

1. מי מהבאים יוצא דופן?

א-  $I_{Ca}$

ב-  $I_K$

ג- Ryanodin receptor

ד- Na/K ATPase pump

ה- Ca/Na exchanger

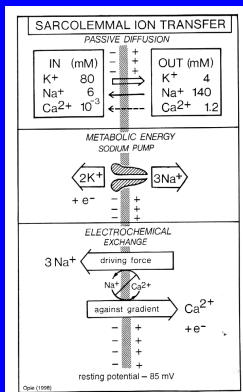
התשובה - ג

## Basic Electrophysiology

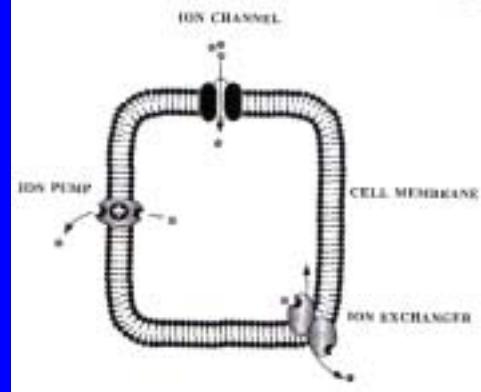
Michael Eldar  
Heart Institute  
Sheba Medical Center

Cesaria, 2004

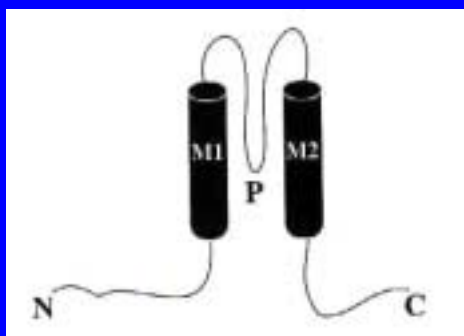
## Transmembrane Ion-Transfer Modes



Opie LH, The Heart 1998:75

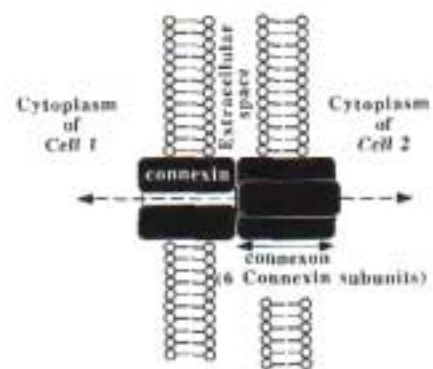


Jalife et al. Basic Cardiac Electrophysiology for the Clinician, 1998:40



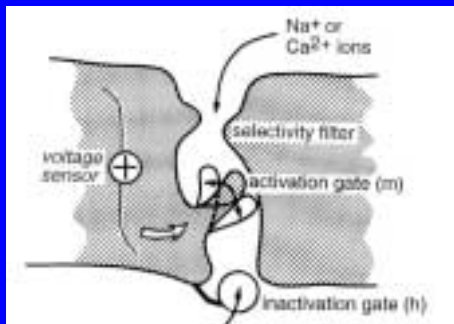
### Inward Rectifier— $I_{K1}$

Jalife et al. Basic Cardiac Electrophysiology for the Clinician, 1998:69

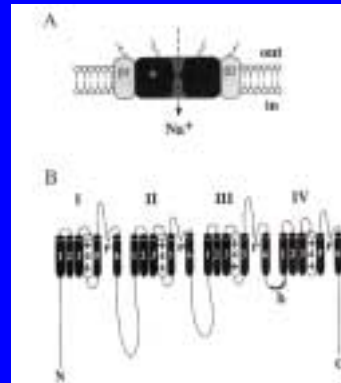


Jalife et al. Basic Cardiac Electrophysiology for the Clinician, 1998:70

## Channel Pore Model



Opie LH, *The Heart* 1998:76



## Voltage-Gated Sodium channel

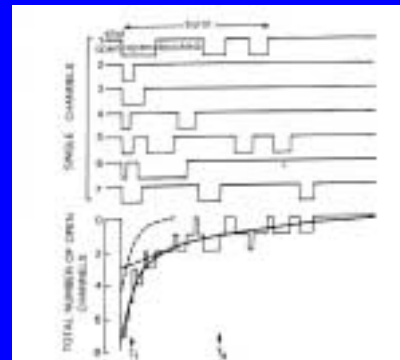
Jalife et al. *Basic Cardiac Electrophysiology for the Clinician*, 1998:64

2. מי מהתעלות הבאות האחראית העיקרית לשלב II של פוטנציאל הפעולה החדרי?

