

Hierarchical study of Guyton Circulatory Model

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General Hierarchical modeling

- Decomposition.
- Successive refinement.
- Mixing formalisms.

Flow variables

PA: arterial pressure.

MDFLW: rate of flow of fluid in the renal tubules at the macula densa.

ANM, ANU, ANUVN: coefficients of angiotensin effects. Respectively: multiplier effect, on other functional circulation systems, on venous constriction.

AMK: multiplier effect for control of potassium transport trough cell membranes.

AMNA: multiplier effect for control of sodium.

CKE: concentration of potassium in the extracellular fluids.

CNA: concentration of sodium.

ADHC: concentration of antidiuretic hormone.

ADHMK, ADHMV: ADH effect on kidney and on blood vessels, respectively.

TVD: rate of fluid intake.

NOD: Na reabsorption rate.

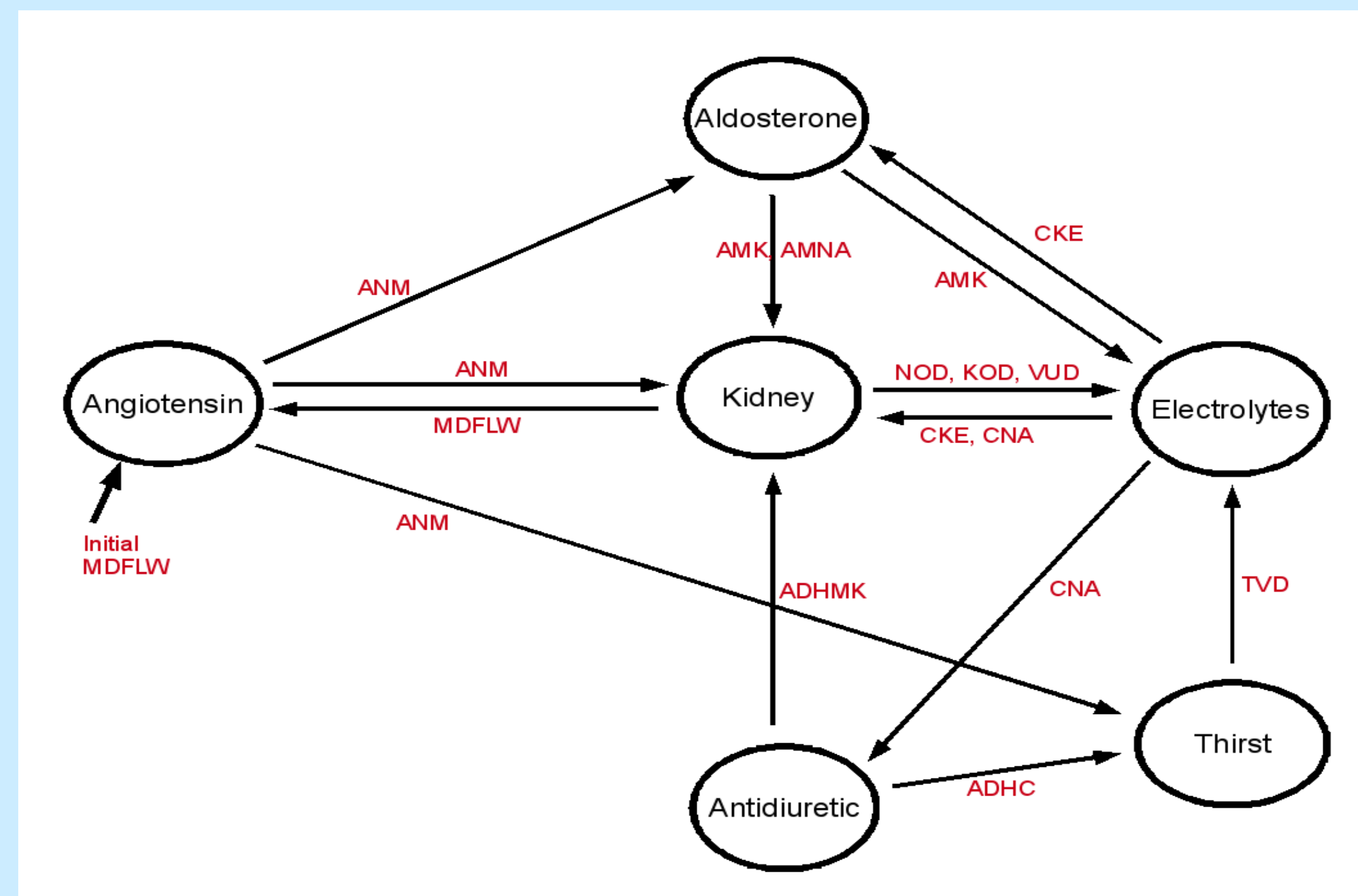
KOD: K excretion rate.

VUD: urine volumen.

AU, AUH, AUM: coefficients of autonomic stimulation. Respectively: heart and for multiple points in the circulatory system.

Guyton model

- Extensive mathematical model of human circulatory physiology.
- 18 connected modules, Circulation Dynamics is the primary module.
- Still the most comprehensive cardiovascular model.

