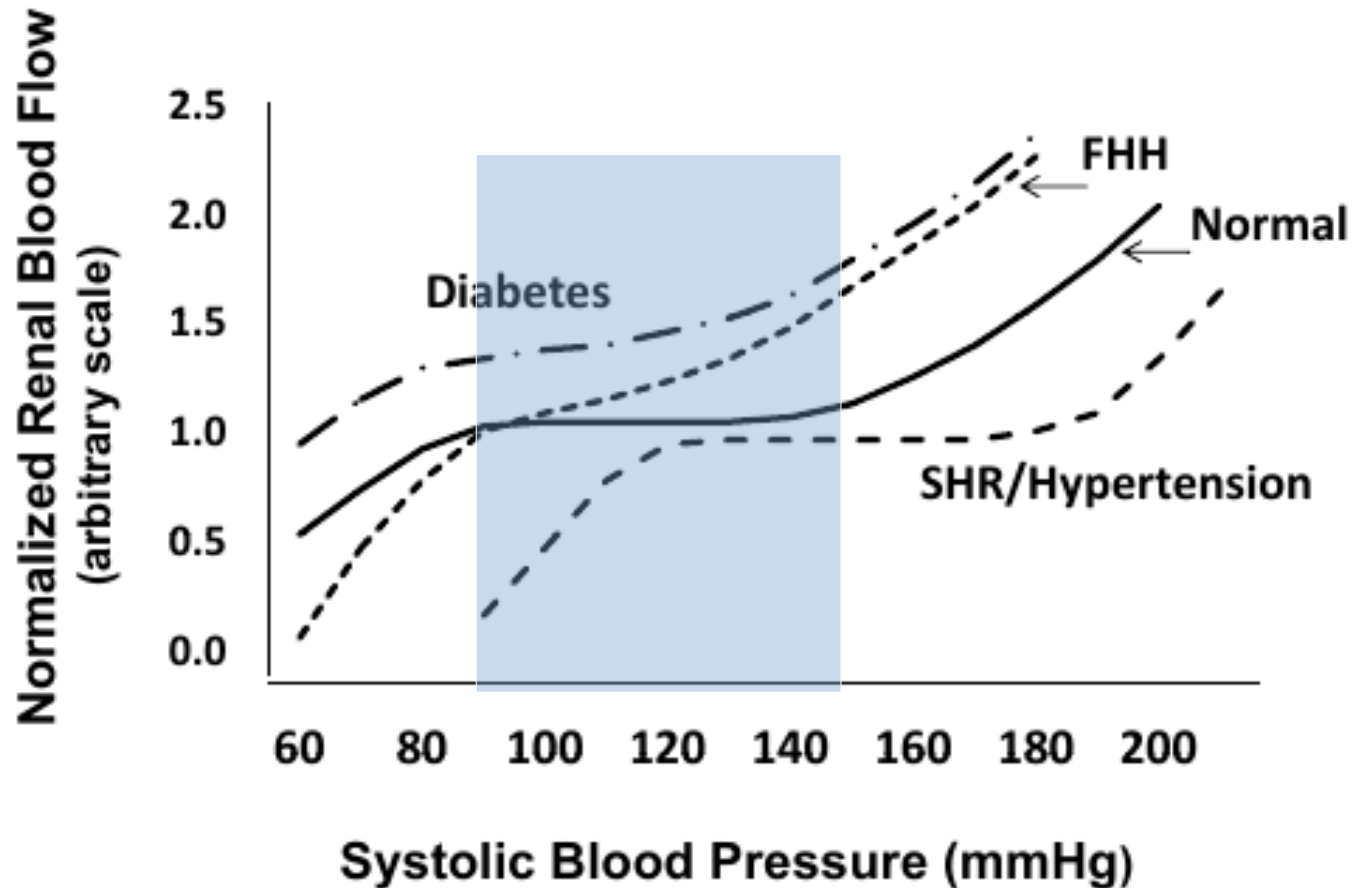
- Regulation of arterial pressure

- Secretion of hormones