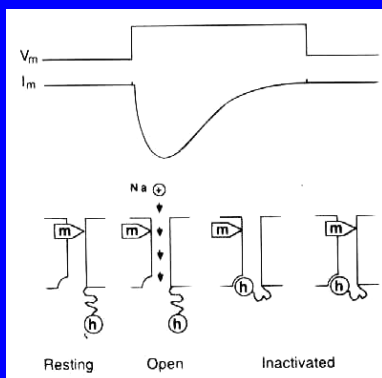
- א-  $I_{Ca,L}$
- ב-  $I_{Na}$
- ג-  $I_K$
- ד-  $I_{K1}$
- ה-  $I_{K,ach}$

התשובה - א'

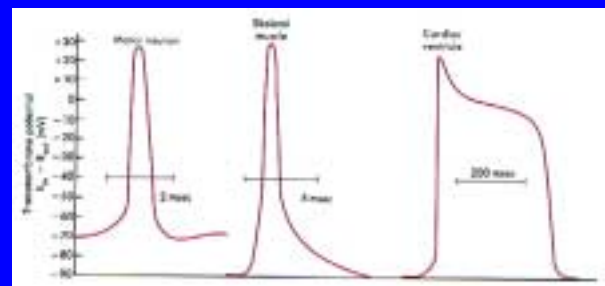
## Channels Open in Bursts



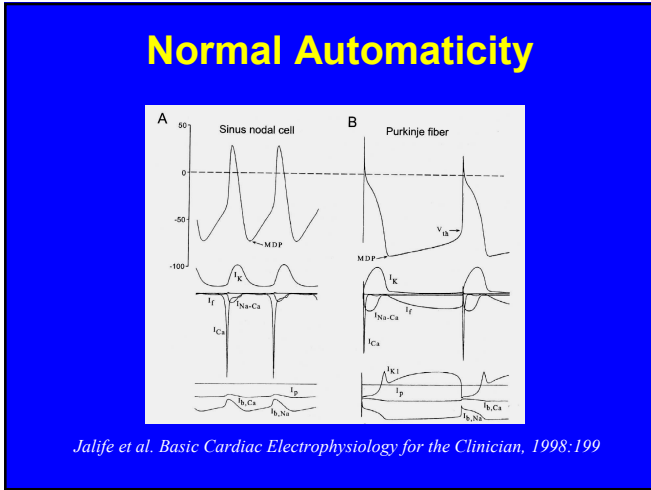
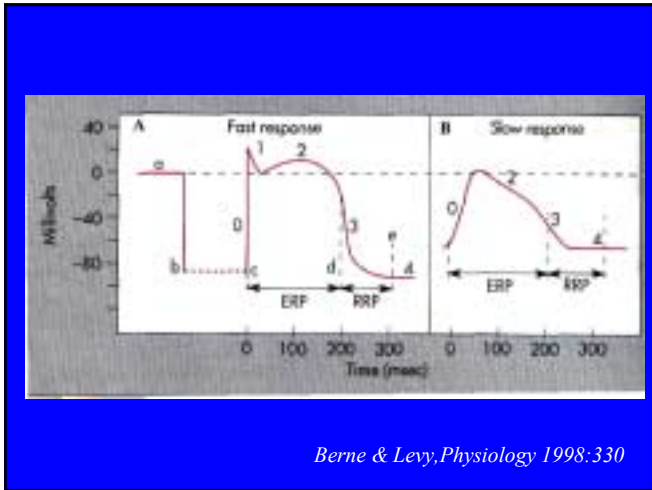
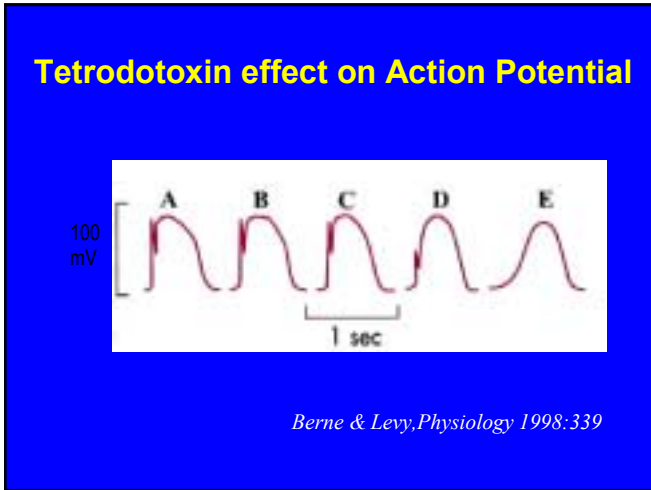
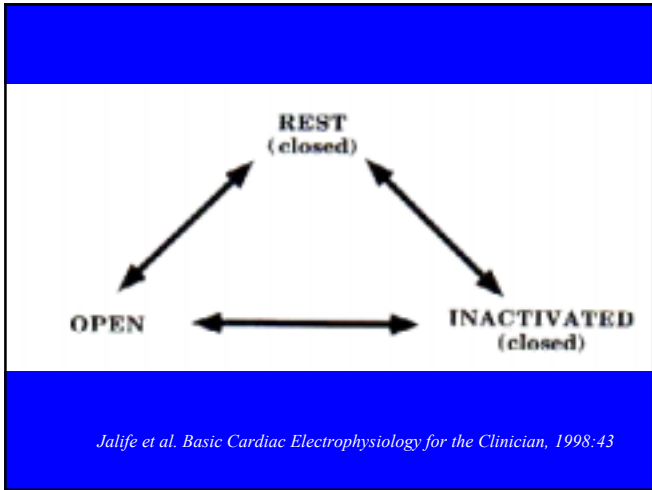
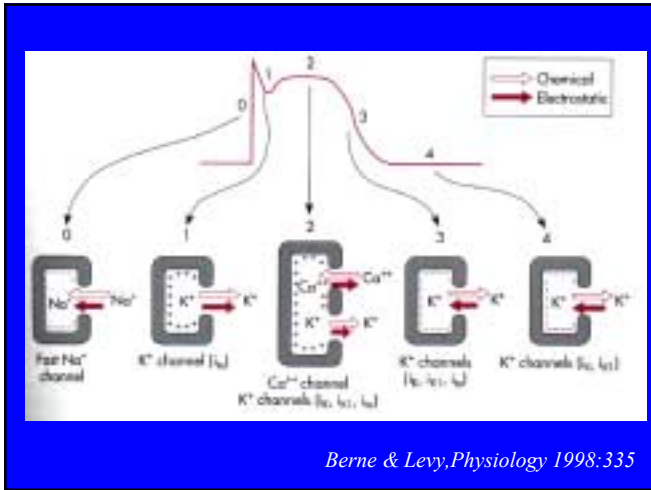
Opie LH, *The Heart* 1998:81



