

6. Estimates

\* note: please add in the statistics from lecture as these numbers are constantly being revised

	<u>Worldwide</u>	<u>Americas (N/S)</u>	<u>United States</u>
<b>HIV-Ab<sup>+</sup></b>			
<b>AIDS</b>			
<b>Deaths</b>			

- number of HIV-Ab+ cases by region:

- a. Sub-Saharan Africa
- b. Latin America
- c. North America
- d. Europe

7. Signs and symptoms of AIDS

- AIDS Related Complex (ARC)

- precursor to full-blown AIDS
- ARC has fewer criteria that need to be met than AIDS
- 99% of people with ARC → AIDS → death
  - this is the assumption

\* note: today, we generally speak of seropositivity and full-blown AIDS

- *immunocompromised* = ↓↓ immune system

- seen as a reduction in CD4 cells
- leads to various *opportunistic infections*

a. decreased number of CD4 cells

- e.g. 800  $\mu$ L → 200  $\mu$ L
- major criterion

b. Kaposi's sarcoma (KS)

- cancerous condition of muscle and tissues underlying the skin
- may be one of few virally induced cancers
- also seen with transplant patients
- seen more in males
- major criterion

c. pneumocystis carinii

- pathogen causes pneumonia
- seen more in females
- major criterion

d. mouth sores

e. thrush

- yeast infection of the throat and mouth

f. colds / flu-like symptoms

g. night sweats

h. febrile conditions (fevers)

- i. dramatic weight loss
  - due to protein wasting
  - 10-20% of normal body weight
- j. generalized muscle weakness / listlessness
- k. recurrent pneumonia
- l. invasive cervical cancer

## 8. Demographics

- affected individuals usually fall into 1 of 4 categories:

- a. IV drug users / abusers
  - needle sharing
- b. hemophiliacs
  - missing or nonfunctional clotting factors (VIII and/or IX)
  - ↑↑ blood needs to be purified to get adequate amounts of clotting factors
    - e.g. equivalent of 2,000 units of blood/instance
  - heat will kill the AIDS virus, but it will also inactivate the clotting factors
  - in 1985 a purification technique that killed the AIDS virus was discovered
    - people that received clotting factors purified prior to 1985 are at risk
  - of the 20,000 hemophiliacs in the U.S., 50% are HIV-Ab<sup>+</sup>
    - \* note: it's estimated that there is a 90% chance of getting HIV from tainted blood
- c. promiscuous individuals
  - homosexual population in the United States was hit hardest by HIV-I
    - probably due to ↑↑ promiscuity within the community at that time
    - the number of new cases has dropped dramatically -- on the rise again
  - heterosexual population in Sub-Saharan Africa was hit hardest by HIV-II
    - mainly because of:
      1. unsterile medical conditions (reused needles, etc.)
      2. heterosexual promiscuity
  - rate of infection varies:
    - vaginal intercourse 0.1% (estimated)
    - receptive anal intercourse 0.3% (estimated)
- d. infants born of AIDS mothers
  - virus can be transmitted through the placenta to the developing fetus
    - 30% chance of transmission to developing fetus
    - <8% with early AZT
  - dramatic increase in the last few years
  - dormancy is 1/2 of adults

\* note: HIV is carried in the following body fluids

- blood
- vaginal secretions
- semen
- saliva
  - no documented case of transmission via saliva, however
- breast milk

## 9. Geographic Distribution

- a. Western Hemisphere and Europe
  - primarily males are affected (60-70%)
  - HIV-I primarily
  - \* note: number of cases among women is rising (40% worldwide)
- b. Sub-Saharan Africa
  - Zaire, Uganda, etc.
  - HIV-II primarily
  - developed in heterosexual community
  - needle re-use is a factor
  - ratios of infected males to females is 1:1
- c. Eastern Europe, China, Japan, Russia
  - HIV-I primarily
  - much lower incidence than the West
  - on rise in Eastern Europe and Russia
  - \* note: China and Japan
    - won't allow HIV-Ab<sup>+</sup> people into the country
    - higher rate of condom usage