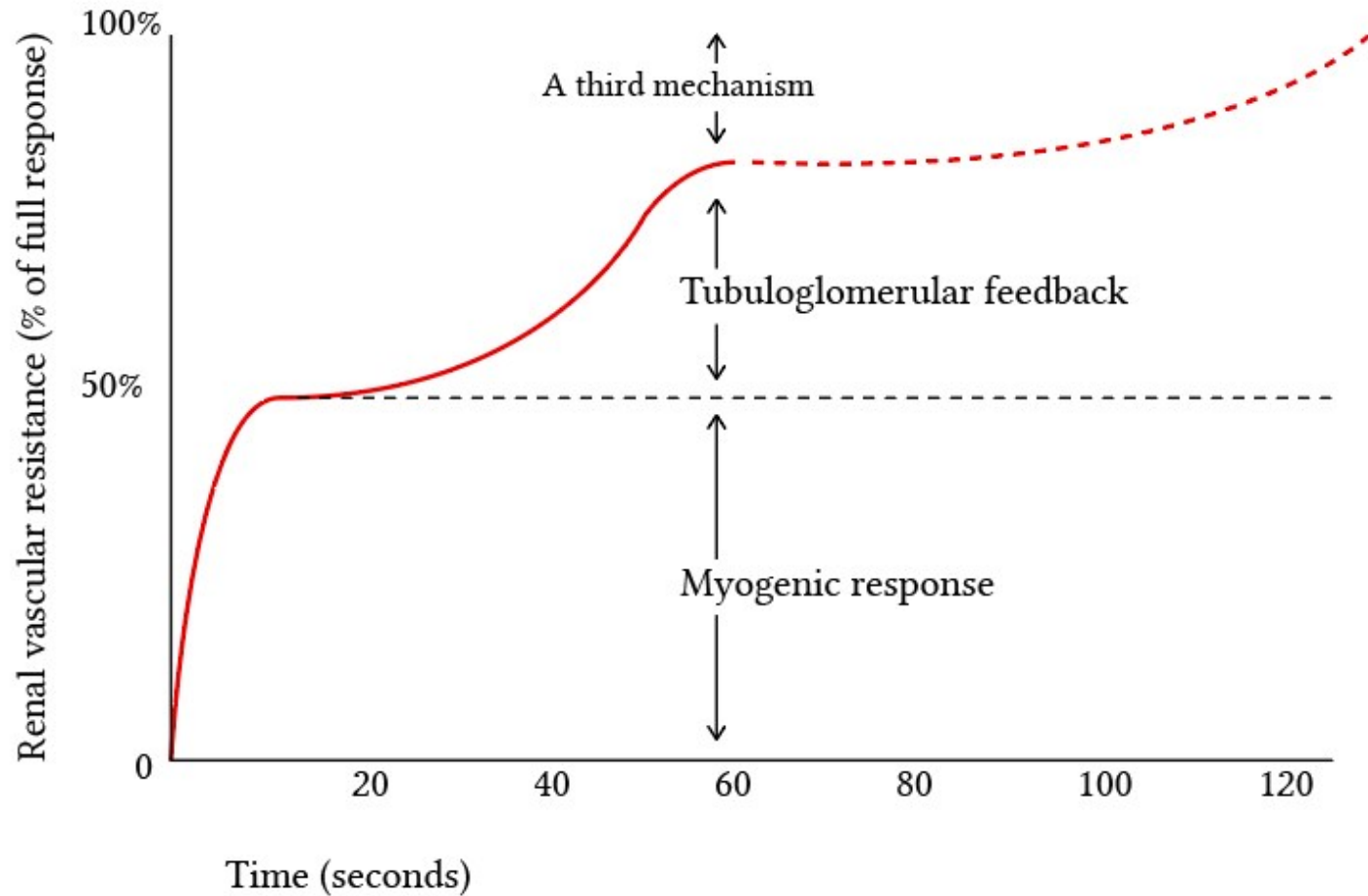
# Nephron function



# Renal autoregulation



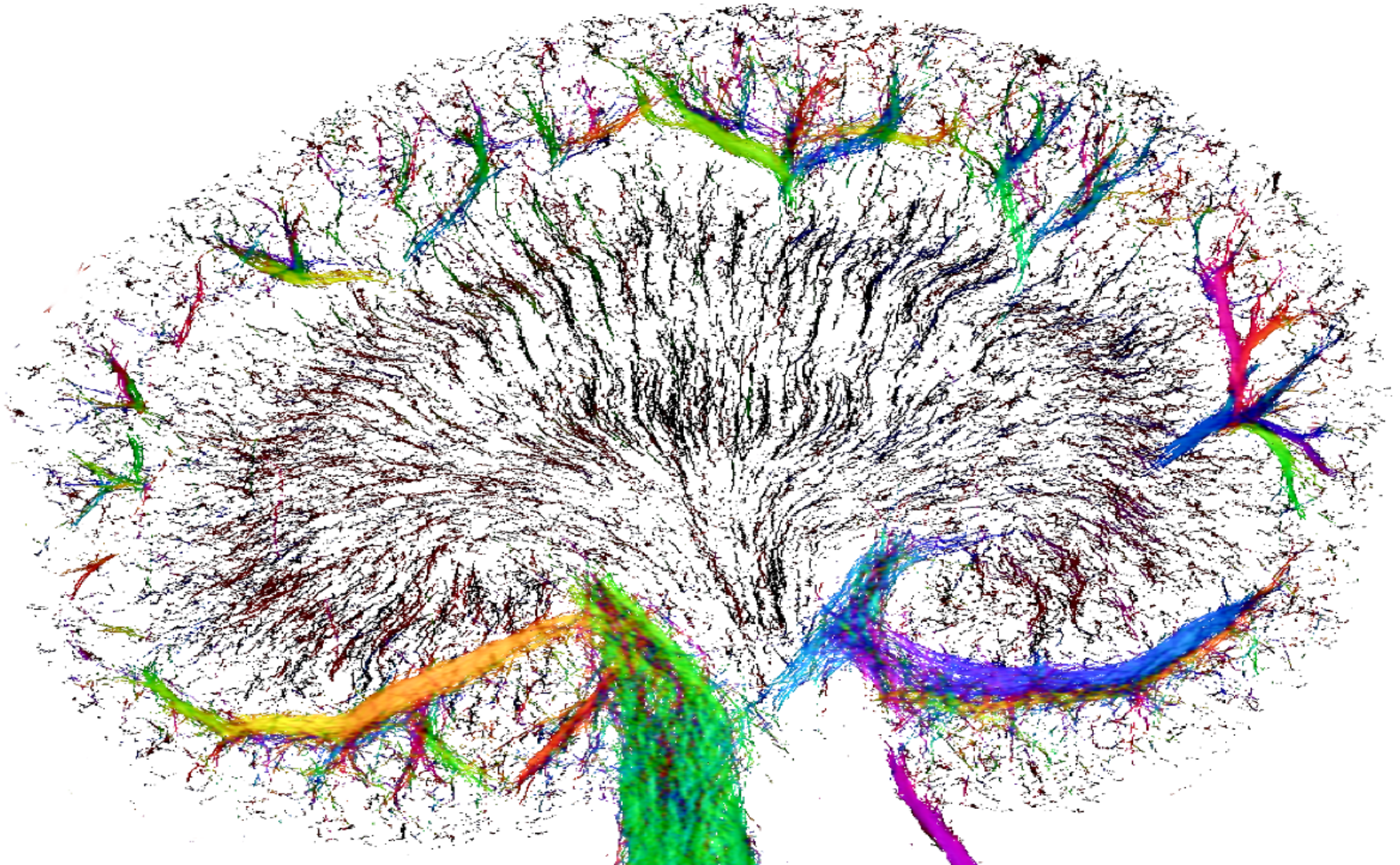