Whalley DW et al, *PACE* 1995;18:1561



Berne & Levy, *Physiology* 1998:30

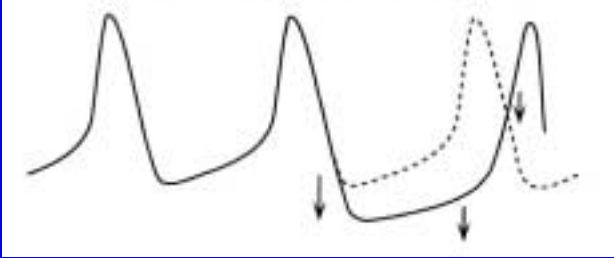


3. אחת מהפרעות הקצב להלן נגרמת עקב Abnormal automaticity. איזו היא?

- א- PAT עקב הרעלת דיגוקסין
- ב- TdP מקינדין
- ג- RVOT VT במאמץ
- ד- AVNRT
- ה- AIVR

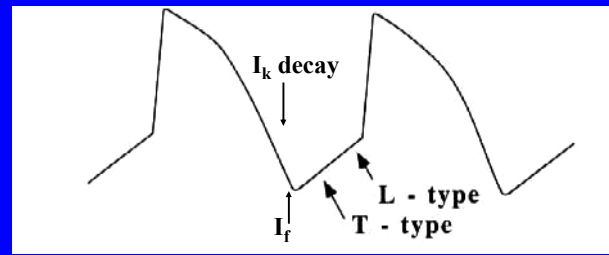
התשובה הנכונה – ה'

