Electrolyte Physiology

Something in the way she moves me…

Electrolyte Movement

- **CONCENTRATION GRADIENT**
- ELECTRICAL GRADIENT
- DRIVING FORCE
- NERNST NUMBER (E-ion)
- CONDUCTANCE (G-ion)
- PERMEABILITY
  - CHANNELS: small ions
  - PORES: medium-sized molecules (sweat)
  - TRANSPORT PROTEINS

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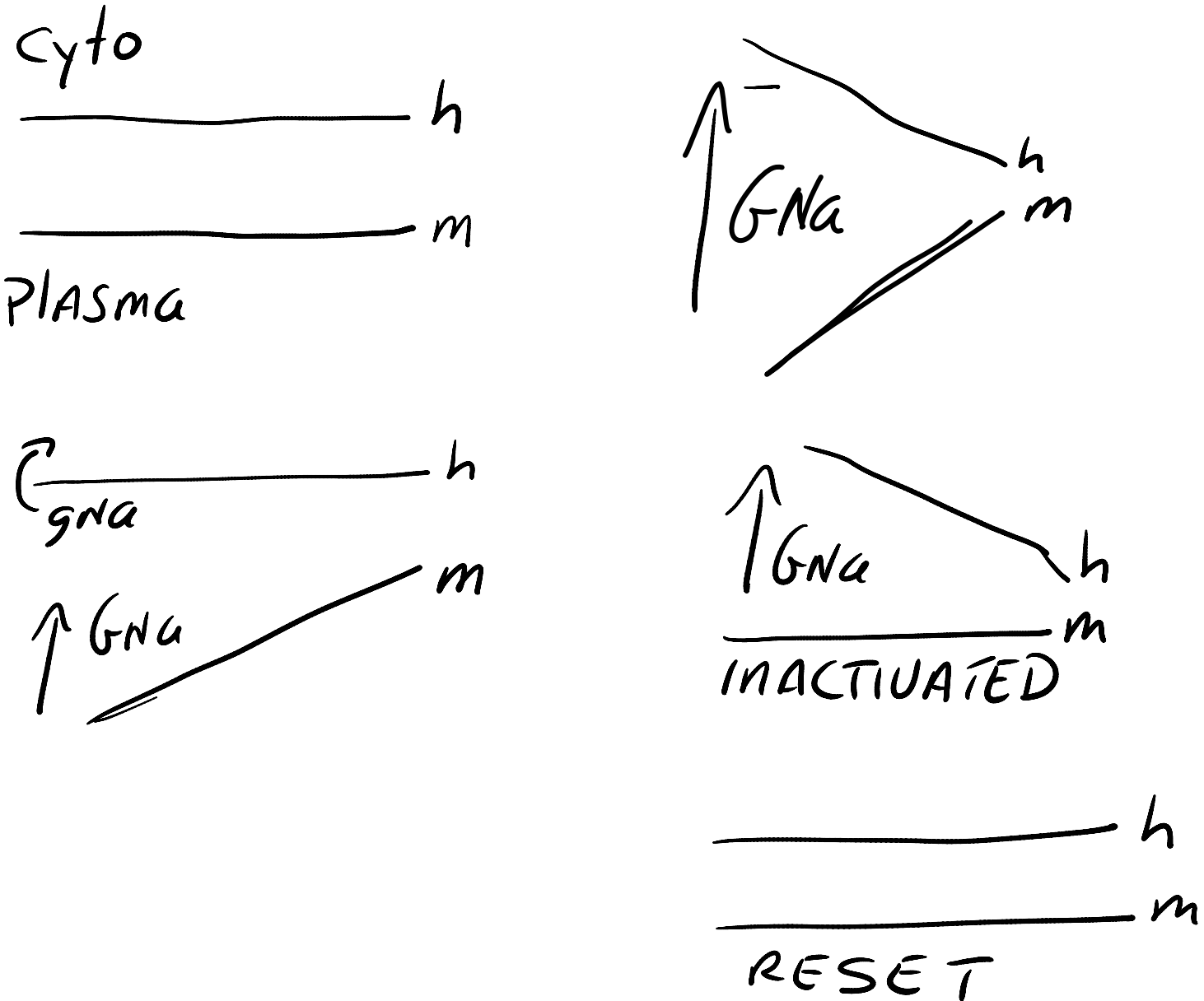
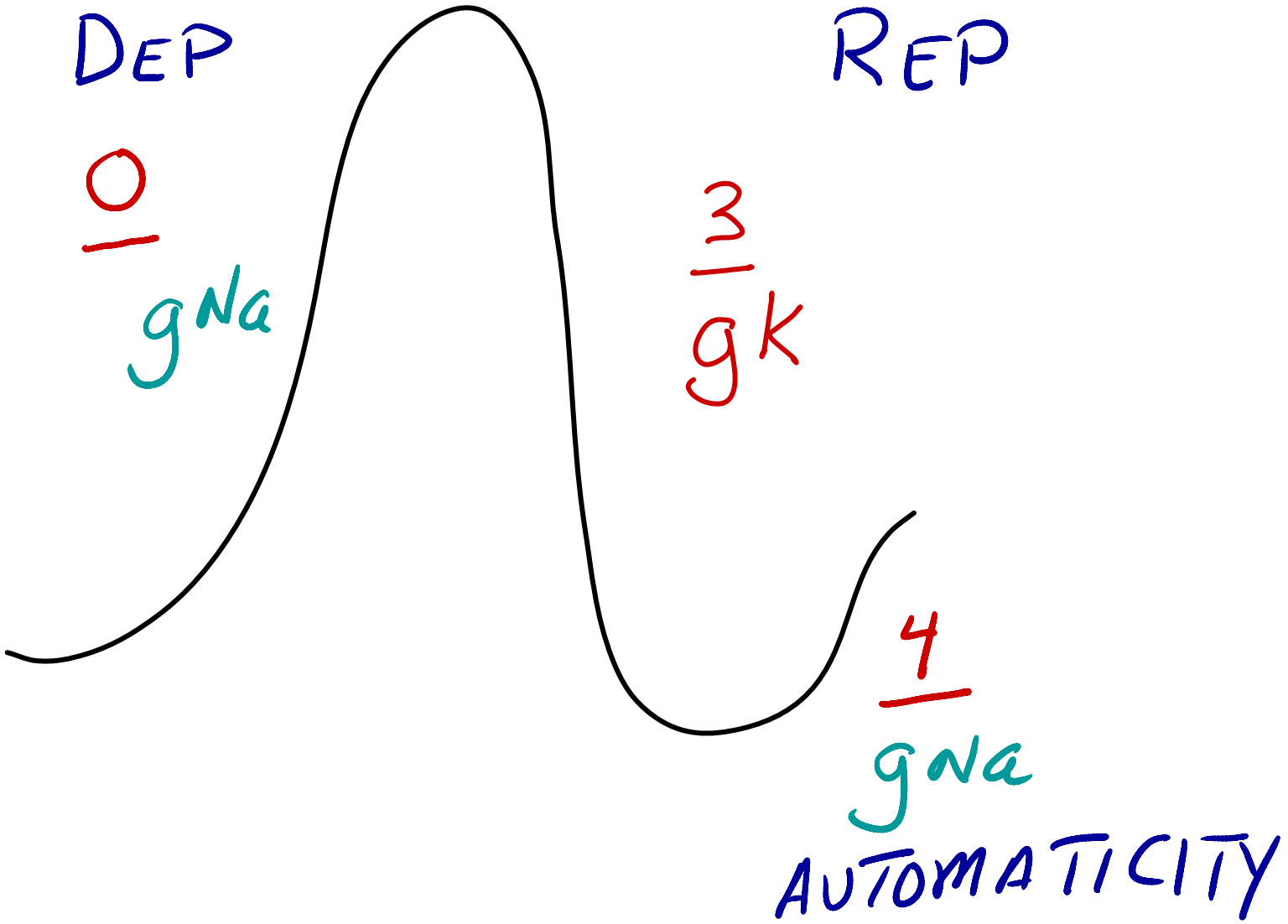
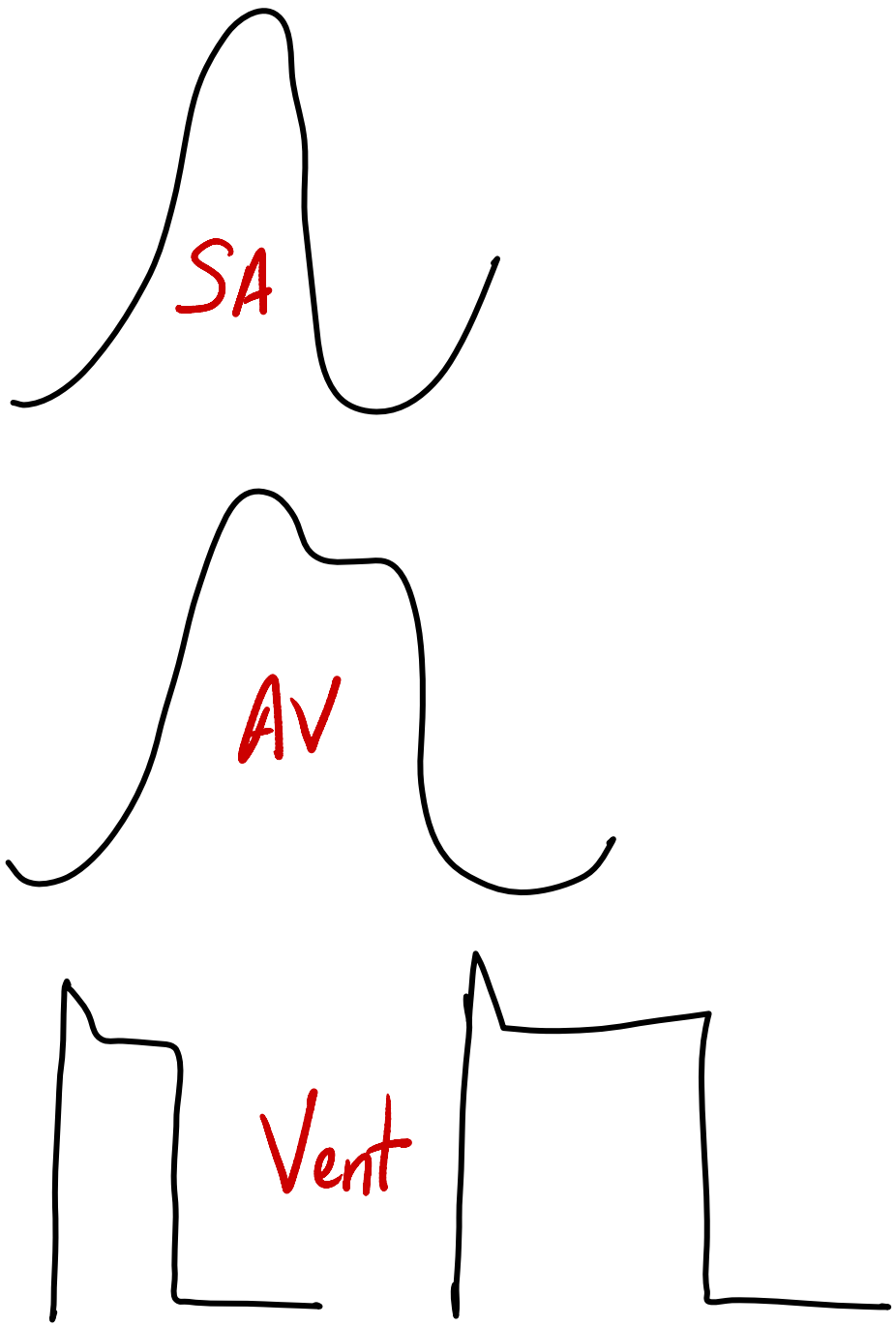
Electrolyte Movement