# Mechanisms of autoregulation



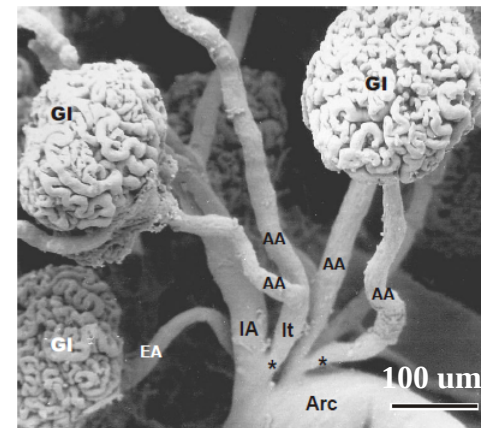
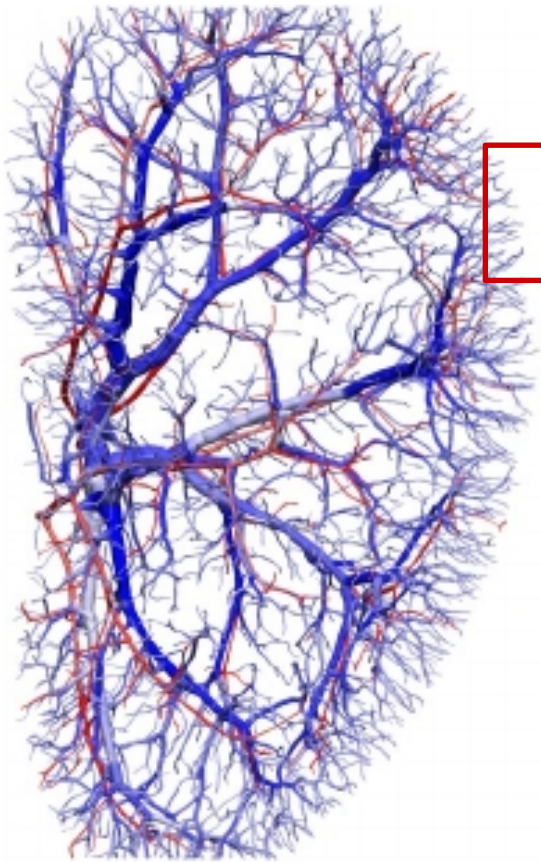