## ACh and Automaticity



Jalife et al. Basic Cardiac Electrophysiology for the Clinician, 1998:202

## Normal Automaticity

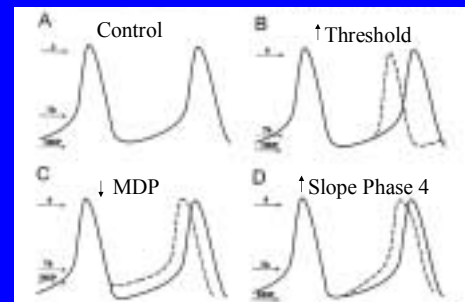


Jalife et al. Basic Cardiac Electrophysiology for the Clinician, 1998:55

## Abnormal automaticity

- Depolarized myocytes (-60 → -10 mV)
- ↓ pH
- ↓ [O<sub>2</sub>]
- ↓ [K<sup>+</sup>]<sub>o</sub>

## Acceleration of Normal Automaticity



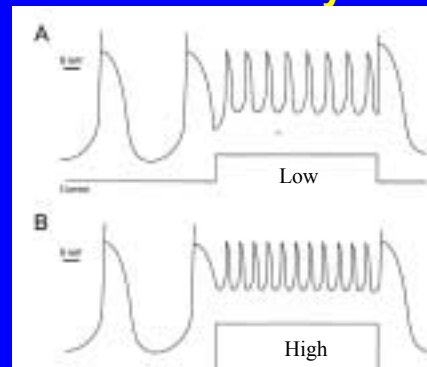
Jalife et al. Basic Cardiac Electrophysiology for the Clinician, 1998:201

## Abnormal automaticity

### Clinical Arrhythmias

- Myocardial infarction
  - 15-30 minutes
  - 24-72 hours
- AIVR
- ↑[K<sup>+</sup>]<sub>o</sub>
  - Ischemia
  - Injury currents

## Depolarization-induced Automaticity



Jalife et al. Basic Cardiac Electrophysiology for the Clinician, 1998:206

## Triggered Activity

- activity arising from membrane potential oscillations during or immediately following an AP
- Should occur following a previous AP (spontaneous or driven)

4. המשפטים הבאים מתייחסים ל-Triggered Activity. אחד אינו נכון, מהו?

- א- DAD גדלים עקב טכיקרדיה
- ב- LQT3 נגרם בשל מוטציה בתעלת אשלגן
- ג- TdP מתרופות נגרם מחסימת תעלת אשלגן
- ד- מחויב להיגרם ע"י פוטנציאל פעולה קודם
- ה- עודף יונים חיוביים בתא גורם להארכת QT

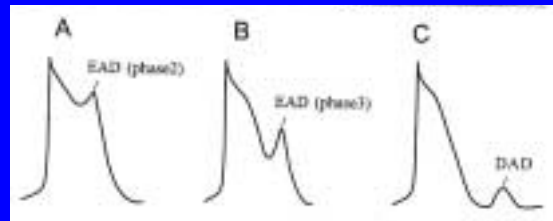
התשובה הנכונה – ב'

## DAD

### Characteristics

- Induction
  - fast train
  - 1 ES
- ↓ CI / CL of initiating stimulus/li
  - ↓
  - ↓ CI of triggered response
- Termination
  - 1 ES
  - ODP

## Triggered Activity



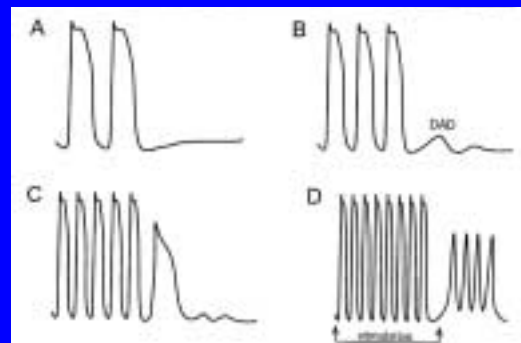
Zipes & Jalife, *Cardiac Electrophysiology* 1995:208

## DAD

### Clinical Arrhythmias

- Dig. Intoxication
  - atrial tach:
  - VT
- Accelerated VT during AMI
- Reperfusion induced arrhythmias
- Congenital LQTS
- Exercise (catecholamine, cAMP dependent) induced RVOT VT

