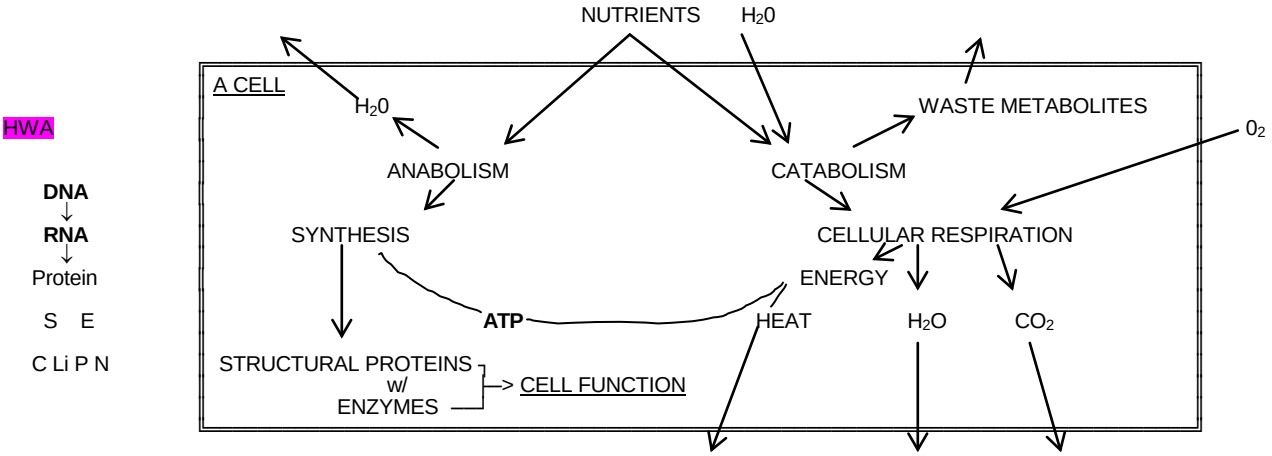
III - ALTERATIONS IN CELL & TISSUE FUNCTION & GROWTH

III.A. CELL & TISSUE CHARACTERISTICS & THEIR ADAPTATION & RESPONSE TO INJURY

A.a. CELL & TISSUE CHARACTERISTICS
A.a.A. FUNCTIONAL COMPONENTS OF THE CELL HWA (review pp 5-8)

A.a.B. CELLULAR ENERGY METABOLISM



Critical Figure IIIA-1. Cell Function Simplified TP IIIA-1

A.a.C. TISSUE TYPES HWA

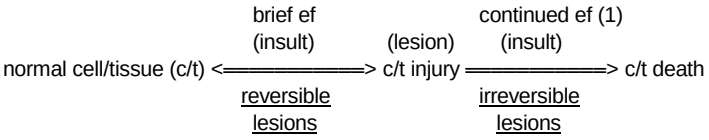
A.b. CELL & TISSUE ADAPTATION & RESPONSE TO INJURY (LESION)
[a morbid change in continuity, form or function of tissue due to an ef]

A.b.A. GENERAL CAUSES OF CELL INJURY (ef's)
A.b.A.a. DEFICIENCY [lack of a substance necessary to the cell] (CF IIIA-1)

A.b.A.b. INTOXICATION [poisoning of metabolic pathways] <metabolic pathways demo>

A.b.A.c. TRAUMA (S XI. *et al*.)

