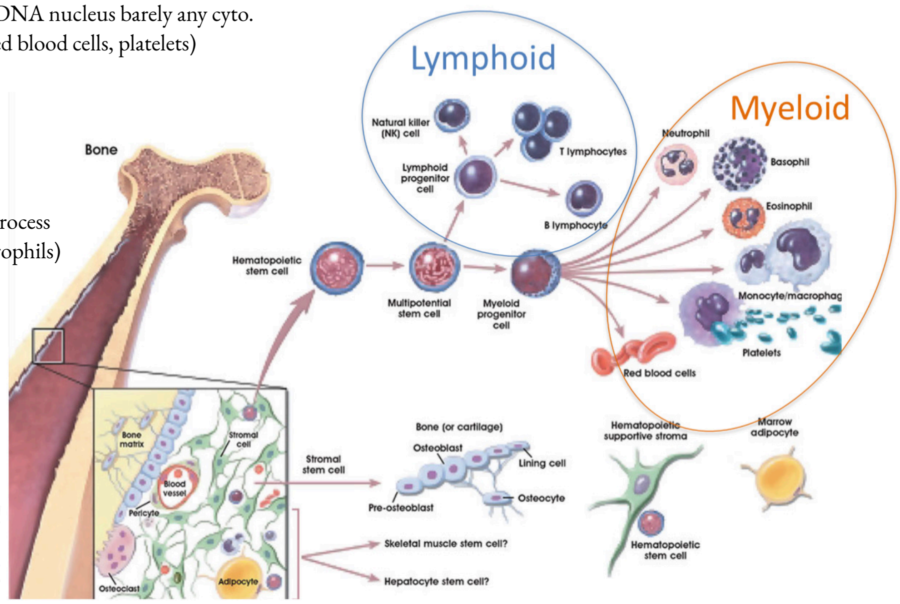
The cells that make up the Immune System

Leukocytes(WBC)

- lymphoid cells(T/B lymphocytes, NK cells) —lymphocytes almost all DNA nucleus barely any cyto.
- myeloid cells(monocytes, macrophages, granulocytes, precursors for red blood cells, platelets)

Myeloid cells

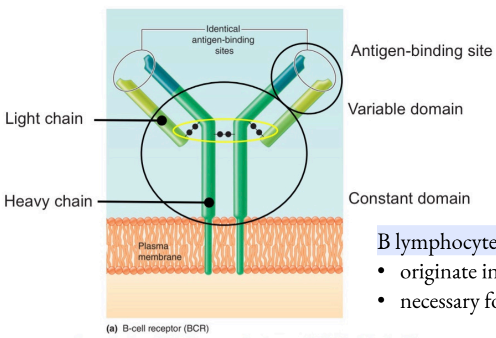
- monocytes—blood macrophages
- Granulocytes(neutrophils and eosinophils)
  - filled with granules that contain toxins—first line of defense
  - ingest microorganisms and release enzymes to kill them
    - release granules to kill pathogen but they themselves die in the process
    - dispensable and contain local infections(pimple pus=dead neutrophils)



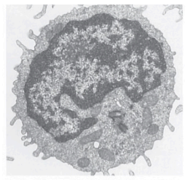
Hematopoietic Stem cell—> Multipotential stem cell—> myeloid or lymphoid progenitor cells

*if someone is getting a transplant they can get an injection of Hematopoietic stem cells in circulation this will travel to bone marrow and help build an entire new immune system

- hollow bone is living tissue filled w/ capillaries, blood vessels, + stromal cells which nurture stem cells



(a) B-cell receptor (BCR)