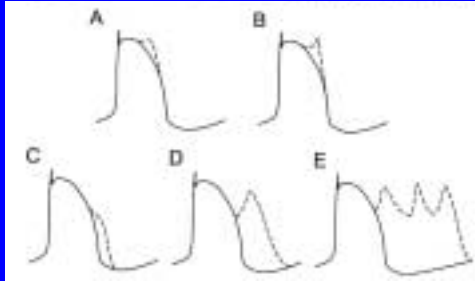
## Digoxin induced DAD



### Rate-Dependence of DAD's

Jalife et al. *Basic Cardiac Electrophysiology for the Clinician*, 1998:211

## Quinidine-induced EAD's



*Jalife et al. Basic Cardiac Electrophysiology for the Clinician, 1998:215*

## Early Afterdepolarization (EAD)

### Pathophysiology

Outward current ↓  
and/or  
↑ Inward current

## EAD

### Clinical arrhythmias

- TDP
- acquired LQTS
- congenital LQTS

## EAD

### Pathophysiology

-AP prolongation

↓ $I_k$ ,  $I_{k1}$ ,  $I_{to}$

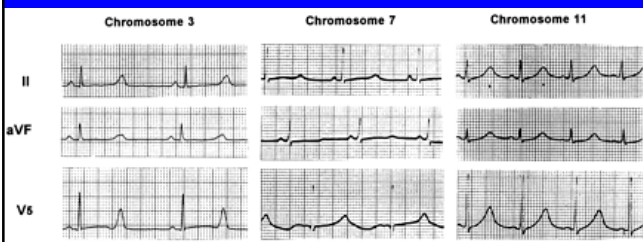
↑ $I_{Na}$ ,  $I_{Ca}$ , electrogenic Na-Ca exchanger

AP Plateau - ↓Currents → ↑sensitivity

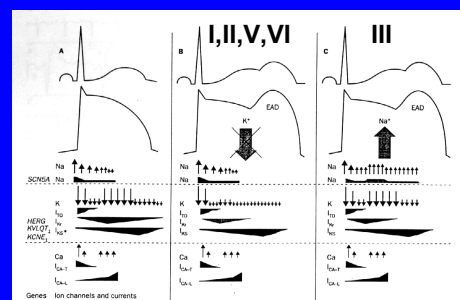
- Net depolarizing current

-  $I_{Ca,L}$  (window) -

## Genotype and ECG



## LQTS- net outward current



*Viskin, Lancet '99;354:1625*

5. המשפטים הבאים מתייחסים ל REENTRY. אחד אינו נכון, מהו?

- א- המנגנון השכיח ביותר לאריתמיות באדם
- ב- אחראי לאריתמיה בתסמונת ברוגדה
- ג- אחראי עיקרי ל VT לאחר אוטם ישן
- ד- אחראי ל TdP ב LQTS מולד
- ה- אזור הולכה אטית אינו תנאי הכרחי

התשובה הנכונה – ד'

## Acquired EAD

- hypokalemia ( $\downarrow$ K conductance)
- Acidosis
- Bradycardia
- Ik blockers
  - AAD
  - Phenothiazine
  - Antihistamines
  - Antibiotics
  - antidepressants

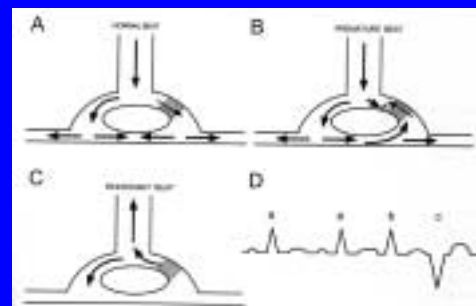
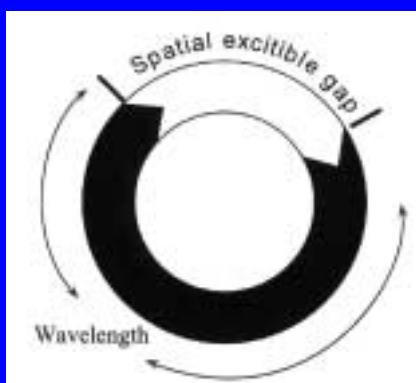
## Reentry

### Unidirectional block

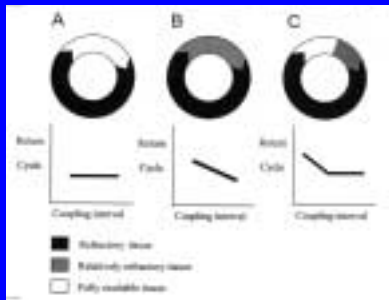
1. Increase in sinus rate
2. Rapid or premature atrial pacing
3. Retrograde activation from VPC
4. Autonomic influence
5. AAD
6. Ischemia

## Circus Movement Reentry

1. Intact anatomic circuit
2. Unidirectional block (onset)
3. Area of slow conduction
4. Wavelength of tach. < length of circuit