A.b.B. EFFECTS & RESPONSES



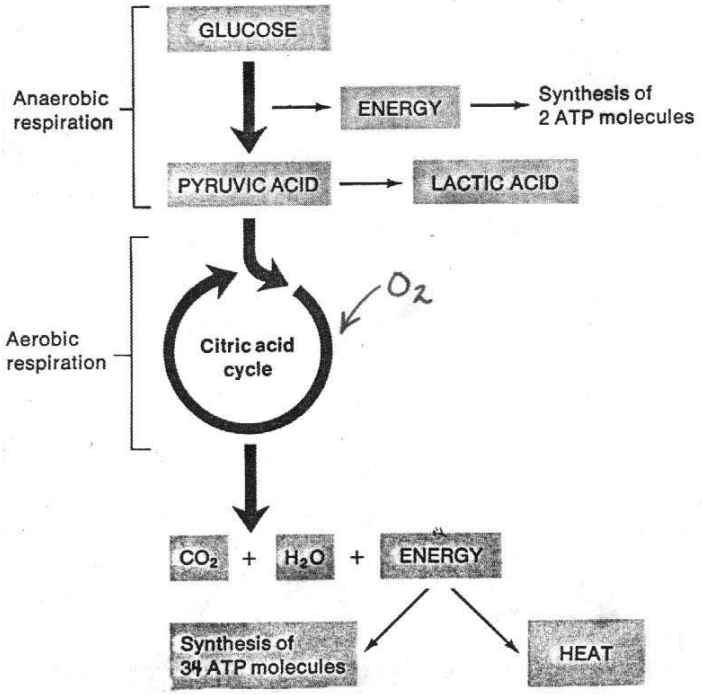
Key: 1: prolonged low or brief high

Critical Path IIIA-1. General Pathophysiology of Cell/Tissue Lesions & Death

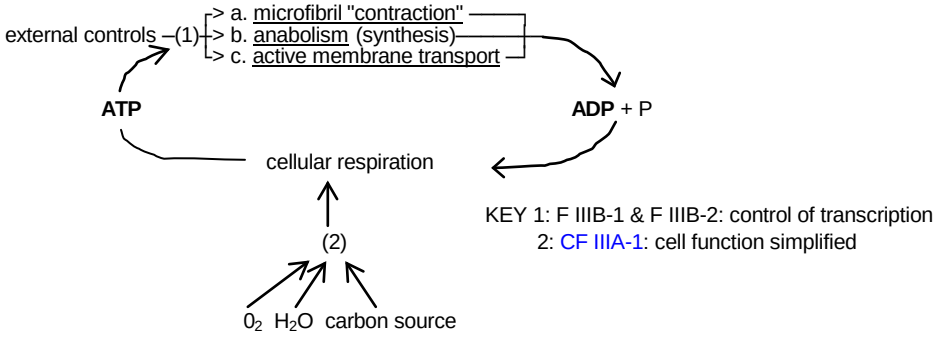
A.b.B.a. REVERSIBLE LESIONS
A.b.B.a.(A.) DEFICIENCIES (3 types; which 3?)
A.b.B.a.(A.a.) HYP\OXIA I {below\G oxygen}
A.b.B.a.(A.a.A.) TRANSIENT HYPOXIA
A.b.B.a.(A.a.A.a.) CELLULAR RESPIRATION (CF IIIA-2, next page)

A.b.B.a.(A.a.A.b.) USES OF **ATP** IN A CELL (CF IIIA-3, next page)

A.b.B.a.(A.a.A.c.) ELECTRON TRANSPORT PHOSPHORYLATION (CF IIIA-4, p IIIA-3)



Critical Figure IIIA-2. Cellular Respiration in the Presence of Adequate & Insufficient Oxygen (1, p 292) TP IIIA-2



KEY 1: F IIIB-1 & F IIIB-2: control of transcription
2: CF IIIA-1: cell function simplified

Critical Figure IIIA-3. The **ATP**-**ADP** Cycle in a Functioning Cell TP IIIA-3

A.b.B.a.(A.a.B.) TRANSIENT TO MILD HYPOXIA

manifestations of <transient hypoxia>: PAIN, WEAKNESS,& FATIGUE
manifestations of <mild hypoxia>: CRAMPS & CELLULAR SWELLING

TP IIIA-5

transient: (2)==> / lactic acid => PAIN; (3a)=> WEAKNESS; (3b)=> FATIGUE } <transient hypoxia>

↓ O_2 =(1)=> / H^+ =(1)=> / **ATP** ↓ (/ pH)

=> ↓ O_2 =T=(3c)=> / active transport => / Ca^{++} reabsorption by sarcoplasmic reticulum => 1)

