Unit 5 - Session 1

SLO 1-2: Elements of Immune system

The immune system consists of a range of components, including:

- white blood cells (leukocytes)
- the spleen
- the bone marrow
- the lymphatic system
- the thymus
- the tonsils, adenoids, and appendix

White blood cells circulate in the blood and lymphatic vessels.
The lymphatic system forms a network similar to the blood vessels. It carries a substance called lymph instead of blood. Lymph is a fluid that carries immune-related cells to areas that need them.
White blood cells are constantly looking for pathogens. When they find one, they begin to multiply and send signals to other cell types to do the same.
The body stores white blood cells in different places, known as lymphoid organs.
These include:

- **The thymus:** A gland behind the breastbone, where white blood cells known as lymphocytes mature.
- **The spleen:** An organ at the upper left of the abdomen where immune cells gather and work.
- **Bone marrow:** Soft tissue in the center of the bones that produces red and white blood cells.
- **Lymph nodes:** These are small, bean-shaped glands throughout the body, especially in the neck, underarms, groin, and abdomen. They link via lymphatic vessels. Immune cells gather in lymph nodes and react when antigens are present. This can lead to swelling.
- **The tonsils, adenoids, and appendix:** These are gateways for pathogens to enter the body, so lymphoid tissue is also there.

How an immune response works

The immune system needs to be able to distinguish healthy from unhealthy cells and tissue to work effectively. It does this by recognizing signals called DAMPS — danger-associated molecular patterns.
Cell damage may be present for many reasons, including:

- infectious agents, such as bacteria or viruses
- toxins, such as a bite or sting
- noninfectious physical damage, for instance, a burn
- a genetic problem within cells, as happens with cancer

An antigen is any substance that can spark an immune response.
In many cases, an antigen is a bacterium, fungus, virus, toxin, or foreign body. But it can also be a cell that is faulty or dead.
The immune system detects pathogen-associated molecular patterns — PAMPs — in the antigen. In this way, various parts of the system recognize the antigen as an invader and launch an attack.
What is an antigen test?

Types of white blood cells

There are two main types of leukocytes, or white blood cells:

1. Phagocytes

These cells surround and absorb pathogens and break them down, effectively eating them.

There are several types, including:

- **Neutrophils:** These are also known as granulocytes and provide an early response to inflammation. They kill pathogens but also die as a result.
- **Macrophages:** These clean up after a response. They remove pathogens, dead neutrophils, and other debris.
- **Dendritic cells:** These activate the immune response and help engulf microbes and other invaders.
- **Monocytes:** These can differentiate into dendritic cells and macrophages, as needed.
- **Mast cells:** These trigger an immune response when they detect an antigen.

2. Lymphocytes

Lymphocytes help the body remember previous invaders and recognize them if they return to attack again.
Lymphocytes begin their life in bone marrow. Some stay in the marrow and develop into B lymphocytes (B cells); others travel to the thymus and become T lymphocytes (T cells). These two cell types have different roles.
B lymphocytes produce antibodies and help alert the T lymphocytes. T lymphocytes destroy compromised cells in the body and help to alert other leukocytes.
Natural killer (NK) cells are also lymphocytes. NK cells recognize and destroy cells that contain a virus.

The role of B lymphocytes

Once B lymphocytes spot the antigen (antibody generators), they begin secreting antibodies. Antibodies are special proteins that lock on to specific antigens.
Each B cell makes one specific antibody. For instance, one might make an antibody against the bacteria that cause pneumonia, and another might recognize the common cold virus.
Antibodies are part of a large family of chemicals called immunoglobulins, which play many roles in the immune response:

- Immunoglobulin G (IgG) marks microbes so other cells can recognize and deal with them
- IgM specializes in killing bacteria
- IgA congregates in fluids, such as tears and saliva, where it protects gateways into the body
- IgE protects against parasites and plays a role in allergies
- IgD stays bound to B lymphocytes, helping them start the immune response

Antibodies lock on to the antigen but do not kill it — they only mark it for death. The killing is the job of other cells, such as phagocytes.

The role of T lymphocytes

There are distinct types of T lymphocytes, or T cells.
Helper T cells (Th cells) coordinate the immune response. Some communicate with other cells, and some stimulate B cells to produce more antibodies. Others attract more T cells or cell-eating phagocytes.
Killer T cells (cytotoxic T lymphocytes) attack other cells. They are particularly useful for fighting viruses. They work by recognizing small parts of the virus on the outside of infected cells and destroying the infected cells.