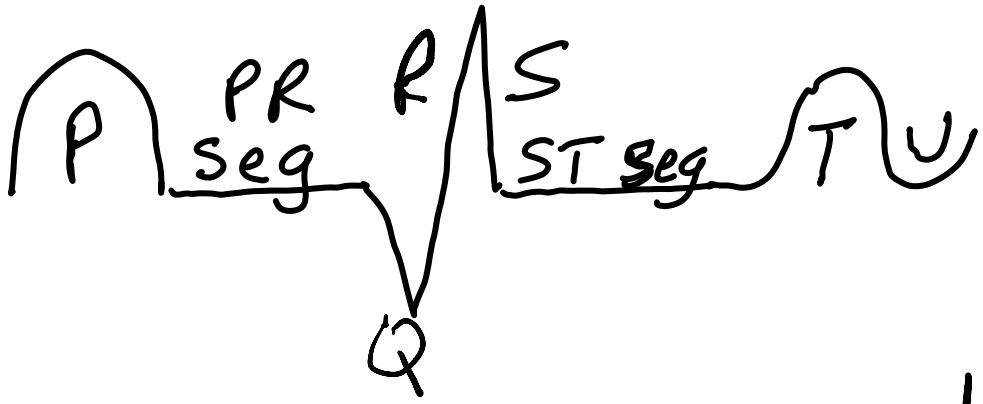
- **Depolarize**: to become **positive** from baseline
- **Overshoot**: more **positive** than the threshold potential
- **Repolarization**: to become **negative** from a positive potential
- **Hyperpolarization** (or undershoot): to become **more negative** than baseline potential