# **KIDNEY WONDERLAND**

# Renal circulation

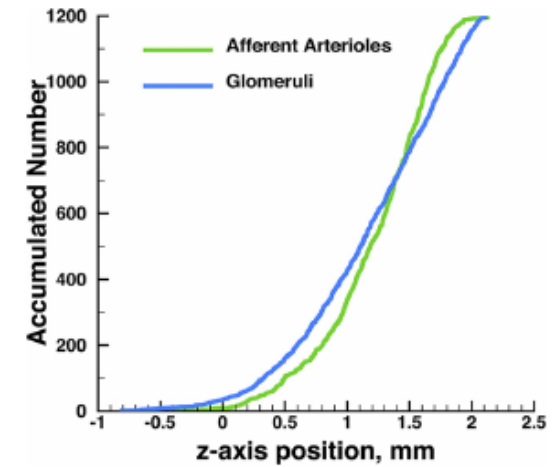
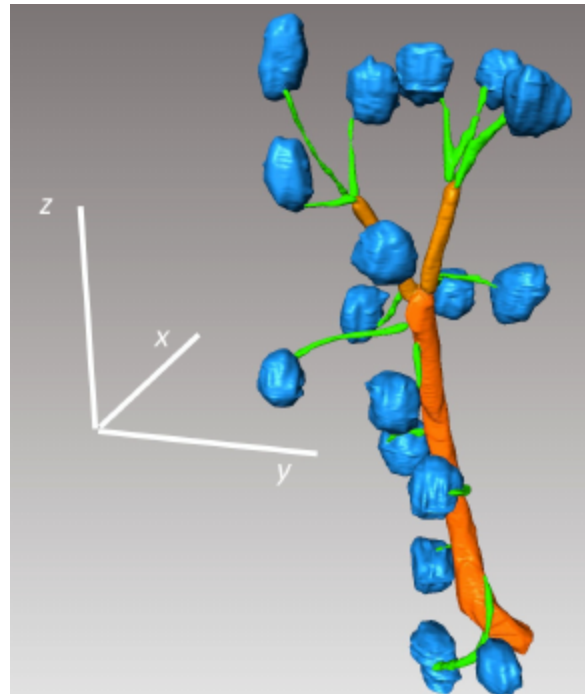
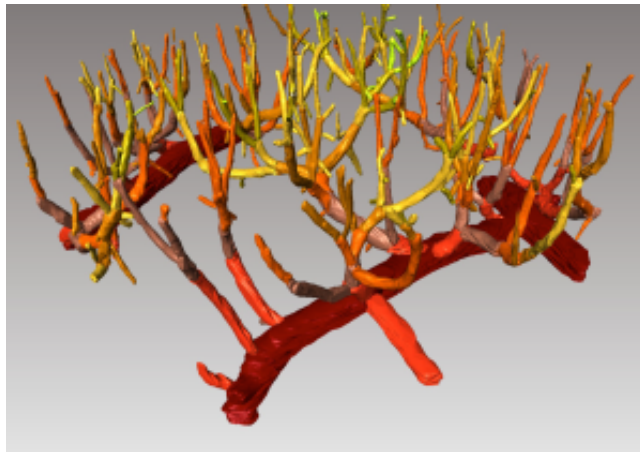


# Renal vascular tree



Nordsletten et al, Am. J. Physiol. 291, 2006  
Vodenicharov, Bulg. J. Vet. Med. 10, 2007