The role of natural killer cells

Also a type of lymphocyte, these contain granules with powerful chemicals. They are useful for attacking many types of unwanted cells.

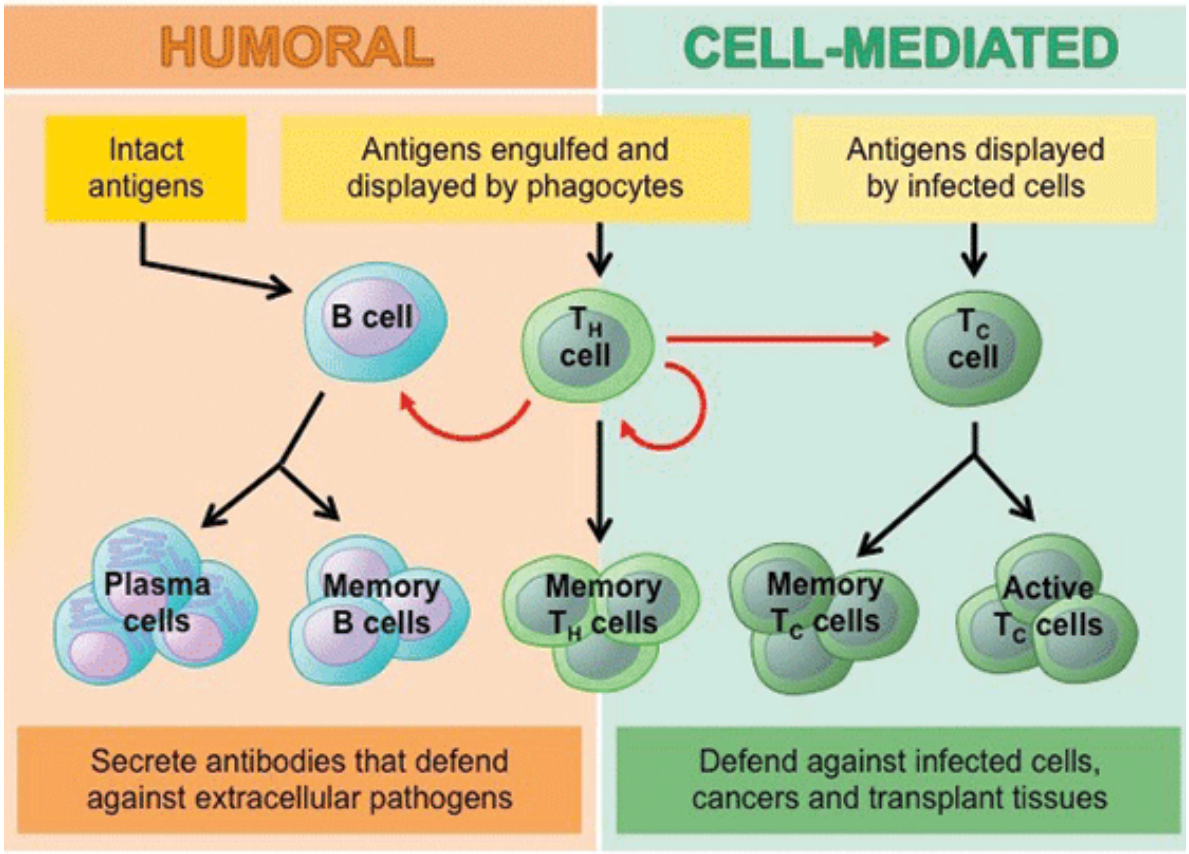
Unit 5 - Session 2

SLO 1-2: Humoral immunity

When foreign material - antigens - is recognized in the body, the body responds with an antibody-mediated reaction. Extracellular intruders, such as bacteria, are commonly found in this foreign material. B cell lymphocytes, a type of immune cell that makes antibodies after detecting a specific antigen, are principally responsible for this method.

Lymphocytes known as naive B cells circulate throughout the body via the lymphatic system. These cells produce antigen-specific molecules that are necessary for detecting infectious pathogens in the human body. When naive B cells in the lymphatic system come into contact with an antigen, they begin the differentiation process that results in the formation of memory B cells and effector B cells.