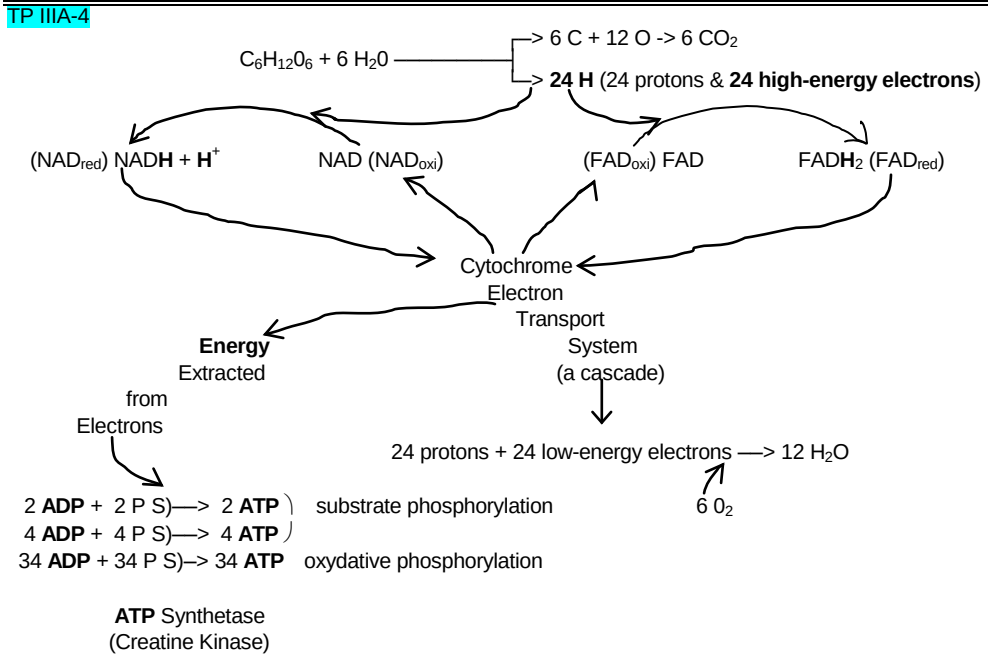
=> ↓ O_2 =T=(3c,4)=> CELLULAR SWELLING

KEY 1: CF IIIA-4: role of H^+ in **ATP** production
2: CF IIIA-2: cell Resp w/ inadequate O_2
3: CF IIIA-3: uses of **ATP** in a cell
4: CF IIIA-7: steps 1&2

1) => / Ca^{++} in sarcoplasm => continued muscle contraction-CRAMPS <mild hypoxia>
HWA

Critical Path IIIA-2. Pathophysiology of Transient & Mild Hypoxia

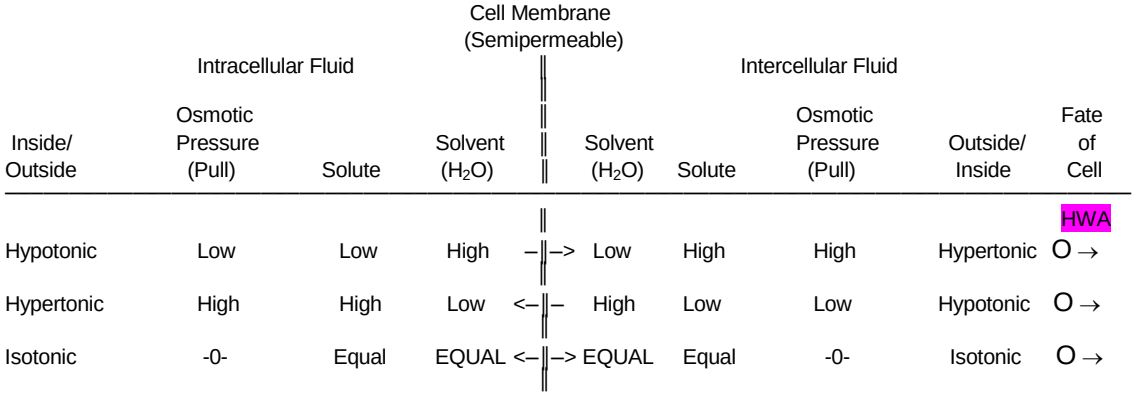
TP IIIA-4



Critical Figure IIIA-4. Electron Transport Phosphorylation

↑ H^+ in 2 ways: 1) ↑ H^+ in Kreb's cycle
2) ↑ lactic acid in Embden-Myerhoff pathway