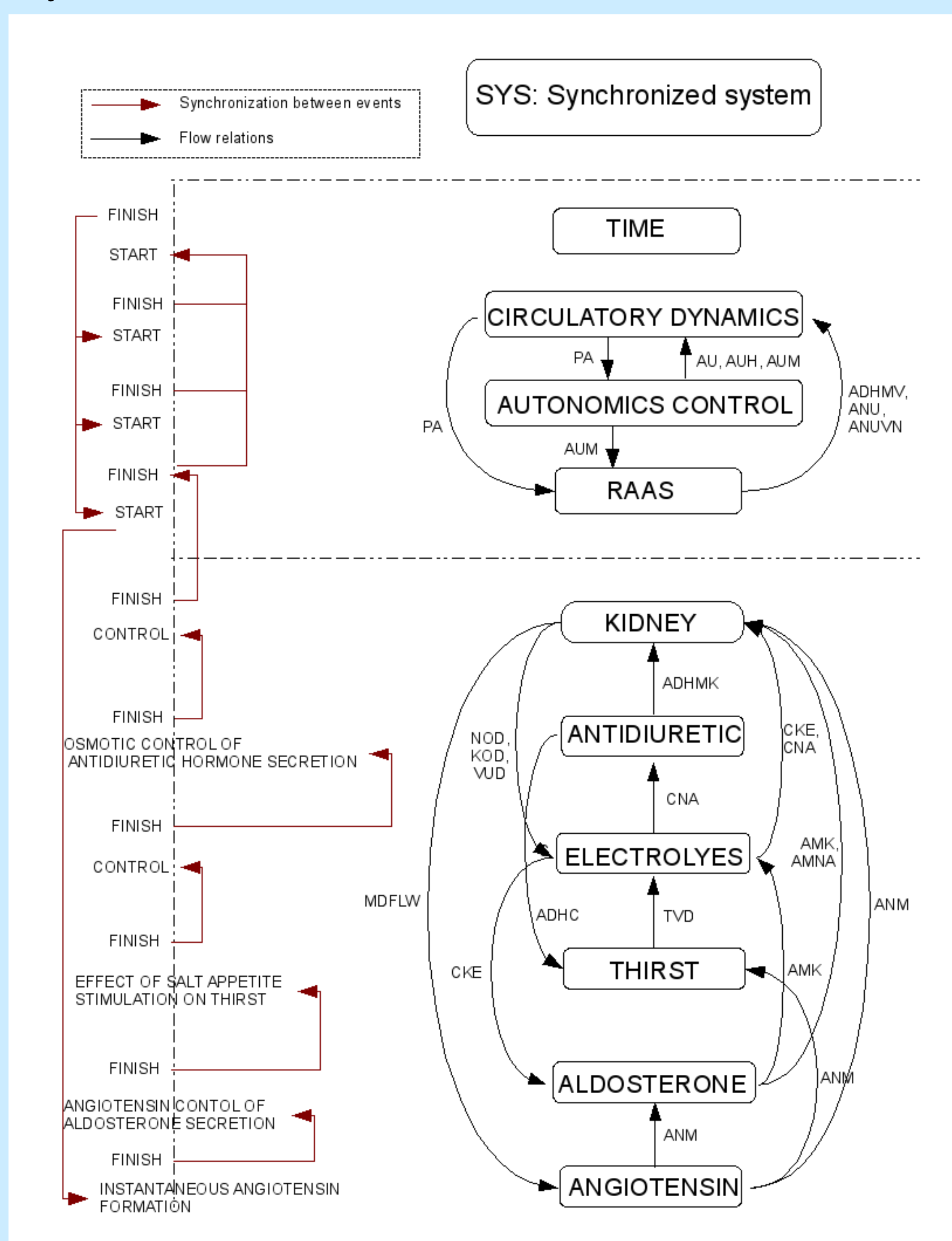


RAAS: Renin-Angiotensin-Aldosterone System

- RAAS is crucial for the model (Guyton et al. 1974, Sagawa et al. 1975).
- Therapeutic manipulation of this pathway is very important in treating hypertension and heart failure.
- Inclusion of Renin, Angiotensin, Aldosterone and antidiuretic hormone mechanisms to control the pressure in the kidneys.

BioRica

- A high-level, hierarchical, modeling framework
- Extension of the AltaRica industrial modeling formalism.
- Mixing in non ambiguous way PDE/ODE & automata definitions.
- Dataflow links define hierarchical relations between nodes.
- Event synchronization shared between nodes.



Simulations

- Complete system.
- Supposing Initial level of MDFLW low or high.
- Introducing controlled, periodic or stochastic changes of MDFLW.

Results and advantages of the approach

- Guyton model is naturally hierarchical.
- Model includes Circulatory Dynamics and Autonomous Control.
- RAAS nodes: Angiotensin, Aldosterone, Antidiuretic hormone, Thirst and drinking, Electrolytes and cell water, Kidney.
- Control of MDFLW to initial low or high levels.
- Easy inclusion of new implemented nodes or mechanisms.
- External alterations that are applied to the organism, medical treatments of pressure control, can be included.
- Inclusion of the external tool Matlab. Electrolytes and Kidney nodes.

References

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