Memory B cells and effector B cells produce the same antigen-specific molecules as their parent naive B cell during this development. The activated memory B cells express these antigen-specific molecules on their surface with the help of T cell lymphocytes, which are activated by MHC class II receptors that recognize microbial-associated antigens. The effector B cells secrete these molecules in the blood to bind the antigen of interest.



Unit 5 - Session 3

SLO 1-2: Cell mediated immunity

Cell-mediated immunity, unlike humoral immunity, does not rely on antibodies to perform adaptive immunological activities. Mature T cells, macrophages, and the production of cytokines in response to an antigen are the main drivers of cell-mediated immunity.

To recognize intracellular target antigens, T cells that participate in cell-mediated immunity rely on antigen-presenting cells that have membrane-bound MHC class I proteins. The maturation and differentiation of naive T cells into helper or killer T cells are dependent on the binding specificity of MHC proteins to external antigens.

Transient cell-in-cell formation by tumor cells found to build resistance to immunotherapy

What is the impact of monkeypox infection on the hemostatic system?

Researchers explore single-cell sequencing technologies to understand molecular mechanisms of autoimmune diseases
Cell-mediated immunity is activated when cells in the body are infected by a virus, bacterium, or fungus (intracellular invaders). T lymphocytes can detect malignant cells with the help of MHC class I proteins. Helper T cells, killer T cells, and macrophages are the three main kinds of lymphocytes involved in cell-mediated immunity.

When a "helper" T cell encounters an antigen-presenting cell in the body, it releases cytokines, which are signaling proteins. These cytokines cause "killer" T lymphocytes and macrophages to flock to the antigen-presenting cell in an attempt to eliminate it.

Unit 5 – Session 4

SLO 1-2: Active and Passive Immunity

Immunity involves physiological mechanisms enabling the body to identify foreign materials and eliminate, and metabolize them without necessarily causing any harm to its own tissues, thus preventing any further infection/harm caused by the foreign substances. The first line of defence in the human body against pathogens is through barriers such as the skin, mucus layers, and saliva. This is known as innate immunity. The second line of defence is through phagocytes; this is again produced by innate immunity. The third line of defence is through adaptive immunity.

Active immunity and passive immunity are two types of acquired immunity. A prominent difference between active and passive immunity is that active immunity is developed due to the production of antibodies in one's own body, while passive immunity is developed by antibodies that are produced outside and then introduced into the body. In this article, let us look at more differences between active and passive immunity.

Active Immunity and Passive Immunity- Differences

The following are the important differences between active and passive immunity:

Active Immunity	**Passive Immunity**
Active immunity is usually long-lasting, sometimes life-long. It is produced by the antibodies of the host in response to direct contact with an antigen	Passive immunity lasts only for a few weeks or months. It is produced by the introduction of antibodies from outside into the host
It produces an immunological memory	It does not produce immunological memory
When the antigens enter the body, antibodies and other specialised lymphocytes are produced	Antibodies are introduced from an external source. For instance, a mother introduces antibodies to a fetus through the placenta and to an infant via mother's milk.
There are no side-effects	It may cause reactions
Immunity does not occur immediately	Immunity develops immediately

Unit 5 - Session 5
SLO 1-2: Immunoinformatics

1. Databases

Immunoglobulins (or Antibodies) (IG)

- IMGT/LIGM-DB, *a comprehensive database of germline and rearranged immunoglobulin and T cell receptor genes from human and other vertebrates, with translation for fully annotated sequences,* LIGM, CNRS, Université Montpellier 2, Montpellier, France.
- IMGT/3Dstructure-DB, *IMGT gene and allele identification and Collier de Perles of PDB structural data.*
- IMGT/PRIMER-DB
- Kabat database, *sequences of Proteins of Immunological Interest,* Rel.15.0, contains 5th edition April 1991 (ftp).
- ExactAntigen, Labome VAD Validated antibody database for search of commercial, academic, and therapeutical monoclonal antibodies.

T cell receptors (TR)

- IMGT/LIGM-DB, *a comprehensive database of germline and rearranged immunoglobulin and T cell receptor genes from human and other vertebrates, with translation for fully annotated sequences,* LIGM, CNRS, Université Montpellier 2, Montpellier, France.
- IMGT/3Dstructure-DB, *IMGT gene and allele identification and Collier de Perles of PDB structural data.*
- IMGT/PRIMER-DB
- Kabat database, *sequences of Proteins of Immunological Interest,* available only by paid subscription.