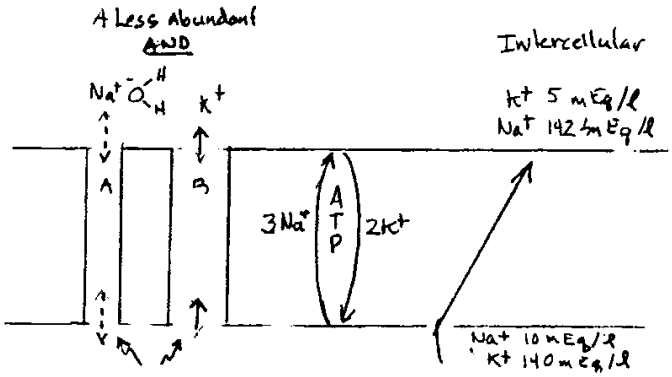
A.b.B.a.(A.a.B.a.) CELLULAR~CLOUDY SWELLING (F 1.13, p 15)
A.b.B.a.(A.a.B.a.)*A.* ACTIVE ISOTONICITY IN HEALTHY CELLS (CF IIIA-5, below & F IIIA-6 & P IIIA-3, next page)



RULE 1: Hypertonic solution (soln) has high solute concentration
RULE 2: Hypertonic soln has high osmotic pressure
RULE 3: Water goes to hypertonic solution

Critical Figure IIIA-5. Osmosis TP IIIA-6

TP IIIA-6



1: high concentration of non-diffusible anions and other solutes

2: non-gated channels

3: Na/K pump

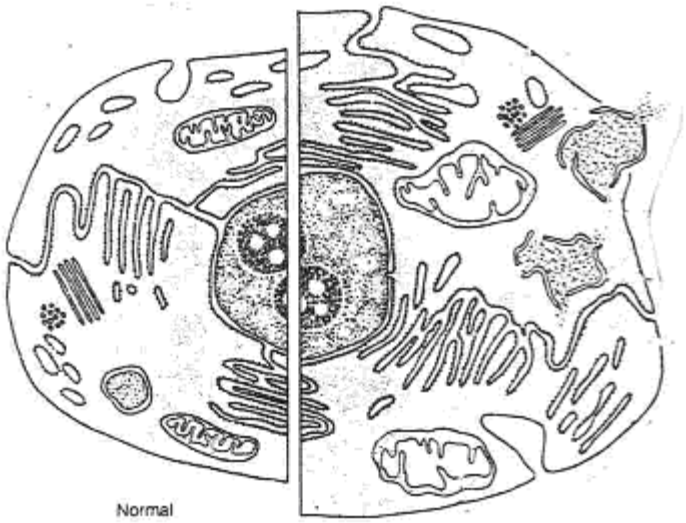
Figure IIIA-6. Mechanisms of Sodium & Potassium Movement Across the Cell Membrane Relevant to Development of the Active Isotonic State

hypertonic
1 + 2 => intracellular => H_2O moves in; + 3 => H_2O pumped out w/ Na^+ => active isotonic state

(isotonicity MAINTAINED by **ATP**
remove **ATP** & cell contents revert to being hypertonic & H_2O enters cell w/out leaving)

Path IIIA-3. Development of the Active Isotonic State in a Healthy Cell

A.b.B.a.(A.a.B.a.)*B.* LOSS OF ISOTONICITY



1. ↓ efflux of Na^+ & H_20 TP IIIA-6a
2. cellular edema
3. mitochondrial swelling
4. lysosomal swelling TP IIIA-12
5. lysosomal enzymes released
6. damage to cell & cell membrane
7. cell lysis
8. efflux of K^+

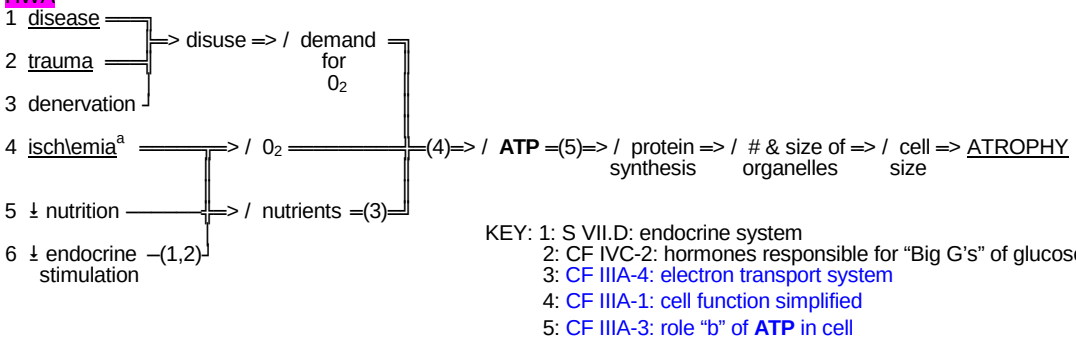
Critical Figure IIIA-7. Cellular~Cloudy Swelling & Lysis (4, p 397)

