A course on Basic Immunology, with emphasis on relevance to immunologic diseases and therapeutic strategies

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Developed as an education program of the Federation of Clinical Immunology Societies (FOCIS)

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Themes of the course

- Introduction to the nomenclature of immunology
- Basic principles: mechanisms underlying immune responses
- Pathogenesis of selected diseases
- Emerging concepts, and their potential clinical and therapeutic implications

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Why the great interest in Immunology?

- Basic science: understanding a complex biological system
- Clinical medicine: cause of many diseases, impact on many more diseases
- New therapies based on biology
- Potential for major role in emerging therapies (gene therapy, stem cell therapy)

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What does the immune system do?

Normal functions

- Defense against infections
- Defense against some tumors

Disease and therapeutic implications

- Cause of disease (autoimmunity, allergy)
- Barrier to transplantation, gene therapy

Take home messages

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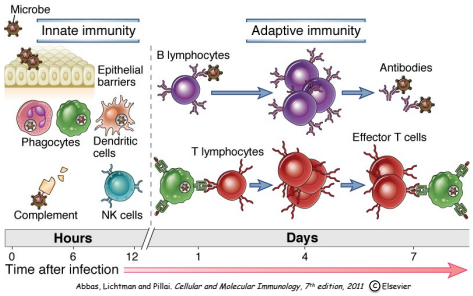
Innate and adaptive immunity



Innate immunity: always present (ready to attack); many pathogenic microbes have evolved to resist innate immunity
Adaptive immunity: stimulated by exposure to microbe; more potent

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Cells of the immune system

- Lymphocytes: the cells of adaptive immunity; recognize antigens and develop (differentiate) into cells that perform the defense functions
- Antigen-presenting cells: cells that capture antigens and display them to lymphocytes
- Effector cells: leukocytes (white blood cells) that eliminate microbes (the "effect" of the immune response); may be lymphocytes, but are often other leukocytes

Classes of lymphocytes

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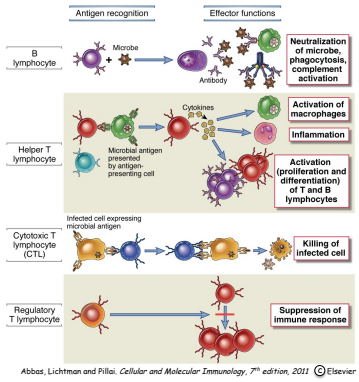

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Excluding NK cells and other innate lymphoid cells

Types of adaptive immunity

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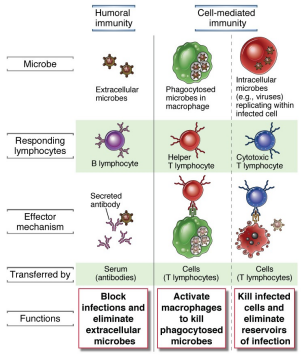

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Different types of immune responses are mediated by different classes of lymphocytes and defend against different types of microbes

Lymphocyte diversity and clonal selection

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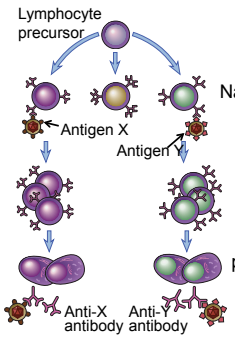

Generation of mature lymphocytes with many different antigen receptors

Naïve lymphocytes circulate through lymphoid organs

Specific lymphocytes recognize antigens

Lymphocytes are activated to proliferate and to differentiate into effector cells

Lymphocytes with highly specific and diverse antigen receptors develop prior to exposure to antigens

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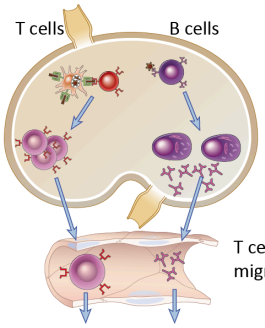
Adaptive immune responses



Take home messages

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Stages in the life history of lymphocytes

Cell type	Stage		
	Naive cell	Activated or effector lymphocyte	Memory lymphocyte
B lymphocytes	Antigen recognition → Proliferation → Differentiation		
Helper T lymphocytes	Antigen recognition → Proliferation → Differentiation		

Proliferation: expands number of antigen-specific cells
Differentiation: converts lymphocytes into effective defenders

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The immune system can cause disease

- Excessive, uncontrolled responses against infectious pathogens (collateral damage)
- Inappropriate responses against self antigens may cause injury to normal tissues, resulting in disease
- Fundamental defect is failure of control mechanisms in the immune system

Take home messages

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The significance of recent advances

- Provides a solid foundation of basic principles
- Improved understanding of disease mechanisms
- Development of novel therapies
- Appreciation of the role of the immune system in non-immune diseases

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Challenges
1. More information initially leads to increased apparent complexity

- Many newly identified cell populations
  - Innate lymphoid cells
  - Subsets of dendritic cells
  - Subsets of helper T lymphocytes
  - Unique roles and functions?
- Complex signaling pathways and gene expression patterns
  - High-throughput "omics" approaches are generating enormous volumes of data

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Challenges
2. In vivo veritas, in vitro maybe?

- Much of our knowledge is based on cell culture and other in vitro models
  - Difficult to convert to in vivo biology
- Emphasis in the last decade has shifted from immune activation to regulation
  - Regulation involves multiple cell populations and pathways and has to be studied in vivo

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Challenges
3. Mouse to human translation

- Animal models are critical for discovery but may not reflect the human situation
  - Complex genetics of humans, environmental influences
- Animal models of disease have not proved to be as predictive of the human disease or therapeutic responses as hoped
  - Nevertheless, MANY successes!