Sodium Channels




DEP
REP
0
g_{Na}
3
g_K
4
g_{Na}
AUTOMATICITY


SA
AV
Vent

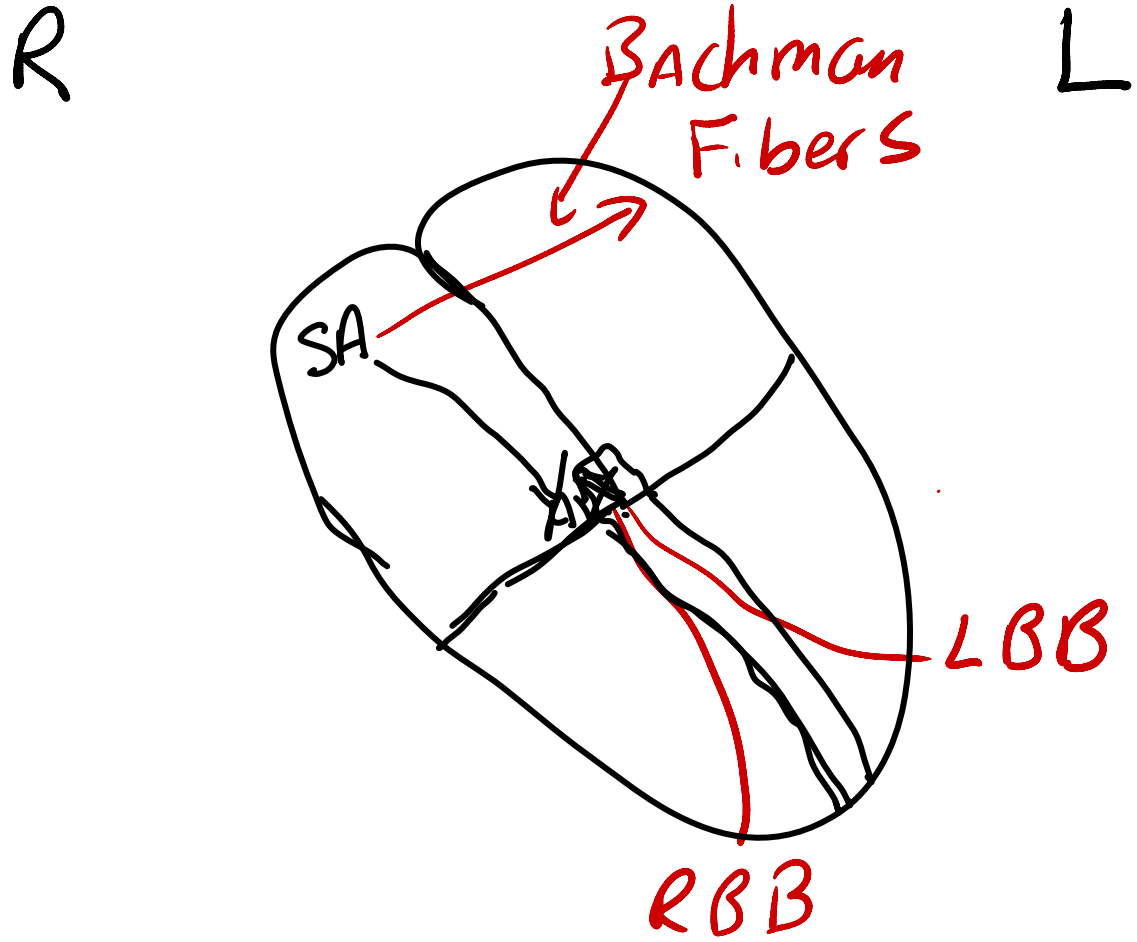


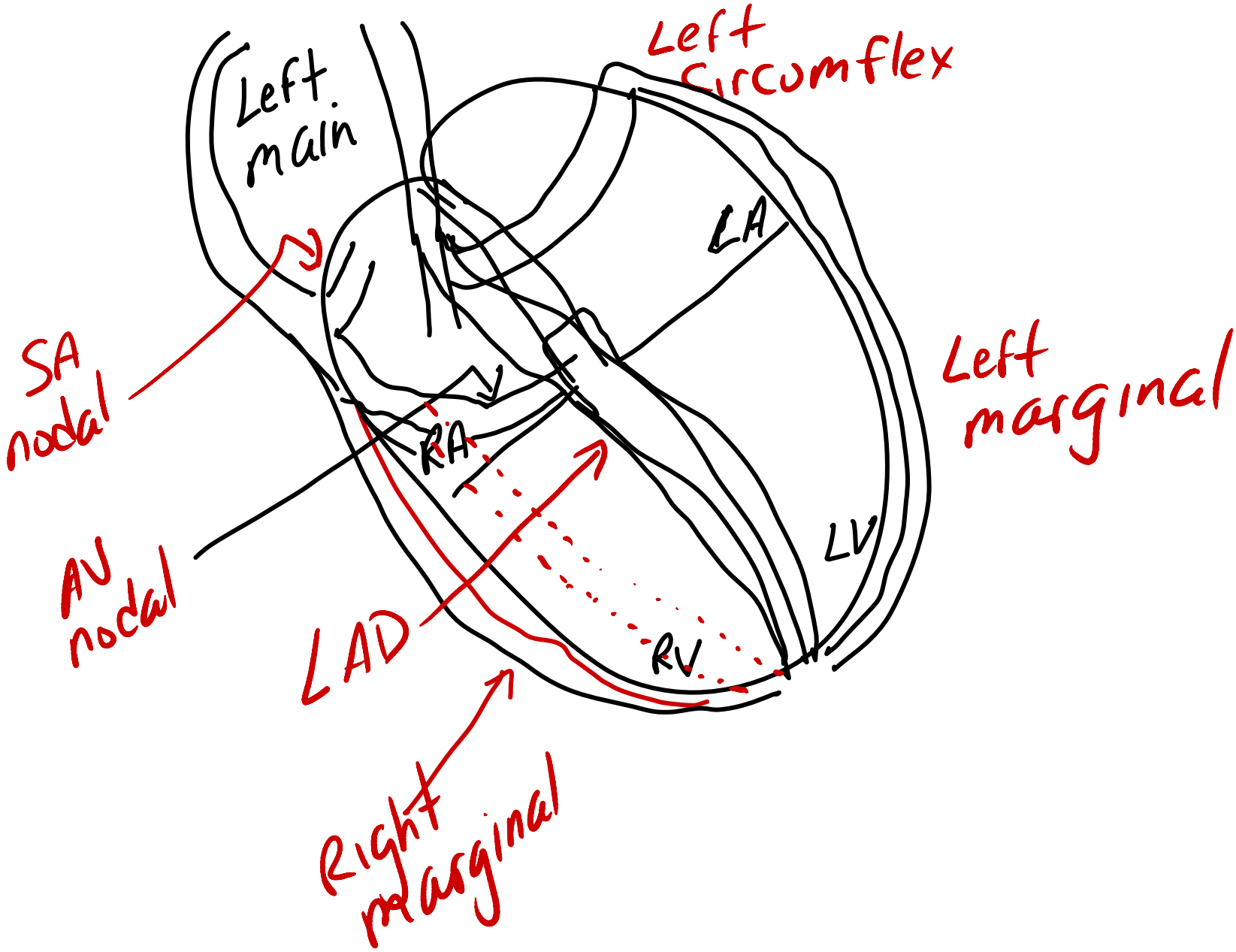
PR int

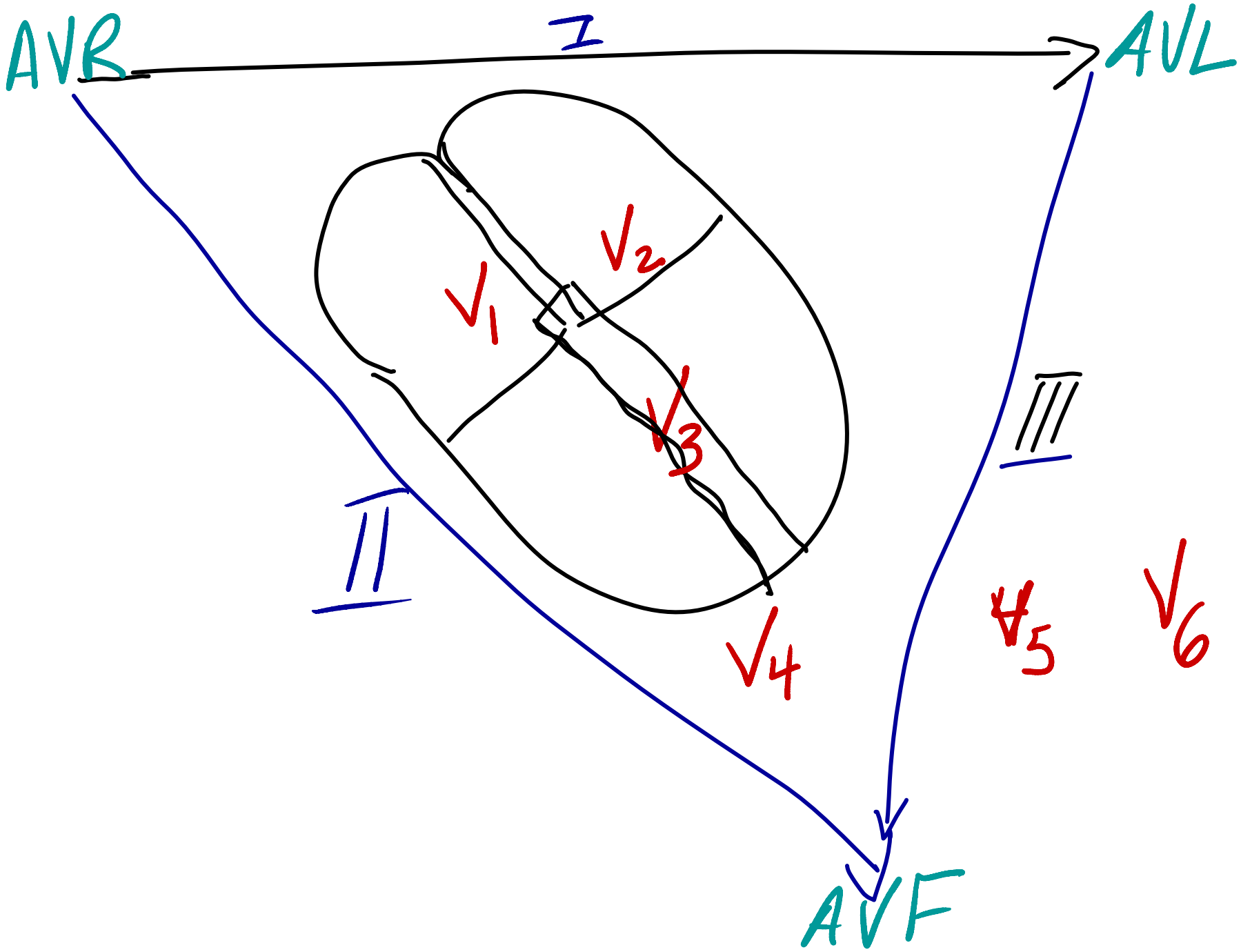
QT int

HEIGHT = VOLTAGE

WIDTH = Duration


R
Bachman
Fibers
L
SA
AV
LBB
RBB


Left main
Left Circumflex
LA
SA nodal
Left marginal
RA
AV nodal
LV
LAD
RV
Right marginal


AVR
I
AVL
V2
V1
V3
II
III
V4
V5
V6
AVF

HEART BLOCKS

- NORMAL PR-interval : <0.2sec
- FIRST DEGREE HEART BLOCK: fixed and prolonged PR-interval
  - Problem is AT the SA node or BETWEEN the SA node and the AV node
  - NO treatment necessary
  - Speeding up the heart rate(exercise) will make the block disappear

HEART BLOCKS, cont

- SECOND DEGREE HEART BLOCK
- MOBITZ 1: progressive lengthening of PR-interval until QRS is dropped
  - Early ischemia at the AV node
  - Also called WENCKEBACK'S
  - Put in pacemaker if symptomatic; do nothing if asymptomatic

HEART BLOCKS, cont

- MOBITZ II: PR-interval is normal; QRS complexes are dropped erratically
  - Late ischemia at the AV node
  - Some cells are negative; some cells are positive
  - ALL must have a pacemaker

HEART BLOCKS, cont

- THIRD DEGREE HEART BLOCK
  - COMPLETE AV DISSOCIATION
  - AV-node has INFARCTED
  - P-waves and QRS complexes have NO relationship
  - ALL must have a pacemaker