A.b.B.a.(A.b.) GLUCONEOGENESIS & OTHER NUTRITIONAL DEFIENCIES (Also see S VIII.C)

A.b.B.a.(A.b.A.) A\TROPHY {G no\G feed} [↓ size of cells]

etiology of ATROPHY: disease, trauma & ischemia

HWA



KEY: 1: S VII.D: endocrine system
2: CF IVC-2: hormones responsible for "Big G's" of glucose metabolism
3: CF IIIA-4: electron transport system
4: CF IIIA-1: cell function simplified
5: CF IIIA-3: role "b" of **ATP** in cell

Critical Path IIIA-4. Pathophysiology of Atrophy

[a] {G suppress\G blood}

A.b.B.a.(B.) INTOXICATION

A.b.B.a.(B.a.) ELEVATED CELLULAR ACTIVITY

A.b.B.a.(B.a.A.) HYPER\TROPHY {G greater\} [↑ size of cells]

↑ demand =(1)=> / protein synthesis =(2)=> / # & size of organelles => / cell size => REACTIVE HYPERTROPHY

KEY 1: F IIIB-1 & F IIIB-2: control of transcription
2: CF IIIA-1: cellular metabolism & synthesis

Path IIIA-5. General Pathophysiology of Hypertrophy

A.b.B.a.(B.a.A.a.) PHYSIOLOGICAL - wt lifter

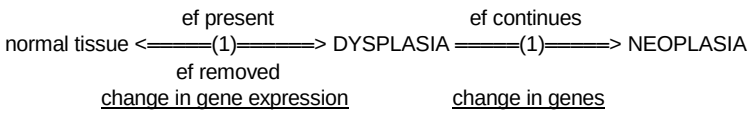
A.b.B.a.(B.a.A.b.) PATHOLOGICAL - valvular disease/hypertension –> thick heart

A.b.B.a.(B.a.B.) HYPER\PLASIA {\G shape} [↑ # of cells]

A.b.B.a.(B.a.C.) META\PLASIA {G change\} [one differentiated cell type –> another]
(see P IIIC-1: cell cycle) (e.g. change in epithelium of trachea in smokers)

A.b.B.a.(B.a.D.) DYS\PLASIA {G bad\} (F 6.1, p132) TP IIIA-7

A.b.B.a.(B.a.E.) NEO\PLASIA {G new\}

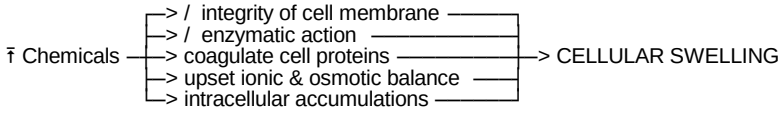


KEY: 1: P IIIA-1: continuum in lesions to cell death

Critical Path IIIA-6. General Pathophysiology of Dysplasia & Neoplasia (also see F 6.1, p 132)

A.b.B.a.(B.a.F.) FATTY CHANGES (F 1.14, p 15 & F 1.15, p 16)
↑ # fat vacuoles damage cell to point of bursting. Especially true of liver (cirrhosis), kidney, heart

A.b.B.a.(B.a.) CHEMICAL AGENTS (toxic compounds)



Path IIIA-7. General Pathophysiology of Chemical Injury HWA

A.b.B.a.(B.b.) PATHOGENS (biological agents) (S V.B)

A.b.B.a.(C.) TRAUMA
A.b.B.a.(C.a.) TEMPERATURE EXTREMES

---

normal tissue <=== (1) low intensity heat / prolonged cold ===> CELLULAR SWELLING ===(1 & 2) high intensity heat / freezing ===> COAGULATION NECROSIS

KEY: 1: CP IIIA-1: continuum in lesions to cell death
2: CP IIIA-10: mechanisms of *CN*

Critical Path IIIA-8. Temperature Extremes - Overview

A.b.B.a.(C.b.) ELECTRICAL FORCES (lightening)

⇑ current w/ resistance } –> / heat –> ?