Major histocompatibility (MH)

- Bovine Leucocyte Antigens (BoLA) Nomenclature Committee Web Site
- Complete Human MHC Sequence at the Sanger Centre, UK
- HLA Database, at Cancer Vaccine Center. The data used in this database has been drawn from the IMGT/HLA database.
- IMGT/3Dstructure-DB, *IMGT gene and allele identification of structural data, IMGT Collier de Perles, IMGT reference pMHC contact sites, TR/pMHC interactions*
- IMGT/MH-DB, at EBI, UK, which comprises sequence databases of human MH or HLA (IMGT/MH-HLA), MH from non human primates (IMGT/MH-NHP), canines and felines (IMGT/MH-DLA) and felines (IMGT/MH-FLA). NAR 2003

Antigens

Peptides binding to MH

- AntiJen, an extension of JenPep, *a database of quantitative binding data for peptide binding molecules, immunological protein-protein interactions and peptide libraries.*
- EPIMHC, a curated database of MH ligands
- EpiPox Database, at Cancer Vaccine Center. The data used in this database has been drawn from the Poxvirus Bioinformatics Resource Center database
- JenPep, Peptide Binding Database, *a database containing quantitative binding data for peptides binding to MH1, MH2 and TAP molecules. JenPep also contains a T cell epitope and B cell epitope database. All entries are from published experimentally determined data.*
- MHCBN, *a database of MH binding and non-binding peptides and T cell epitopes.*
- SiPeP (SNPs in Peptides/Proteins), a database of nonsynonymous coding SNPs (Single Nucleotide Polymorphisms) obtained from dbSNP, with matrix and molecular dynamic scoring data for binding of these peptides with available MH alleles.
- SNPBinder, a database of predicted minor histocompatibility antigens (mHAgs) and antigenic peptides.

- SYFPEITHI, *a database of MH ligands and peptide motifs. For MH ligands, only contains peptides that have been eluted from MH and sequenced by Edman degradation or mass spectrometry.*

Antigens eliciting an antibody response

- AntiJen, an extension of JenPep, *a database of quantitative binding data for peptide binding molecules, immunological protein-protein interactions and peptide libraries.*
- Bcipep, *a database of immunant dominant B cell epitopes.*
- CIDB, Cancer Immunome Database, *repertoire of antigens eliciting an antibody response in cancer patients (CIDB is an updated version of SEREX), the serological identification of antigens by recombinant expression cloning (need registration).*
- JenPep, Peptide Binding Database, *a database containing quantitative binding data for peptides binding to MH1 and MH2 and TAP molecules. JenPep also contains a T cell epitope and B cell epitope database. All entries are from published experimentally determined data.*
- Platelet glycoprotein antigens (human)

Allergens

- ALLERDB
- Allergen Nomenclature, International Union of Immunological Societies (IUIS). Allergen Nomenclature Sub-Committee
- Farrp Allergen Database (needs registration)
- Food Allergen Sequences. The Biotechnology Information for Food Safety (BIFS) Database.
- InformAll Database. Communicating about Food Allergies. Contains data from previous Protall Database, *food allergens of plant origin*
- Nomenclature and index of allergen sequences, Swiss-Prot
- SDAP, Structural Database of Allergenic Proteins
- The Allergen Database (adb) at CSL, *allergen epitopes* (needs registration)

Epitopes

- Epitome, a database of structure-inferred antigenic residues in antigen/antibody complex structure
- CED, a conformational epitope database
- IEDB, The Immune Epitope Database and Analysis Resource

Haptens

- HaptenDB, a database of haptens, carrier proteins and anti-hapten antibodies

KIR

- KIR database

Peptides with antimicrobial activity or antibiotic peptides

- AMSDb, Antimicrobial Sequences Database
- APD: the Antimicrobial Peptide Database
- BACTIBASE Database, a data repository of bacteriocin natural antimicrobial peptides
- Cybase, a database of cyclic peptides and proteins (or cyclotides)
- DBAASP - Database of Antimicrobial Activity and Structure of Peptides
- Defensins Knowledgebase
- PenBase, Penaeidin database, curated database of antimicrobial peptides from penaeid shrimps
- Peptaibol Database, a database of peptaibols, antimicrobial peptides with non-standard amino acids, mainly from fungii (Trichoderma, Emericellopsis)
- PhytAMP, a database dedicated to antimicrobial plant peptides
- The KNOTTIN database