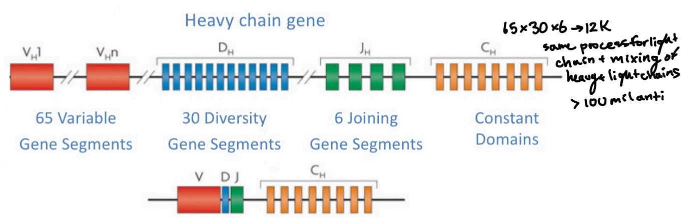
(a) Unactivated B cell

B lymphocytes

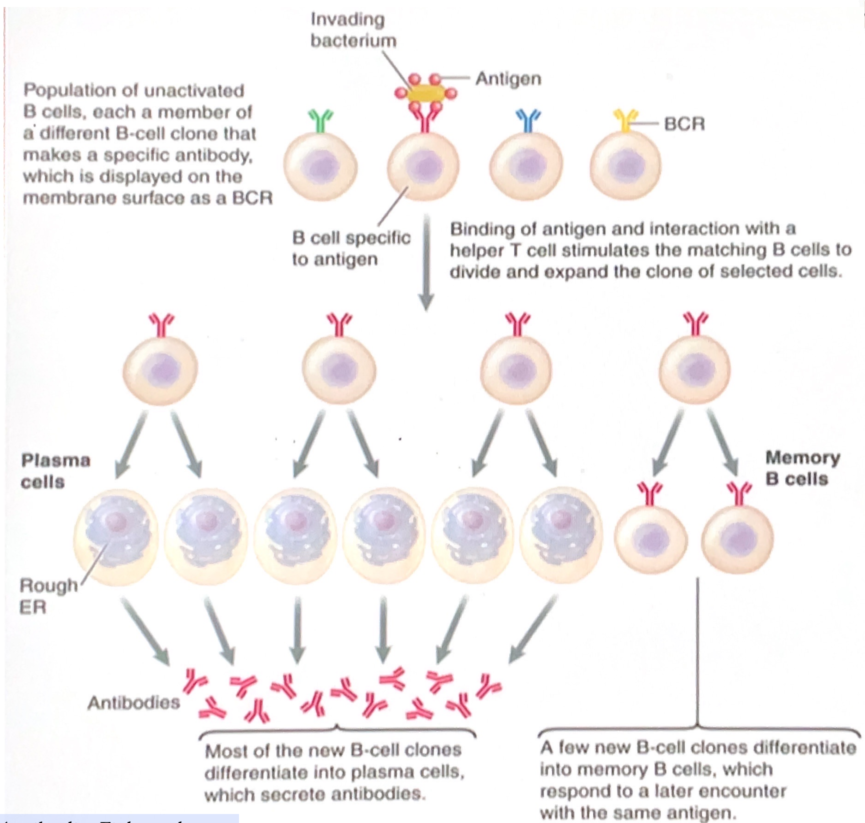
- originate in Bursa of Fabricius(+bone marrow)
- necessary for humoral immunity

B cell receptors are antibodies

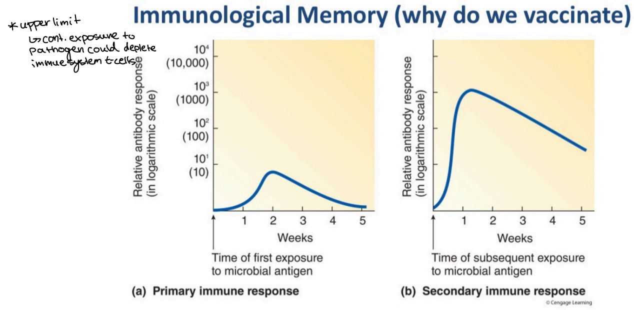
- 2 heavy, 2 light chains, linked by disulfide bonds
- constant domain determines antibody properties
- tip of variable domain provides the antigen binding site
- each B cell only makes 1 kind of antibody—unique + highly specific



- random comb of light +heavy chains+ segments >100mill possible antibodies
- negative selection—B cells killed off in bone marrow that make antibodies that recognize our own body



Immunological Memory (why do we vaccinate)

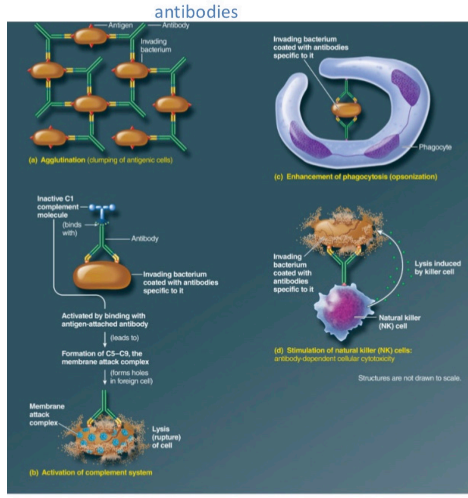


Primary Antibody Response
-in response to first antigen exposure
-takes a few weeks
-moderate concentration of low – medium-strength antibodies

Secondary Antibody Response
-in response to subsequent antigen exposure
-takes a few days
-high concentration of high-strength antibodies

Antibodies Fight pathogens:

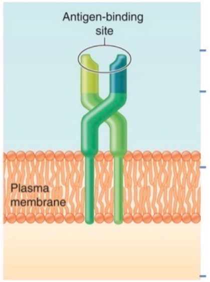
1) Agglutination—2 binding sites allow antibody complexes which can get so large that they ppt out, essentially neutralizing the pathogen
2) Activation of Complement Pathway
   - Cascade of biochemical responses that ends with the formation of the membrane attack complex (kills pathogens)
   - invading bacterium coated with antibodies—> membrane attack complex(forms hole in foreign cell)—> cell lysis
3) Opsonization(Coating of surface pathogens with antibodies), initiating phagocytosis
4) Activation of NK cells



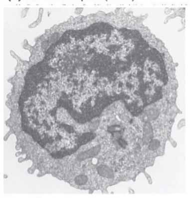
Macrophages—scavenge tissue in sera h of pathogens, dead cells, and other debris, sometime stake up life long residence in cells

Granulocytes— phagocytic cell that releases the content of their granula as part of specific immune response(against large extra cellular parasites)

- neutrophils, eosinophils,basophilic, mast cell(trigged by histamine, cause allergies + asthma)



(b) T-cell receptor (TCR)

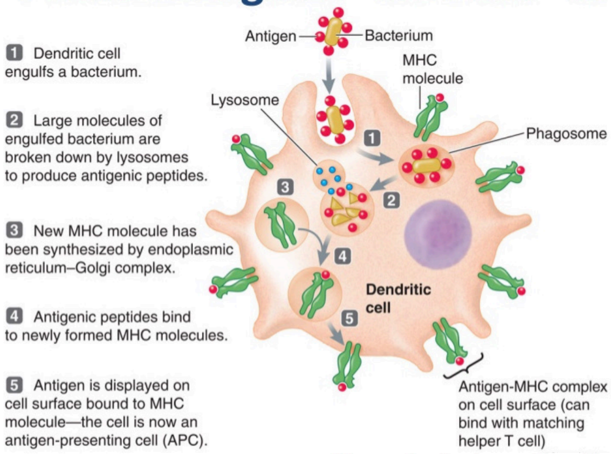

T cell

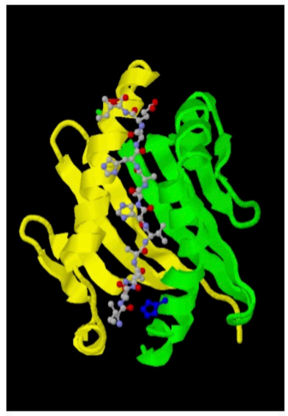
*MHC genes - highly variable b/t indiv; when looking for organ donor we want a similar MHC gene as the transplant recipient

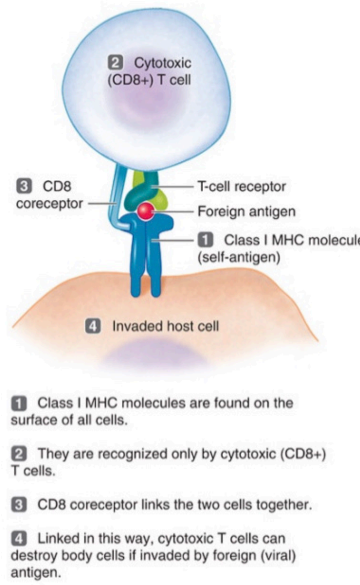
T Lymphocytes

- bone marrow—> thymus—>T cells
- dimer of 2 TCR
    - 2 major subtypes; Helper T+ Cytotoxic T cells

T cells recognize 'non-self' in the context of 'self'