# Renal microvascular



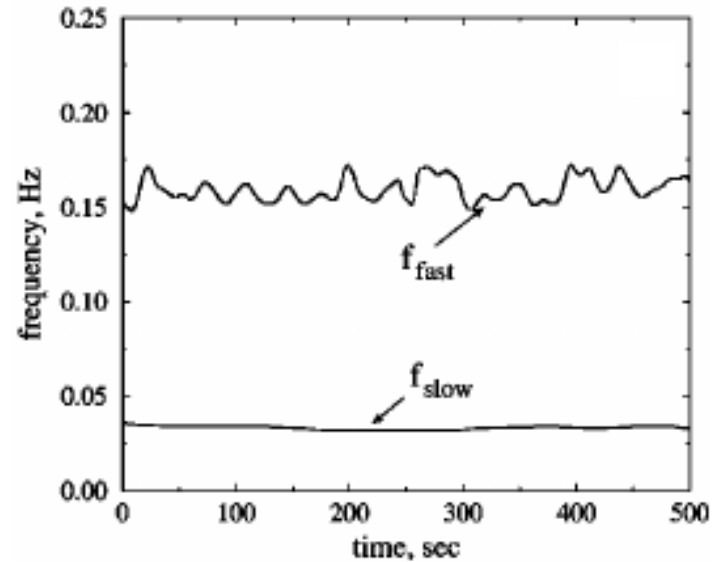
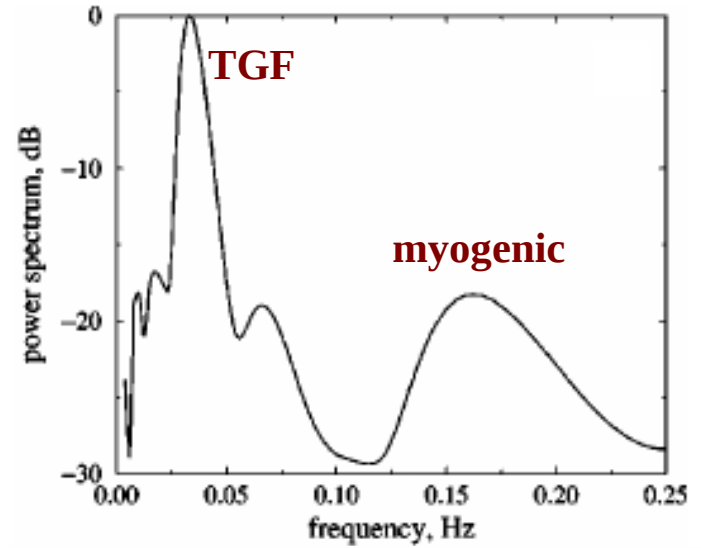
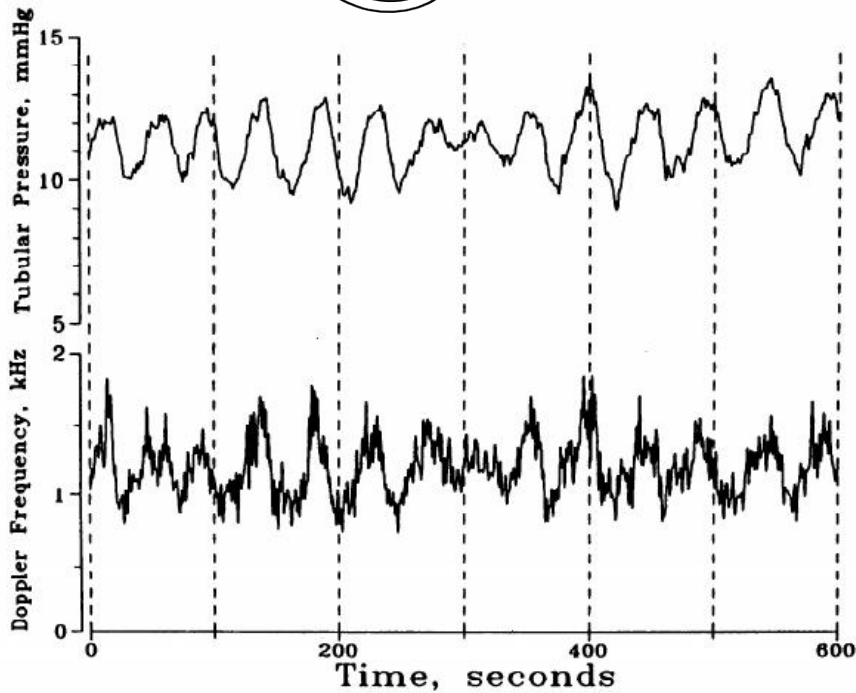
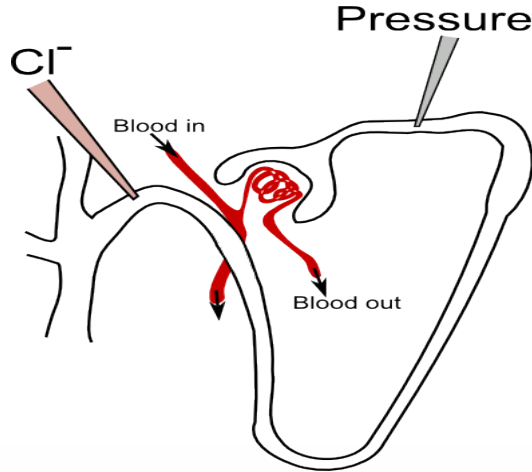
# Stable autoregulation in irregular environment



- How can the kidney achieve homogeneous perfusion despite being regulated locally in a highly variable arterial tree?
- What are the means of communication if post-glomerular blood flow from 90 % of glomeruli perfuse other nephrons, not the same nephron?
- How can each nephron maintain the same pressure when branching is so irregular?