Immunodeficiency

- IDbases, databases for immunodeficiency-causing mutations, Lund University, Sweden

Innate immunity genes

- ImmunomeBase: A database for metazoan immunity genes and orthologs.
- IRIS, Immunogenetic Related Information Source

2. Tools

Immunoglobulins (or Antibodies) (IG)

- Gene and allele identification - Analysis of the V-J and V-D-J junction
  - IMGT/V-QUEST *sequence alignment software and IMGT Collier de Perles for V-DOMAIN.*
  - IMGT/HighV-QUEST NGS High-Throughput analysis of IG and TR
  - JoinSolver®
  - VDJsolver
- Analysis of the V-J and V-D-J junction
  - IMGT/JunctionAnalysis
- Gene identification
  - IgBLAST
  - SoDa, Somatic Diversification Analysis (requires e-mail).
  - VBase/DNAPlot
- Phylogeny
  - IMGT/Phylogene
- Sequence comparison
  - IMGT/Allele-Align
  - iHMMune-align, a HMM-based Partitioning Utility for the Human Immunoglobulin Heavy Chain.
  - VBASE2
- 3D Structures
  - IMGT Collier de Perles
  - IMGT/DomainDisplay
  - IMGT/DomainGapAlign
  - IMGT/DomainSuperimpose
  - IMGT/StructuralQuery allows to retrieve IMGT/3Dstructure-DB entries according to domain and/or position criteria, using the IMGT unique numbering for V-DOMAIN and C-DOMAIN
- Modelisation
  - WAM - Web Antibody Modelling, *uses the same algorithm as its commercial homolog "AbM".*

T cell receptors (TR)

- Gene and allele identification - Analysis of the V-J and V-D-J junction
  - IMGT/V-QUEST *sequence alignment software and IMGT Collier de Perles for V-DOMAIN.*
  - IMGT/HighV-QUEST NGS High-Throughput analysis of IG and TR
- Analysis of the V-J and V-D-J junction
  - IMGT/JunctionAnalysis
- Gene identification
  - SoDa, Somatic Diversification Analysis (requires e-mail)
- Phylogeny
  - IMGT/Phylogene
- Sequence comparison
  - IMGT/Allele-Align
- 3D Structures
  - IMGT Collier de Perles
  - IMGT/DomainDisplay
  - IMGT/DomainGapAlign
  - IMGT/DomainSuperimpose

    - IMGT/StructuralQuery allows to retrieve IMGT/3Dstructure-DB entries according to domain and/or position criteria, , using the IMGT unique numbering for V-DOMAIN and C-DOMAIN

IG and TR software using IMGT/HighV-QUEST outputs

- **Standalones**
    - IMGT/StatClonotype Statistical analysis from IMGT/HighV-QUEST output
- **Pipelines**
    - Antigen Receptor Galaxy (ARGalaxy) (IG and TR)
    - BRepertoire (IG)
    - ImmunExplorer (IMEX) (IG and TR)

Major histocompatibility (MH)

- Sequence comparison
    - Polymorphism search tool, *for HLA sequence polymorphisms.*
- 3D Structures
    - IMGT/StructuralQuery allows to retrieve IMGT/3Dstructure-DB entries according to domain and/or position criteria, using the IMGT unique numbering for G-DOMAIN
- Prediction of MH1 binding peptides
    - NetCTL, predicts CTL epitopes in protein sequences. NetMHCpan, predicts binding of peptides to 478 and 791 different HLA-A and HLA-B alleles using artificial neural networks (ANNs).
- Prediction of MH2 binding peptides
    - NetMHCII, predicts binding of peptides to a number of different HLA-DR alleles using position specific weight matrices (PSSM).