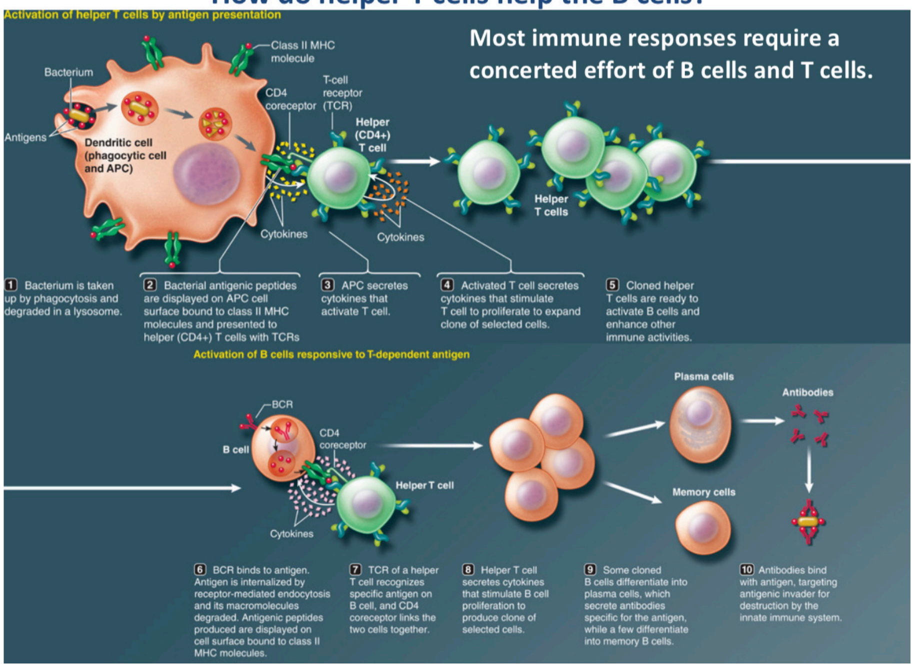
Cytotoxic T Cells

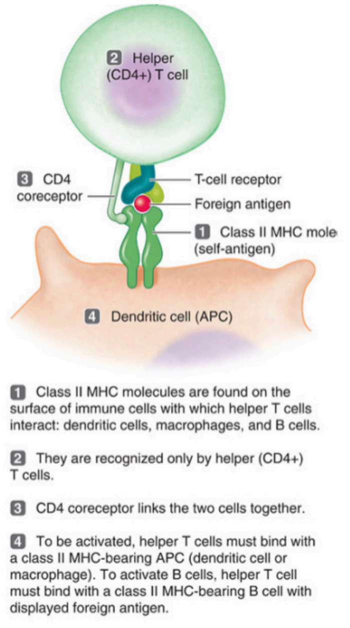
- recognize cell infected by a virus +kill infected cell
- all cells express MHC class I
- MHC-I +peptide w/ CD8 co-receptor recognized by TCR on Cytotoxic T cells
- release toxic mole next to host cell killing it and moves onto next cell

Helper T cells

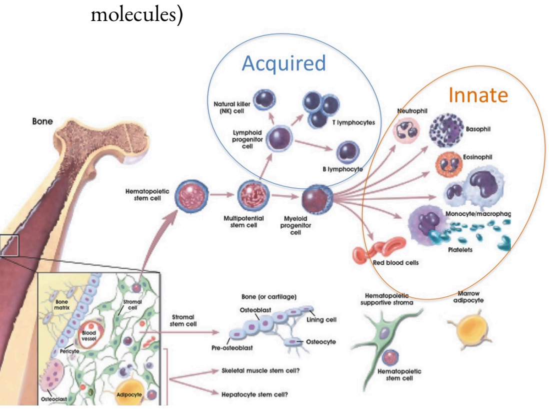
- specific antigen presenting cells express MHC class II
- MHC II + peptide along with CD4 co-receptor
- helper T cell releases cytokines—> promotes cell proliferation of activated B cells
    - co-stimulation/ growth factors—> clonal expansion
    - helps in antibody mediated humoral response
    - cytokines(soluble signaling molecules)

How do helper T cells help the B cells?





(b) Class II MHC self-antigens



Multiple layers of control—complicated arrangement ensures that we don't typically activate our immune response unless we have to

<— image is not perfect
NK cells are Innate but lymphoid in lineage
Big picture overview

- T Cells and B cells are part of our acquired immune response
- whereas macrophages and granulocytes are part of our innate immune response

Innate Immunity

- innate immune cells are really efficient APCs
- w/o antigen presentation, there will be no acquired immune response
- very capable of scavenging our bodies for anything damaging(foreign or self) and clean up
- provides much faster local response(inflammation) to a a threat(damage or pathogen). usually takes care of threat + promotes tissue repair

PAMPs or Danger Signals—broadly flag innate immune system that something is wrong + requires immune response

- lipopolysaccharide(gram negative bacteria)
- unmethylated DNA(virus)
- heat shock proteins(self), normally would never occur outside of cell, sign of cell death/damage

- genetic mutations in signaling pathway of PAMPs or danger signals—> susceptibility to severe recurrent viral and bacterial infections
- over active innate immune response—> auto-inflammatory diseases related to excess strength of signals that promote inflammation

Disorder of Acquired Immunity—Severe Combined immune deficiency

- rare mutation that affects ability to carry out VDJ recombination; no BCR and TCRs can be made—> absence of acquired immune system
- HIV—infects and kills CD4+ helper T cells—> lack of B and cytotoxic T activation