A.b.B.a.(C.c.) RADIATION f = λ//sec
A.b.B.a.(C.c.A.) ELECTROMAGNETIC SPECTRUM

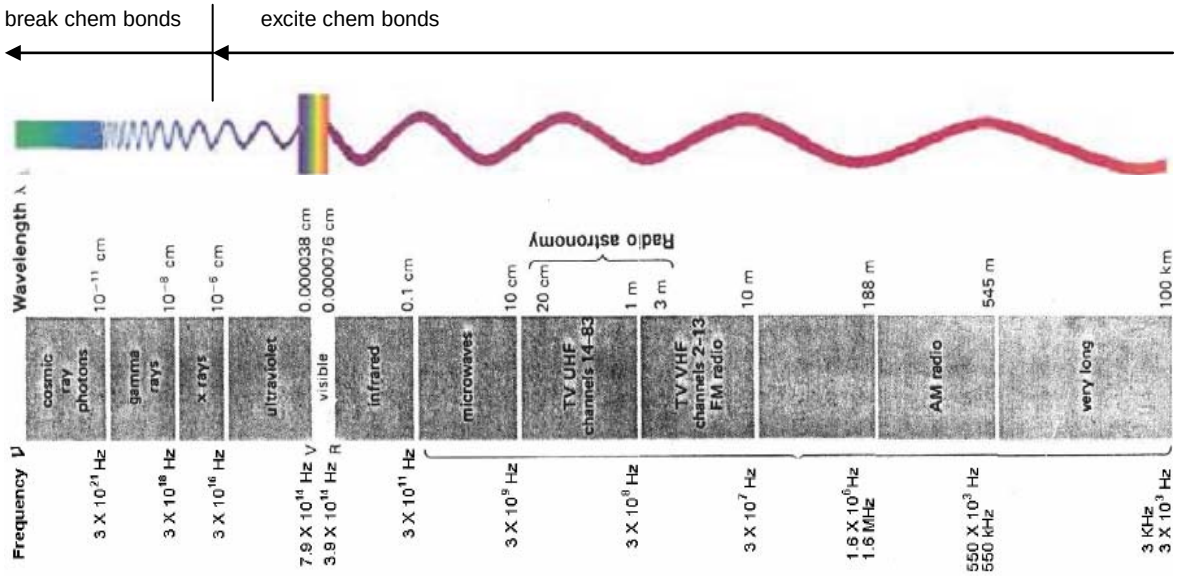


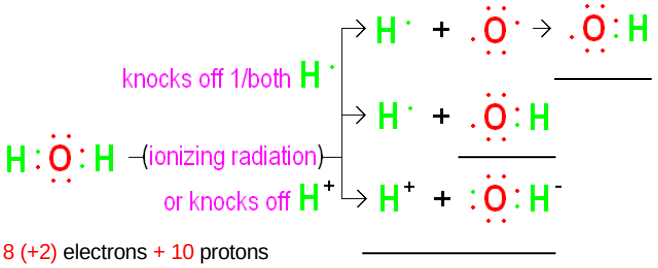
Figure IIIA-8. The Electromagnetic Spectrum and Ionizing/Nonionizing Radiation (32, p 30) TP IIIA-8

A.b.B.a.(C.c.A.a.) NONIONIZING RADIATION

NIR –> ↑ kinetic energy of atoms & molecules –> temperature effects

A.b.B.a.(C.c.A.b.) IONIZING RADIATION
A.b.B.a.(C.c.A.b.)*A.* FREE RADICALS & IONS (Box Figure 1.2, p 20)
hydroxyl radical on next page, posted on web site

TP IIIA-9



7 (+2) electrons + 9 protons =
neutral molecule w/ 1 unpaired electron//hydroxyl =
FREE (HYDROXYL) RADICAL
These will react with many compounds in an attempt to capture an electron from them