Peptides binding to MH

- Prediction of proteasome cleavages
    - MAPPP, MH1 Antigenic Peptide Processing Prediction, *combined proteasome cleavage and MH ligand prediction.*
    - NetChop Prediction Server, *produces neural network predictions for cleavage sites of the human proteasome.*
    - PAProC, Prediction Algorithm for Proteasomal Cleavages
- Prediction of MH1 binding peptides
    - CombiPRED, a matrix-based MH1 prediction tool that combines MH allele matrices from three MH prediction programs - nHLAPred, BIMAS and SYFPEITHI, part of a pipeline of tools for vaccine design applied to bacteria.
    - CTLPred, *a SVM and ANN based CTL epitope prediction.*
    - HLA Peptide Binding Predictions, Bioinformatics and Molecular Analysis Section (BIMAS), *a method based on profiles and predicted half-time of dissociation of a given MH1 - peptide complex.*
    - MHCPred, *quantitative prediction of peptide-MH binding.*
    - NetMHC, *prediction of peptide binding to HLA alleles using artificial neural networks (ANNs) and hidden Markov models (HMMs).*
    - nHLAPred, a neural network based MH1 Binding Peptide Prediction Server.
    - PopCover-2.0, *selection of peptide sets with optimal HLA and pathogen diversity coverage.*
    - PREDEP, MH1 epitope prediction (see Resources).
    - ProPred-I, the Promiscuous MH1 Binding Peptide Prediction Server.
    - RANKPEP, *prediction of binding peptides to MH1 and MH2 molecules.*
    - SMM, *prediction of high affinity HLA-A2-binding peptides, based on an matrix-based algorithm.*
    - SNEP, single nucleotide polymorphism (SNP)-derived Epitope Prediction program for minor histocompatibility antigens (miHAgs), at the Department of Immunology, University of Tuebingen, Germany.

    - SVMHC, *a machine learning method based on the support vector machine package SVM-light.*
    - SYFPEITHI T cell epitope prediction, *a method based on profiles.*
- Prediction of MH2 binding peptides
    - EPIPREDICT, *prediction of MH2 HLA restricted T cell epitopes and ligands.*
    - ProPred, MH2 Binding Peptide Prediction Server, *uses quantitative matrices.*
    - RANKPEP, *prediction of binding peptides to MH1 and MH2 molecules.*
    - SNEP, single nucleotide polymorphism (SNP)-derived Epitope Prediction program for minor histocompatibility antigens (miHAgs), at the Department of Immunology, University of Tuebingen, Germany.
- Mimicry probability and immunodominant profile
    - SEMANTICA:SEquence Minicry and ANTIgen Composition Analysis
- Commercial MH prediction sites
    - EpiVax, using EpiMatrix. *MH1 and MH2 binding predictions for researchers working on vaccines and therapeutics for HIV and a range of other pathogens, a method based on statistical analysis techniques (frequency matrix).*

Allergens

- Allermatch™ - Sequence comparison to allergenic proteins.

Recombination signal (RS)

- Recombination Signal Sequences Site

3. Resources

Immunoglobulins (or Antibodies) (IG)

- Antibody engineering (The IMGT Biotechnology page)
- Monoclonal antibodies with clinical indications (IMGT Repertoire)
- AAAAA, AHo's Amazing Atlas of Antibody Anatomy, maintained by Annemarie Honegger, Zurich University, Switzerland
- ABG: directory of 3D structures of antibodies (last update 2001).
- Antibodies and diseases
    - Antibody testing in neuromuscular disorders
    - Autoantibodies in neuropathy and CNS syndromes
    - Antibodies and complement in myopathies and NMJ disorders
- Antibody Resource Page , *links to information and sites related to antibody suppliers, immunology resources, news, books, advertising.*
- EuroMAbNet European Monoclonal Antibodies Network
- ExactAntigen, Labome VAD Validated antibody database for search of commercial, academic, and therapeutical monoclonal antibodies
- Humanization bY Design, *a compilation of data on humanization of murine antibodies.*
- IG chains and V-DOMAIN. IMGT unique numbering for immunoglobulin and T cell receptor variable domains and Ig superfamily V-like domains. Lefranc, M.-P. et al., Dev. Comp. Immunol., 27, 55-77 (2003) PMID: 12477501 *with permission from Elsevier*
- IG chains and C-DOMAIN. IMGT unique numbering for immunoglobulin and T cell receptor constant domains and Ig superfamily C-like domains. Lefranc, M.-P. et al., Dev. Comp. Immunol., 29, 185-203 (2005) PMID: 15572068 *with permission from Elsevier*
- IMGT Genes on the Ensembl Genome Browser
- IMGT Repertoire ★ *a resource on locus representations, germline genes and alleles, protein displays, two-dimensional representations designated as Colliers de Perles, and three-dimensional representations of immunoglobulins, T cell receptors and Major Histocompatibility Complex*, LIGM, CNRS, Université Montpellier 2, Montpellier, France.
- Immunoglobulins and B cells | Immunoglobulines et lymphocytes B - Tutorials, IMGT Education, Marie-Paule Lefranc and Gérard Lefranc, LIGM, Montpellier, France.