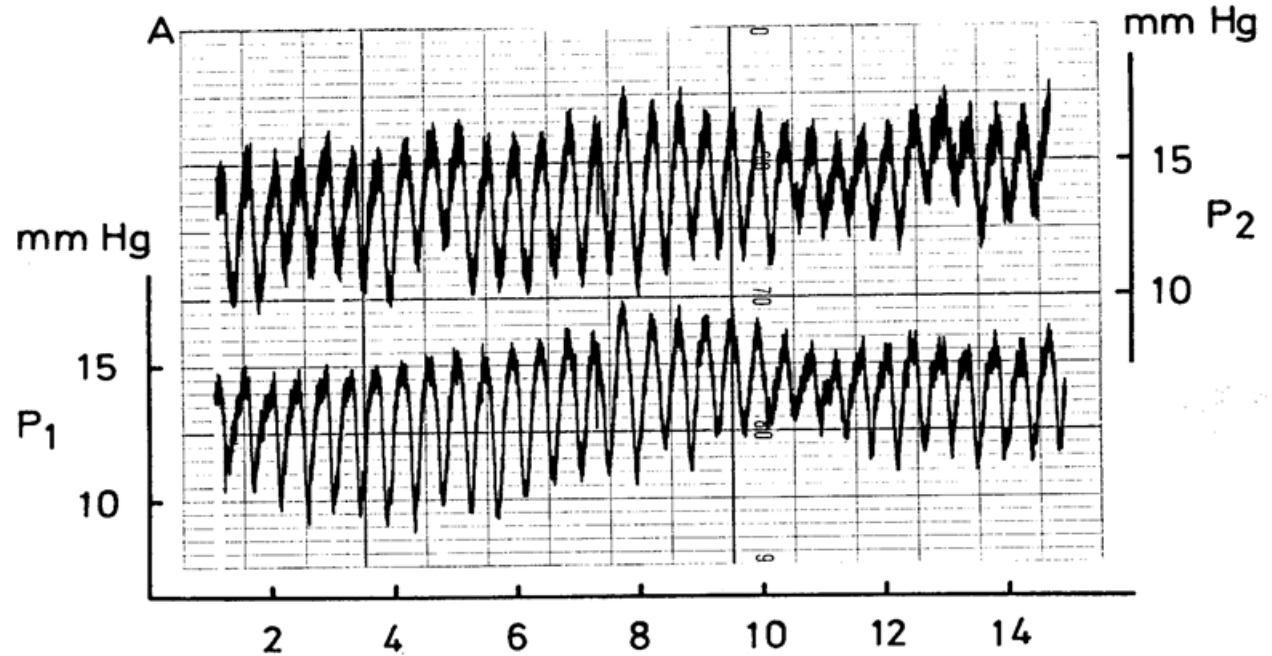
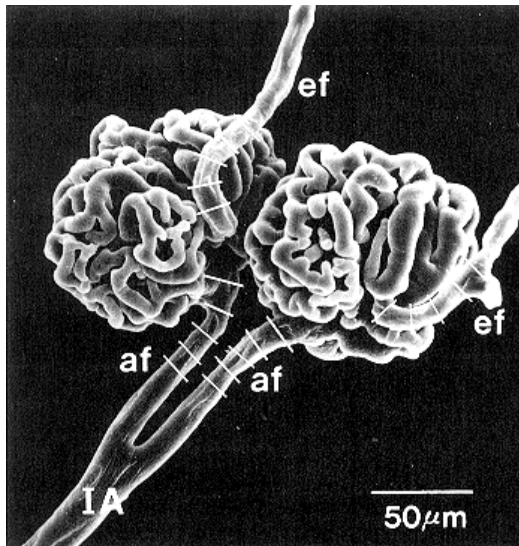
**Nephrons need to operate in larger groups**