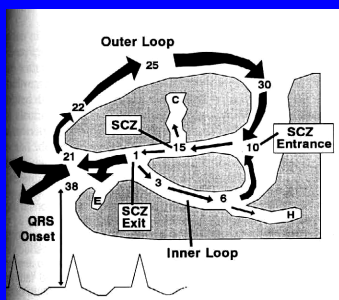
## Resetting



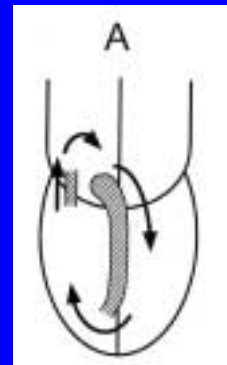
## Reentry

### EPS-Diagnosis

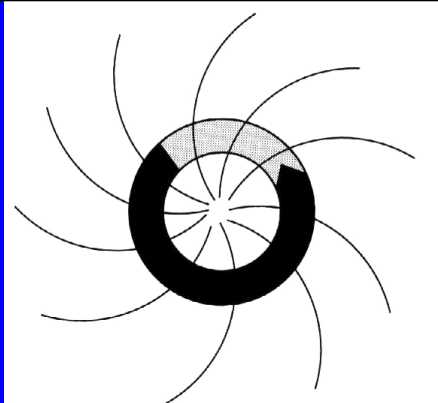
1. Continuous electric activity
2. Inducibility/termination by electric stimulation
3. Inverse relationship of C.I. of initiating extra-stimulus/1<sup>st</sup> tachycardia beat
4. Entrainment (resetting) by external stimuli



Reentry circuit



WPW Syndrome



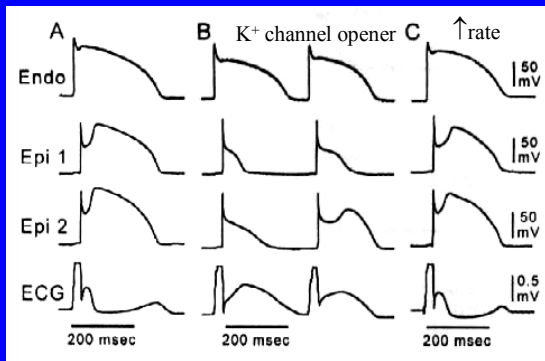
Leading Circle

*Jalife et al. Basic Cardiac Electrophysiology for the Clinician, 1998:237*

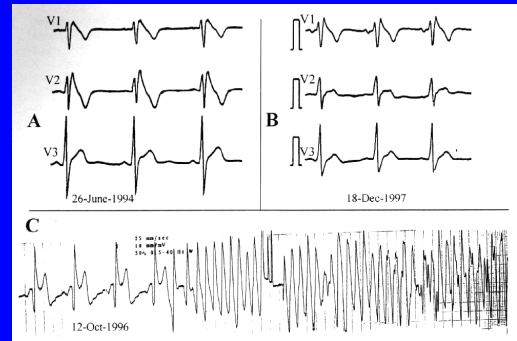
## Leading Circus Reentry

1. Cannot be interrupted by disrupting the circuit
2. No fully excitable gap
  - unstable
  - insensitive to electrical stimulation
3. Short cycle length



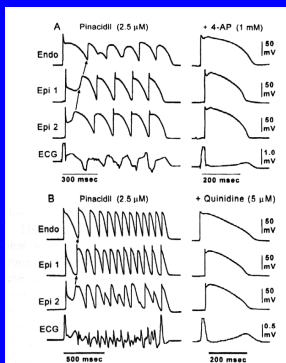


Yan Gan-Xin, *Circulation* 1999;100:1660

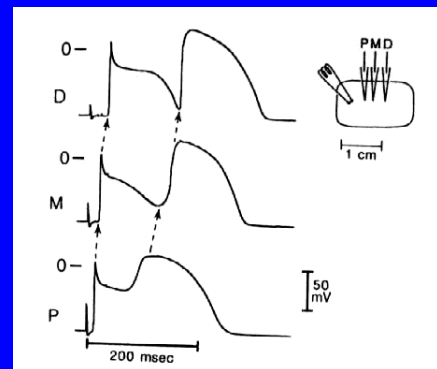


Viskin, *Prog Cardiovasc Dis* 1998;41:17

## Phase II Reentry



## Phase II Reentry



Di Diego, *Circulation* 1993;88:1177

## Clinical Reentry Tachyarrhythmias

Definite  
AVNRT  
AVRT  
A Flutter  
Post MI VT  
BBR VT

Probable  
A Fibrillation  
PVT  
VF