## 10. Origin of AIDS -- Theories

- simian immunodeficiency virus-I (SIV-I)
  - similar to HIV-II
  - African green monkey can have the virus and show no effects
  - theories:
    - a. maybe two different viruses co-mutated
    - b. maybe a green monkey bit someone and caused AIDS in humans
- first cases reported in 1979
  - first published report on AIDS in 1981 (Science)
- patient "Zero"
  - showed many symptoms similar to full-blown AIDS
  - this man died in 1969
  - tests from his blood samples looked quite similar to HIV-I
- now say that it may have arisen over 100 years ago in rural Africa
  - modernization allowed it to spread more easily to urban areas
- \* note: these are only theories

## 11. Treatment

- a. AZT
  - inhibits *reverse transcriptase* enzyme
    - recall, AIDS is a *retrovirus* (genetic makeup is RNA)
    - it allows RNA → DNA
  - AZT looks very similar to some of the bases that make up DNA
    - enzyme can't tell difference between the two
    - attempts to use AZT molecules to make DNA
    - DNA won't function properly
    - virus can't further replicate
  - will extend an individual's life span (if given during a specific time)
    - possibly only by months
    - side effects may not enhance quality of life

- b. DDI, DDC, D4T
  - these also work by inhibiting reverse transcriptase
- c. protease inhibitors
  - *protease* = enzyme that breaks apart protein
  - inhibit viral replication
  - recently FDA approved
- d. anti-serum
  - hope that it will someday become an AIDS vaccine

## 12. Preventions

- a. abstinence
- b. monogamous relationship with an uninfected partner
- c. education
- \* condoms
  - latex condoms impair about 99% of transmission of HIV and other STDs
  - lamb-skin condoms are membranes
    - they have pores and are not effective in impeding HIV transmission
  - \* note: they **will not prevent** HIV transmission

## Thrombocytes -- a closer look

- See *text p. 595-596*
- Also called *platelets*
- Produce a *thrombus* (blood clot)
- 1. Cascade for blood clot formation
  - 13 factors involved in clotting
  - calcium is important in many of the steps
  - a. thromboplastins
    - produced by tissues and thrombocytes
    - released in response to tissue trauma
      - e.g. cuts (extrinsic) or plaque build-up within vessels (intrinsic)
    - inactive initially, become activated
  - b. prothrombin
    - inactive form
    - converted to thrombin via activated thromboplastins
  - c. thrombin
    - active form
    - this is an enzyme
    - catalyzes conversion of fibrinogen to fibrin
  - d. fibrinogen
    - soluble protein in bloodstream
  - e. fibrin
    - insoluble protein
    - this is cleaved off of fibrinogen
    - enmeshes blood cells
    - allows formation of fibrin clot to occur
  - f. fibrin clot
    - \* note: *fibrinolysins* break up the clot when it is no longer needed

2. Hemophilia
  - this is a genetic blood disease
  - sex-linked
    - carried on the X chromosome
    - typically expressed in men
  - won't allow blood to clot normally
    - e.g. person can bleed to death from a cut
  - a. hemophilia A
    - also called "classic hemophilia"
    - deficiency or absence of factor VIII
  - b. hemophilia B
    - also called "Christmas disease"
    - first described in a boy whose last name was Christmas
    - deficiency or absence of factor IX
3. Inhibiting / breaking up clots
  - a. heparin
    - prevents clot formation
    - anti-coagulant
    - works by inhibiting factor IX and anti-thrombin III
  - b. streptokinase
    - breaks up an already-formed clot
    - systemic effects
      - not localized -- acts throughout the body
  - c. tissue plasminogen activator (TPA)
    - breaks up an already-formed clot
    - more localized effects -- stays within area of injection
  - d. coumadin
    - also called "coumarin" or "warfarin"
    - inhibits clot formation
      - inhibits activity of vitamin K
    - used in hospitals to inhibit clotting
    - originally used as a rat poison
    - caused internal bleeding
4. Terms
  - "*pro-*" = inactive molecule or enzyme
  - "*-ogen*" = inactive molecule or enzyme
  - *fibrinolysins* = break apart clots
  - *plasma* = whole blood minus cellular elements
  - *serum* = plasma minus the clotting factors
  - *thrombus* = stationary blood clot
  - *embolus* = wandering blood clot
  - *thrombo-embolic phenomena* = person genetically prone to clotting would show these
  - *antigen* = large molecule that elicits an immune response
  - *antibody* = produced by lymphocytes in response to an antigen

## Blood Typing Systems

- See *text p. 603-605*

### 1. ABO system inheritance

- sometimes referred to as “triple allelism”