# Oscillations



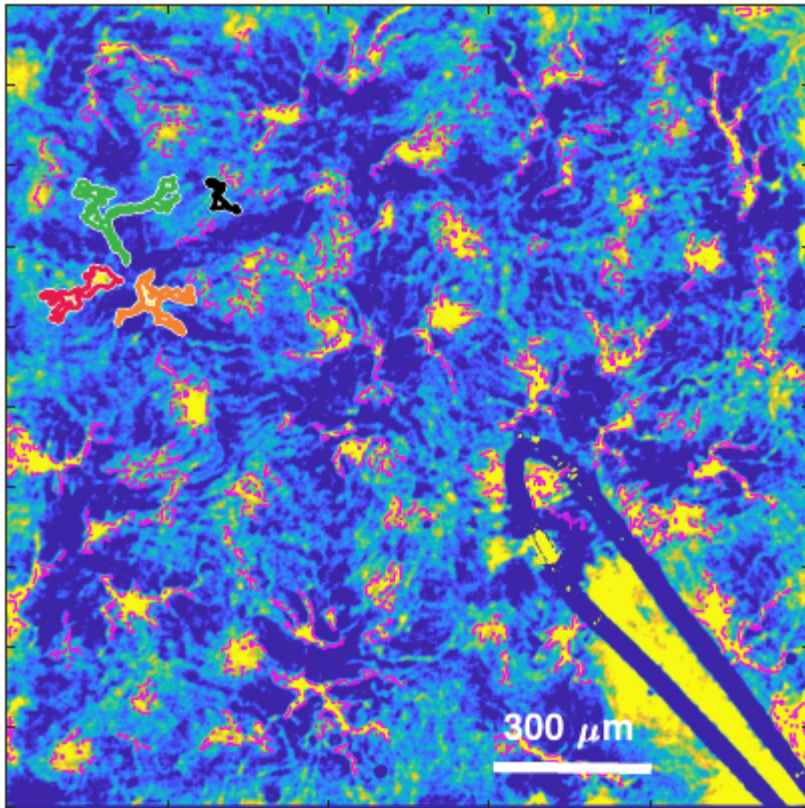
K.-P. Yip et al, *Am. J. Physiol.* 264, 1993  
 O. Sosnovtseva, *PRE* 70, (2004)