- Immunoglobulins | Immunoglobulines - Questions and Answers, IMGT Education, Marie-Paule Lefranc and Gérard Lefranc, LIGM, Montpellier, France.
- Mike's Immunoglobulin Structure/Function
- Immunoglobulines ou anticorps - Pharmacorama
- Recombinant Antibody Pages, provided by Stefan Dübel, Heidelberg, *links to webpages related to recombinant antibody technology.*
- Rotating RasMol Images, Immunoglobulin domain
- The immunoglobulin kappa genes and the kappa locus of the mouse

T cell receptors (TR)

- IMGT Genes on the Ensembl Genome Browser
- IMGT Repertoire ✭ *a resource on locus representations, germline genes and alleles, protein displays, two-dimensional representations designated as Colliers de Perles, and three-dimensional representations of immunoglobulins, T cell receptors and Major Histocompatibility Complex*, LIGM, CNRS, Université Montpellier 2, Montpellier, France.
- T cells receptors and T cells | Récepteurs T et lymphocytes T, Tutorials, IMGT Education, Marie-Paule Lefranc and Gérard Lefranc, LIGM, Montpellier, France.
- T cells receptors | Récepteurs des cellules T, Questions and Answers, IMGT Education, Marie-Paule Lefranc and Gérard Lefranc, LIGM , Montpellier, France.
- TR chains and V-DOMAIN. IMGT unique numbering for immunoglobulin and T cell receptor variable domains and Ig superfamily V-like domains. Lefranc, M.-P. et al., Dev. Comp. Immunol., 27, 55-77 (2003) PMID: 12477501 *with permission from Elsevier*
- TR chains and C-DOMAIN. IMGT unique numbering for immunoglobulin and T cell receptor constant domains and Ig superfamily C-like domains. Lefranc, M.-P. et al., Dev. Comp. Immunol., 29, 185-203 (2005) PMID: 15572068 *with permission from Elsevier*

Major histocompatibility (MH)

- Allele Frequencies in Worldwide Populations, *a compilation of population studies developed by Dr Derek Middleton, UK.*
- BMDW Bone Marrow Donors Worldwide
- dbMHC Alignment viewer, Probe/Primer, MH Graphic View, IHWG Projects (Anthropology, Allele frequencies, NK Receptors...), NCBI, USA
- HLA cDNA clones, Gene Set Bank, RIKEN Bioresource center
- HLA Data Library - Japanese Population Data, JSHI, Japan
- HLA-related links, M. Tevfik Dorak
- IMGT Repertoire for MH, Montpellier, France.
- Major histocompatibility complex | Complexe majeur d'histocompatibilité, Questions and answers, IMGT Education, Marie-Paule Lefranc and Gérard Lefranc, LIGM, Montpellier, France.
- Major histocompatibility complex | Complexe majeur d'histocompatibilité, Tutorials, IMGT Education, Marie-Paule Lefranc and Gérard Lefranc, LIGM, Montpellier, France.
- MHC chain and G-DOMAIN. IMGT unique numbering for MHC groove G-DOMAIN and MHC superfamily (MhcSF) G-LIKE-DOMAIN. Lefranc, M.-P. et al., Dev. Comp. Immunol., 29, 917-938 (2005) PMID: 15936075 *with permission from Elsevier*
- NMDP National Marrow Donor Program - HLA Resources
- Structure and Function of the Major Histocompatibility Complex (MHC) Proteins
- The major histocompatibility complex of the rat (RT1)
- The MHC Haplotype Project
- IHWG International Histocompatibility Working Group
- The Molecular Immunology Foundation
- WMDA World Marrow Donor Association

Genomes

- Human Genome Browser Gateway, UCSC Genome Browser
- Ensembl Genome Browser, The Sanger Institute and EBI

- Human Genome Resources, NCBI
- IMGT Genes on the Ensembl Genome Browser
- Eukaryotic genomes annotated at NCBI
- Other links in
    - IMGT Bloc-notes Resources for the human genome
    - The IMGT Veterinary page for the genomes of domestic, model and wild life species