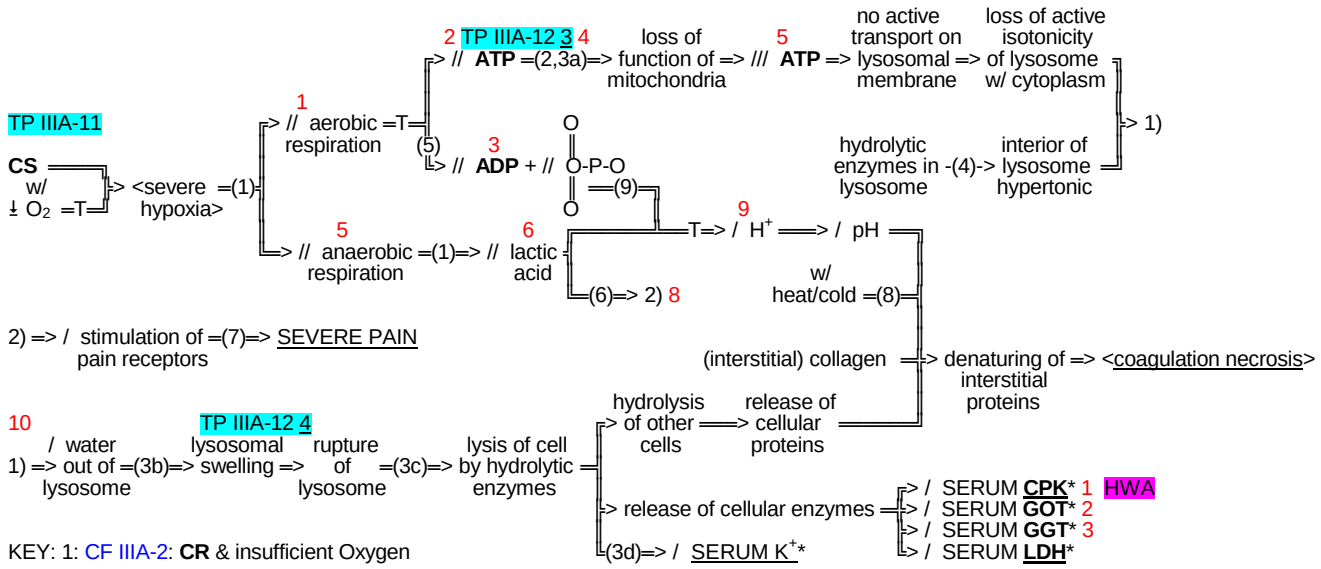
0 electrons + 1 proton: +1; 8 (+2) electrons + 9 protons: -1 = IONS =
charged atoms and molecules w/ 0/all paired electrons
These will react with other ions and polarized molecules

Figure IIIA-9. The Effects of Ionizing Radiation on Water (2, p 211)

A.b.B.b. IRREVERSIBLE LESIONS
A.b.B.b.(A.) DEFFICIENCY
A.b.B.b.(A.a.) SEVERE HYPOXIA & MITOCHONDRIAL DYSFUNCTION (CP IIIA-9)

manifestations of severe hypoxia: SEVERE PAIN, / SERUM K^+*, / SERUM ENZYMES*

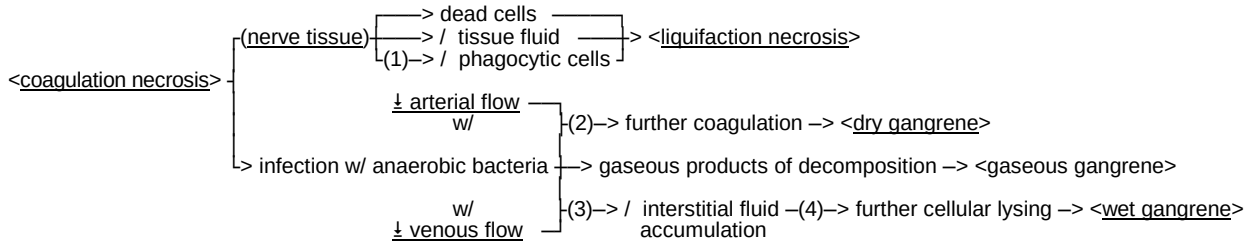
A.b.B.b.(A.a.A.) COAGULATION NECROSIS {G deadness} [death of cell/tissue/organ while it is still part of body]



KEY: 1: CF IIIA-2: **CR** & insufficient Oxygen
2: P IIIA-3: **ATP** & isotonicity
3: CF IIIA-7: cellular swelling & lysis; 3a = step 3; 3b = step 4; 3c = steps 5-7; 3d = step 8
4: CF IIIA-5: osmosis
5: CF IIIA-3: **ATP**/**ADP** cycle
6: CP IIIA-2: lactic acid triggers pain receptors
7: S X.E: pain triggering compounds
8: P IIIA-8: temperature extremes
9: S IV.C.b.D.a.(B.) phosphate buffering system

Critical Path IIIA-9 Manifestations of Severe Hypoxia TP IIIA-10

A.b.B.b.(A.a.B.) GANGRENE [decay of tissue following necrosis]