QRS COMPLEXES

- Premature ventricular complex (PVC)
  - No P- wave; wide QRS complex; a pause following the QRS complex
  - **BIGEMINY**: A PVC every other beat
  - **TRIGEMINY**: A PVC every third beat
  - **VENTRICULAR TACHYCARDIA**: three or more consecutive PVCs with a minimum heart rate of 150
  - **VENTRICULAR FIBRILLATION**: NO recognizable QRS complexes

VENTRICULAR TACHYCARDIA

- IF PATIENT STABLE: treat with medication
- IF PATIENT UNSTABLE:
  - SHOCK with 200joules
  - SHOCK with 300joules
  - SHOCK with 360(max)joules
  - LIDOCAINE
  - SHOCK
  - BRETYLIUM or AMIODORONE

VENTRICULAR FIBRILLATION

- EPINEPHRINE
- TREAT LIKE VENTRICULAR TACHYCARDIA

ATRIAL ARRHYTHMIAS

- Premature atrial contraction (PAC)
- Multifocal atrial tachycardia
- Paroxysmal supraventricular tachcardia
- Atrial flutter
- Atrial fibrillation
  - If ACUTE and STABLE: treat with medication
  - If ACUTE and UNSTABLE: DEFIBRILLATE
  - If CHRONIC: treat medically; put on coumadin
  - May defibrillate after minimum 2 weeks on coumadin

- TX: use synchronized button

ELECTROLYTES AFFECT DEPOLARIZATIONS

- FOUR SPECIALIZED MEMBRANES
  - **NEURONS**
  - **SKELETAL MUSCLES**
  - **SMOOTH MUSCLES**
  - **CARDIAC MUSCLE**
    - ATRIUM: uses calcium to depolarize
    - VENTRICLE: uses sodium to depolarize; uses intracellular calcium to contract; depends on extracellular calcium to trigger off intracellular calcium release

HYPERMAGNESEMIA

- LESS LIKELY TO DEPOLARIZE
- AFFECTS CALCIUM AND POTASSIUM
- GETS IN THE WAY OF SODIUM
- TX: IV normal saline; loop diuretic

HYPOMAGNESEMIA

- MORE LIKELY TO DEPOLARIZE
- AFFECTS CALCIUM and POTASSIUM
- AFFECTS all KINASES
- TX: magnesium sulphate

HYPERCALCEMIA

- LESS LIKELY TO DEPOLARIZE everywhere except the atrium(more likely)
- SMOOTH MUSCLE: initially less likely (blocks nerve) to depolarize, then more likely to CONTRACT (due to second messenger systems)
- TX: IV normal saline; loop diuretics

HYPOCALCEMIA

- MORE LIKELY TO DEPOLARIZE everywhere except the atrium(less likely)
- WILL AFFECT SECOND MESSENGER SYSTEMS
- SMOOTH MUSCLE: initially more likely to depolarize(nerve fires more) followed by less likely to CONTRACT (affects second messenger systems)

HYPERKALEMIA

- Initially MORE LIKELY TO DEPOLARIZE
- Potassium will flow into the cell, taking the membrane potential closer to threshold
- Potassium gets trapped INSIDE the cell during repolarization; repolarization therefore takes longer > LESS LIKELY TO DEPOLARIZE
  - **Peaked T waves**
  - **Widened T waves**
  - **Prolonged QT interval**
    - Predisposes to arrythmias

HYPOKALEMIA

- LESS LIKELY TO DEPOLARIZE
- Potassium will rush out of the cells, making them more negative
  - Cells repolarize even faster
  - Cells repolarize too much
    - **Narrow T waves**
    - **Flat T waves**
    - **Flipped and inverted T wave**
    - **The U wave**(exaggerated flipped T wave)