Antigens

Antigens eliciting an antibody response

- Human Protein Atlas, Swedish Human Proteome Resource (HPR) program
- EU ProteomeBinders, A European Infrastructure of Ligand Binding Molecules against the Human Proteome

Peptides binding to MH

- Prediction and analysis of protein epitopes
    - EpiMatrix. *MH1 and MH2 binding predictions for researchers working on vaccines and therapeutics for HIV and a range of other pathogens, a method based on statistical analysis techniques (frequency matrix).*
    - ePitope informatics - Links
- Prediction of proteasome cleavages
    - Prediction of proteasome cleavage sites (see Resources)

Virus epitopes

- HCV Immunology database
- HIV Molecular Immunology database
- Poxvirus Bioinformatics Resource Center

Allergens

- AllALLERGY
- Allergome - A platform for allergen knowledge (needs registration)
- Allergy and Immunology - Hardin MD
- Les bases de données d'allergènes (diaporama), Marie-Paule Lefranc, Montpellier, France
- Food vegetal allergens, IMGT Lexique, LIGM, Montpellier, France.
- Food animal allergens, IMGT Lexique, LIGM, Montpellier, France.
- Cross-reactivities between allergens, IMGT Lexique, LIGM, Montpellier, France.
- Gliadins, lectins and profilins from wheat *(Triticum aestivum, T. wartu, T. durum)* , IMGT Lexique, LIGM, Montpellier, France.

Immunoglobulin superfamily (IgSF)

- IgSF chains and V-LIKE-DOMAIN. IMGT unique numbering for immunoglobulin and T cell receptor variable domains and Ig superfamily V-like domains. Lefranc, M.-P. et al., Dev. Comp. Immunol., 27, 55-77 (2003) PMID: 12477501 *with permission from Elsevier*
- IgSF chains and C-LIKE-DOMAIN. IMGT unique numbering for immunoglobulin and T cell receptor constant domains and Ig superfamily C-like domains. Lefranc, M.-P. et al., Dev. Comp. Immunol., 29, 185-203 (2005) PMID: 15572068 *with permission from Elsevier*
- IMGT Repertoire (RPI) 2. Proteins and alleles
- IMGT Repertoire (RPI) 4. IgSF other than IG or TR

Major histocompatibily superfamily (MhSF)

- IMGT Repertoire 2. Proteins and alleles (RPI)
- IMGT Repertoire - MhSF other than MH
- MhSF chains and G-LIKE-DOMAIN. IMGT unique numbering for MHC groove G-DOMAIN and MHC superfamily (MhcSF) G-LIKE-DOMAIN. Lefranc, M.-P. et al., Dev. Comp. Immunol., 29, 917-938 (2005) PMID: 15936075 *with permission from Elsevier*

Protein expression

- Human Protein Atlas

Peptides

- The Peptide Resource Page

Adhesion molecules

Killer cell immunoglobulin-like receptors (KIR)

- Chromosome 19 LRC Haplotype Project
- dbLRC, NCBI, USA
- NK receptors / Récepteurs des cellules NK, IMGT Education, LIGM, Montpellier, France.
- Nomenclature of the human LRC (Leucocyte Receptor Complex) genes: LILR/ILT nd KIR (19q13.42), IMGT Education, LIGM, Montpellier, France.
- The KIR Gene Cluster, Mary Carrington and Paul Norman, Bethesda (MD), National Library of Medicine (US), NCBI, 2003

Immunodeficiency

- ImmunoDeficiency Resource (IDR), University of Tampere, Finland

Integrins

- Integrins
- Diversity of integrins (IMGT Education)

Translocations

- Atlas of Genetics and Cytogenetics in Oncology and Haematology

Tumour cells

- ESTDAB - European Searchable Tumour Line Database, *allows search of tumour cell lines, predominantly melanoma, by parameters such as HLA genotype, tumour antigens, etc.*

Pathogens

- **Pathogen invertebrate vectors**
  - VectorBase, a web resource for invertebrate vectors of human pathogens. Currently contains genome information for *Anopheles gambiae*, a vector for the Plasmodium protozoan agent causing malaria, and *Aedes aegypti*, a vector for the flaviviral agents causing Yellow fever and Dengue fever.
- **Pathogen-host interactions**
  - PHIDIAS, a Pathogen-Host Interaction Data Integration and Analysis System.

Unit 5 - Session 6

SLO 1-2: Epitope prediction tool