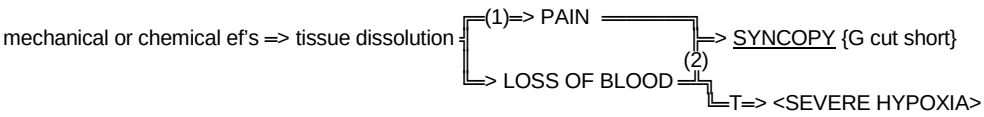


KEY: 1: CP VE-3: cell damage –> / **WBC**'s to site
2: CP IIIA-9: severe hypoxia
3: S IV.A.c.B.d: condition 3): ↑ arterial & venous pressure –> / **IFF**
4: CF IIIA-5: osmosis & CF IIIA-7: cellular swelling, step 1 – w/ more H_20 present, more H_20 can enter cell

Path IIIA-10. Sequalae to Coagulation Necrosis & Etiology of Gangrene HWA

A.b.B.b.(B.) TRAUMA
A.b.B.b.(B.a.) MECHANICAL FORCES
A.b.B.b.(B.a.A.) TISSUE DISSOLUTION [separation of tissue]

manifestations of tissue dissolution: PAIN, SYNCOPY, LOSS OF BLOOD, SEVERE HYPOXIA



Path IIIA-11. General Pathophysiology of Tissue Dissolution

A.b.B.b.(B.b.) IONIZING RADIATION
A.b.B.b.(B.b.A.) DECAY PARTICLES OF RADIOISOTOPES & IONIZING PHOTONS OF THE EMS

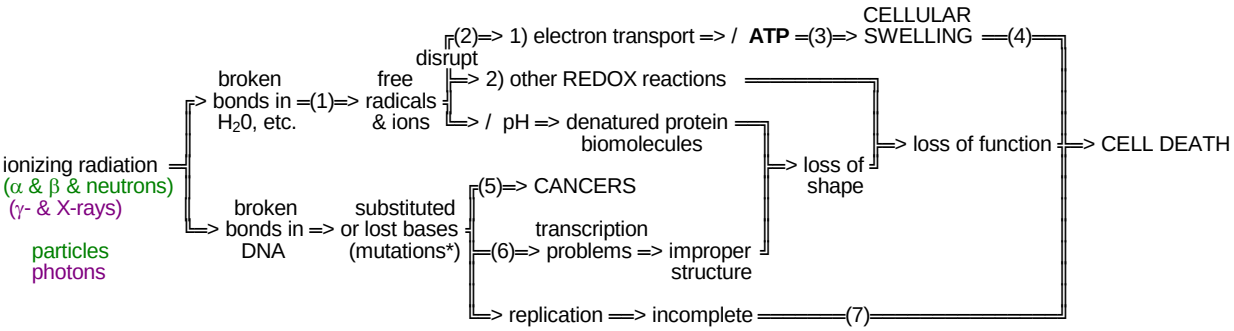
Table IIIA-1. Biologically Important Properties of Products of Radioactive Decay & Ionizing Photons of the EMS

PARTICLE/ RAY	NATURE	CHARGE	SIZE	PENETRATION	EMITTER
Alpha α	He Nucleus	+2	4 AMU	Shallow	Internal
Beta β	Electron	-1	$\approx$ 0	Shallow	Internal
Neutron	Neutron	0	1 AMU	Deep	External
Gamma γ	Photon	0	(0)	Deep	External
X-ray	Photon	0	(0)	Deep	External

A.b.B.b.(B.b.B.) DOSAGES

Table IIIA-2. Estimated Amounts of Radiation Received Yearly by an Average Member of US Populace (2, p 212)

SOURCE	Dose Equivalent, in mrems
Natural background	100-150
Medical & dental tests & treatment	20-100
Fallout from nuclear bomb tests, nuclear power plants & accidents	1-5
Other (radioactive pollutants, TV, smoke detectors)	3-5
TOTAL	124-260



KEY: 1: F IIIA-8: effects of ionic radiation on water
2: CF IIIA-4: importance of electrons in production of **ATP**
3: CP IIIA-2: pathophys of **CS**
4: CF IIIA-5: lysosomal rupturing
5: S III.C: neoplasia
6: CFIIIA-1: **DNA** –> **RNA** –> protein
7: P IIIB-1: chromosome breakage

HWA

Critical Path IIIA-12. Pathophysiology of Injury from Ionizing Radiation (1, several pages; 2, several pages)