Blood Type	Antigen (on RBC)	Antibody (in serum)
O (44% of pop.)	--	anti-A, anti-B (universal donor is O)
A (42% of pop.)	A	anti-B
B (10% of pop.)	B	anti-A
AB (4% of pop.)	A and B	-- (universal recipient)

#### a. hospital blood

- type O supplies about 12% of available blood
  - only 7% of population has this blood type
- screened for ↓↓ *titers* of A and B antibodies
  - chance of a transfusion reaction is much less likely

#### b. transfusion reaction

- hemolysis of RBCs
- seen in an individual receiving blood containing antibodies to own antigens
  - e.g. recipient is type A, donor is type B
- febrile response in mild cases
- death in severe cases

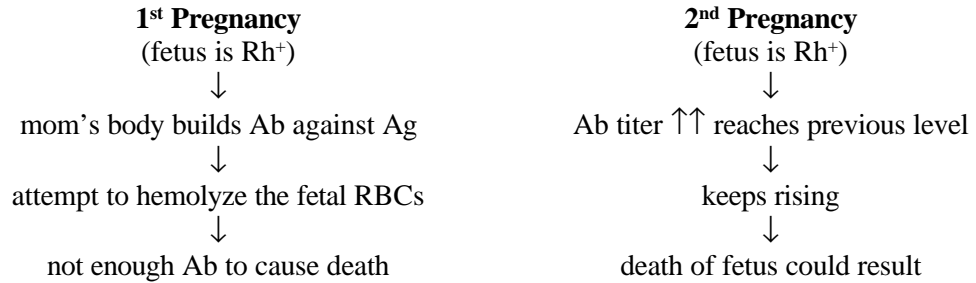
#### c. genetics involved

- heterozygous
  - 2 alleles code for different antigens
  - about 75% of population is heterozygous for the ABO system
    - e.g.  $I^A i$
  - example of cross between two heterozygotes:
 

$I^A i \times I^B i =$	$1/4 I^A I^B$	AB -- called <i>co-dominance</i>
	$1/4 I^A i$	A
	$1/4 I^B i$	B
	$1/4 ii$	O -- must be <u>homozygous</u> recessive to be this blood type
- homozygous
  - 2 alleles code for like antigen

### 2. Rh system

- first found in Rhesus monkeys
- particular antigen (protein) present on the surface of RBC
  - $Rh^+$  = Rh factor is present in 85% of U.S. population
  - $Rh^-$  = factor is absent in 15% (U.S.)
- *erythroblastosis fetalis*
  - also known as “hemolytic disease of the newborn” and “jaundice of the newborn”
  - occurs when mom is  $Rh^-$  and fetus is  $Rh^+$



- “recollection” phenomenon
  - cells have a memory capacity
  - if a foreign antigen is seen again, body responds and produces antibodies rapidly
  - e.g. injection with vaccine
    - body's reaction is very swift
- Rhogam treatment
  - anti-Rh antiserum
  - injected shortly after the birth of the first child
  - antibodies against the Rh factor
  - desensitizes mom's immune system

## Heart

- See *text p. 614-645*
- Found between 2<sup>nd</sup> rib and 5<sup>th</sup> intercostal space
- If a midsagittal cut is made
  - 2/3 heart lies left of the midline
- *Anatomical axis*
  - angle (vector) of how the heart is oriented in the thoracic cavity
  - 45 ° from midsagittal cut
- *Electrical axis*
  - summation of vectors of electrical activity through heart
  - typically 59 °
  - often will follow the anatomical axis
- 1. Structure
  - a. base of heart
    - site of great vessel attachment
  - b. apex
    - hangs relatively free
  - c. size
    - of adult fist