# Neighbors can communicate

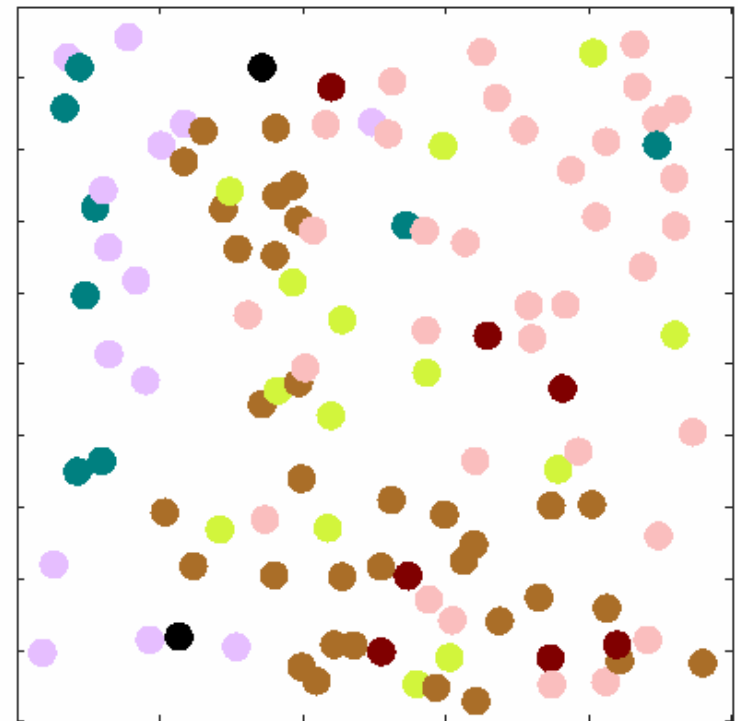


# Cooperative community

Flow map

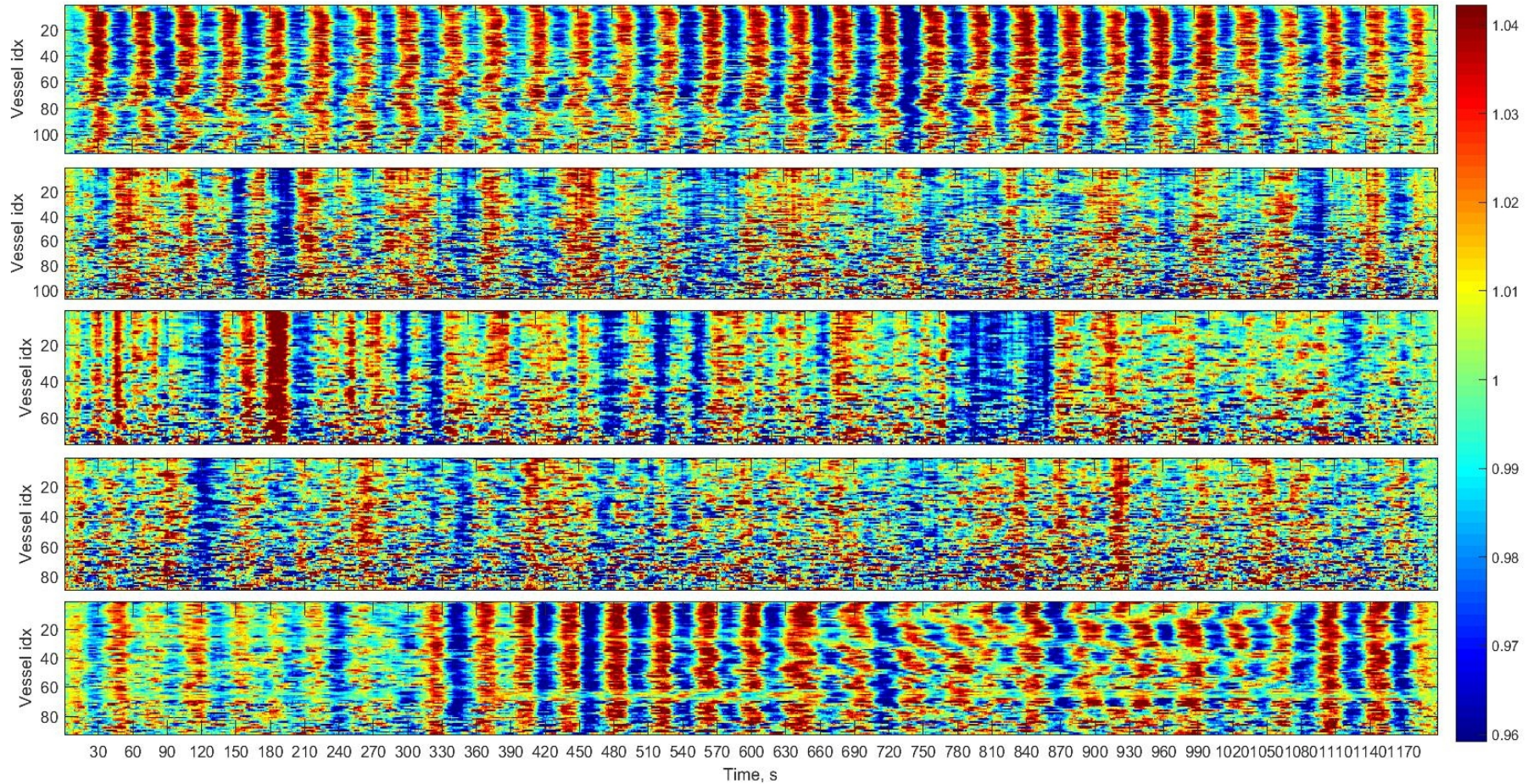


$t=0.5 \text{ s}$ ;  $S=0.46421$

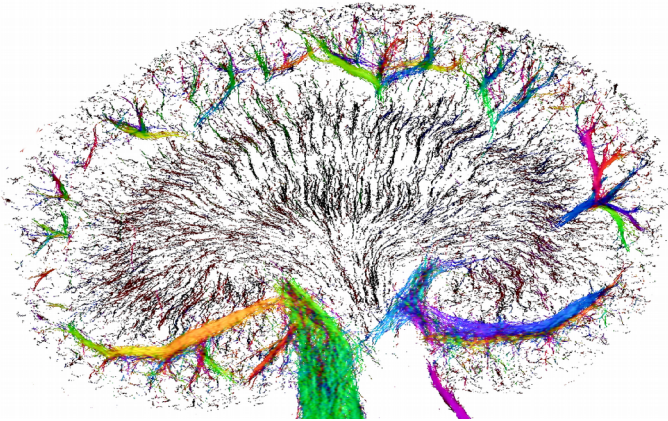




# Nephron synchronization



# Open questions



- **What does the renal vascular tree actually look like?**
- **How many nephrons are coupled?**
- **How far can the signal travel?**
- **What happens during diabetes and hypertension?**
- **Is a rat really a tiny human?**