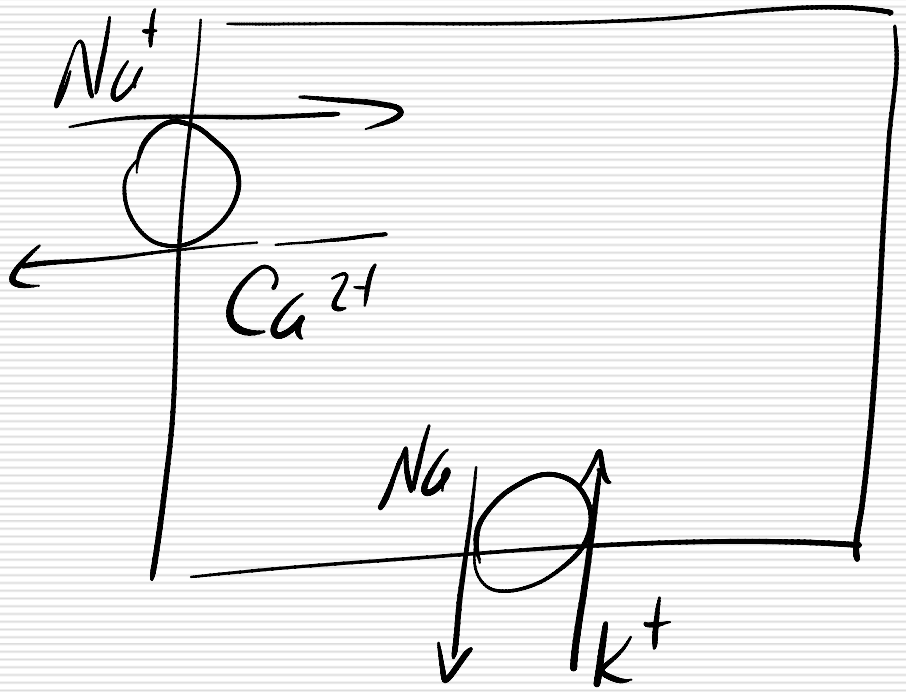
HYPERNATREMIA

- MORE LIKELY TO DEPOLARIZE
- SODIUM rushes into the cells, making them more positive
- After sometime, the NA-K ATP-ase kicks Into high gear, making the cells more negative(less likely to depolarize)
- TX: IV normal saline; correct slowly

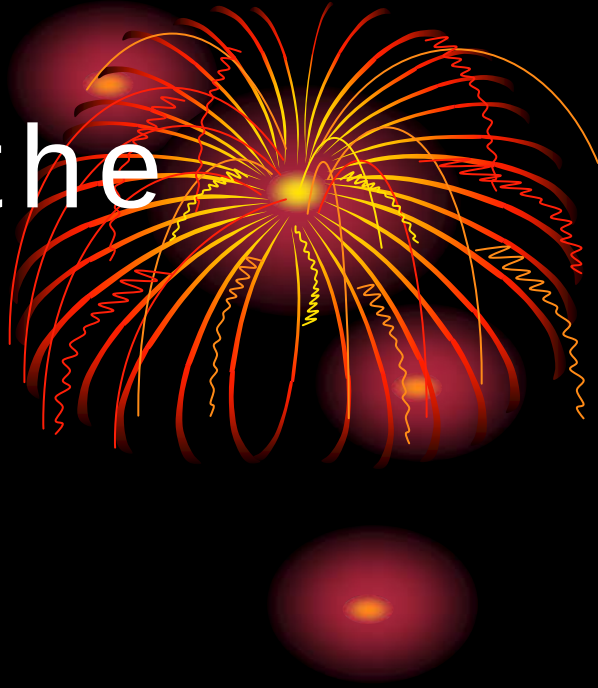
HYPONATREMIA

- MORE LIKELY TO DEPOLARIZE
- SODIUM will now leak out of a cell by Na-K exchange
- When calcium leaks INTO cell in exchange for sodium leaking OUT, cells become more positive
- TX: IV normal saline; correct slowly
  - Use 3% saline if sodium under 120 with symptoms
  - Use fluid restriction if hyponatremia due to SIADH

Hyponatremia



The End: Turn off the lytes



Antiarrhythmics

Class 1: Na channel blockers

- 1a
  - Quinidine
  - Procainamide
  - Disepyramide
- 1b
  - Lidocaine
  - Tocainide
  - Mixelitine
  - Phenytoin
- 1c
  - Encainide
  - Flecainide
  - propofenone

Class II: Beta Blockers

- All end in –lol
- Specific beta 1: begins with A thru M, but NOT L or C
- Blocks B-1 and B-2: begins with N thru Z, including L and C

Class II: Beta Blockers

- Propanolol
- Esmalol
- Sotalol
- Timalol
- Butexalol
- Labetalol
- Carvedilol

Acebutalol

Atenalol

Pindalol

Class III: K Channel blockers

- Napa (from procainamide)
- Sotalol
- Bretylium
- Amiodorone

Class IV: Ca Channel blocker

- Verapamil
- Diltiazem
- Nifedipine
- Nicardipine
- Nimodipine
- Femlodipine
- Amlodipine

Quinidine

Procainamide

Phenytoin

IF YOU PLAY WITH LYTES…

You may go down

IN FLAMES