## 2. Coverings:

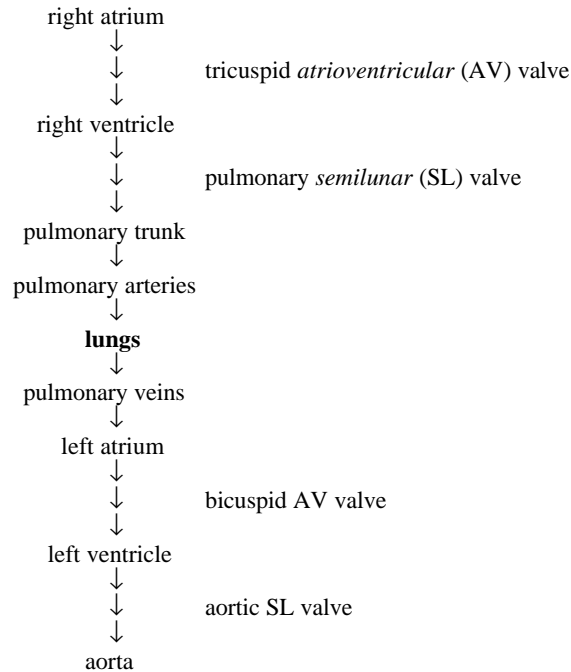
- a. pericardial sac
  - sac around the heart
    - pericardial fluid inside of sac -- ↓ friction on the heart while beating
  - 1. parietal pericardium
    - outer component
    - touches the chest cavity
  - 2. visceral pericardium
    - inner component
    - touches the surface of the heart
    - also known as the *epicardium* = on top of the heart
- b. myocardium
  - musculature of the heart
  - majority of the heart is this
  - thicker in the ventricles than in the atria
- c. endocardium
  - inner aspect
  - in contact with blood
    - involved with blood flow
  - *trabeculae carneae*
    - invaginations / evaginations of myometrium
    - ↑ surface area
    - changes flow dynamics of blood
  - *endocarditis* = inflammation of the endocardium
    - may be due to bacterial infection, viral infection, etc.

## 3. Chambers and valves:

- a. left and right *atria*
  - *atrium* = sing.
  - *tricuspid* valve
    - located on the right side
    - *chordae tendinae* and *papillary muscles*
      - hold down “flaps” of the valve
      - prevent *prolapse* of the valves
  - ↓ myocardium than ventricles (thinner walls)
  - smaller, upper chambers
  - less pressure (<20 mmHg)
- b. left and right *ventricles*
  - high pressure chambers
  - *bicuspid* valve
    - also called the “mitral” valve
    - located on the left side
  - myocardium thickest on the left side
  - left ventricular pressure as high as 120 mmHg
  - right ventricular pressure as high as 30 mmHg

## Blood Flow

- See *text p. 627, 660* and *figure 20.1, 20.8, 21.7 and 21.8*
- Deoxygenated blood from body tissue travels toward heart via:
  1. Inferior vena cava
    - blood comes from body regions below the heart
  2. Superior vena cava
    - blood comes from body regions above the heart
- \* Note: there are no valves within vena cavae -- blood has constant flow into the right atrium
- Sequence of blood flow through the heart:



- Coronary arteries
  - ventral side
  - come directly off of aorta just above the aortic SL valve
  - blood supply to the myocardium
  - can become blocked by atherosclerotic plaques
    - heart by-pass surgery (as many as 7 by-passes)
- Coronary sinus
  - dorsal side
  - expanded, venous type vessel
  - drains blood from heart into the rt. atrium

## Valvular Disease States

- See *text p. 647*

1. Mitral regurgitation
  - problem with the bicuspid AV valve (also called the “mitral valve”)
  - insufficient or leaky valve
  - may see this with people that have had rheumatic fever
  - may need to replace the valve
2. Mitral stenosis
  - *stenosis* = physical narrowing
  - could be due to scar tissue or plaque build-up
  - can result in *hypertension*
3. Aortic or pulmonary artery stenosis
  - physical narrowing of either of these two major vessels

## Excitation and Conduction System of the Heart

- See *text p. 627-631* and *figure 20.11*

- Electrical events always precede mechanical events in the heart

1. Sinoatrial (SA) node
    - located near juncture of superior vena cava with rt. atrium
    - spontaneously depolarize -- self excitatory
    - pace-maker of the heart
      - intrinsic; will beat without any extrinsic influence
      - extrinsic influences include nervous input (SNS, PSNS)
    - generate wave of depolarization
      - wave of depolarization also goes to left atrium (via Bachman’s bundle) and to AV node
  2. Atrioventricular (AV) node
    - located near AV valve on right side of the heart
    - *AV nodal delay*
      - very brief pause in the wave of depolarization
      - allows the two atria to depolarize together and contract together before wave continues
  3. AV bundle
    - also known as the “Bundle of His”
  4. Right and left bundle branches
    - physically located on either side of the *interventricular septum*
      - interventricular septum separates oxygenated blood from deoxygenated blood
  5. Purkinje fiber network
    - goes through entire ventricular musculature of the heart
    - ventricles can now contract and eject blood (to the body/lungs)
- Summary of above:

