试题形式

一、选择题（每题1分，共50题）

二、名词解释 （每个2分，共10题）

三、简答题 （每题2分，共5题）

四、问答题（英文题, 中文回答）

（共3题，20分）

卷面成绩占70%, 作业占30%, 共4次作业，补交无效

要求掌握内容

一、选择题（50个，50分）

（每次课2-6个题，专业名词为英文，基本概念需清楚，多为知识点引深内容）

二、名词解释 （基本为课后习题内容，英文题目，翻译正确得1分，解释正确再得1分；每题2分，10个，20分）

三、简答题 （5题，10分）

（专业名词为英文，课堂反复强调过的内容，只答标题，不细答）

四、问答题（3个英文问题，中文回答）（20分）

要求掌握内容

四、问答题（3个英文问题，中文回答）（其中一道为作业题）（20分）

1. 阻止微生物入侵的屏障
2. 天然免疫系统识别抗原的机制：模式识别，识别受体及其引发的下游效应
3. 吞噬细胞杀伤病原微生物的机制
4. 抗体的结构以及抗体识别的机制
5. TCR的结构以及TCR如何进行特异性识别
6. 抗原的处理及提呈：能够被αβT细胞的受体（αβTCR）识别的抗原是如何产生的？抗原提呈的不同途径：MHC-I 途径：提呈内源性抗原，MHC-II 途径：提呈外源性抗原
7. T细胞在胸腺发育中的阳性选择和阴性选择过程
8. B细胞对胸腺依赖抗原的应答过程，T细胞如何帮助B细胞进行应答
9. B细胞在生发中心进行抗体亲和力成熟的过程：体细胞高频突变，生发中心B细胞的阳性选择

recognition, effector, regulation, memory

The first lines of defense

Innate immunity
(immediate:0-4h)

Innate immune cells

Innate Immune Response

inflammatory response

Early induced
Innate response
(early: 4-96h)

Adaptive Immune Response

Cell-mediated immune

Humoral immune

Adaptive
immune
response
(late: >96h)

Immunedefense, Immunesurveillance, Homeostasis

Immunology

研究免疫系统结构与功能的学科

Immunobiology

研究免疫现象生物学基础的免疫学分支学科

Immune system

由免疫器官、免疫组织、免疫细胞、免疫分子和淋巴循环网络组成。

Immune System

Innate Immune Syste	Adaptive Immune System
1、模式识别 2、胚系编码 3、迅速应答，4、无记忆	1、特异性识别；2、机体获得性 3、多样性；4、记忆性
物理、化学和微生物屏障、 免疫分子和固有免疫细胞	T，B lymphocytes

Immunedefense, Immunesurveillance, Homeostasis

免疫系统具有区分“self”和“non-self”的能力

Immune response

凡是外来的就response

凡是宿主的就tolerance

Immune response 程序

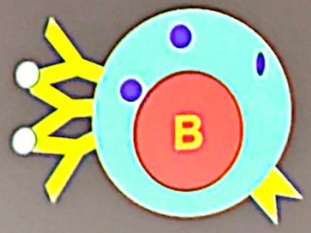
Immunological recognition, effector function, regulation, memory

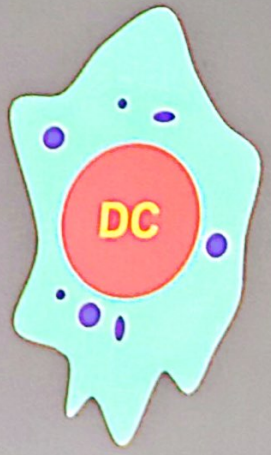
Innate Immune Cells

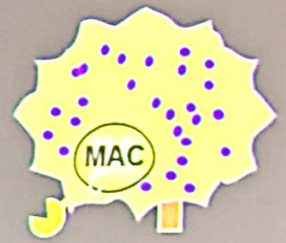
Adaptive Immune Cells

Immunedefense, Immunesurveillance, Homeostasis

APC (Antigen Presenting Cells)







Central or primary lymphoid organs

BM

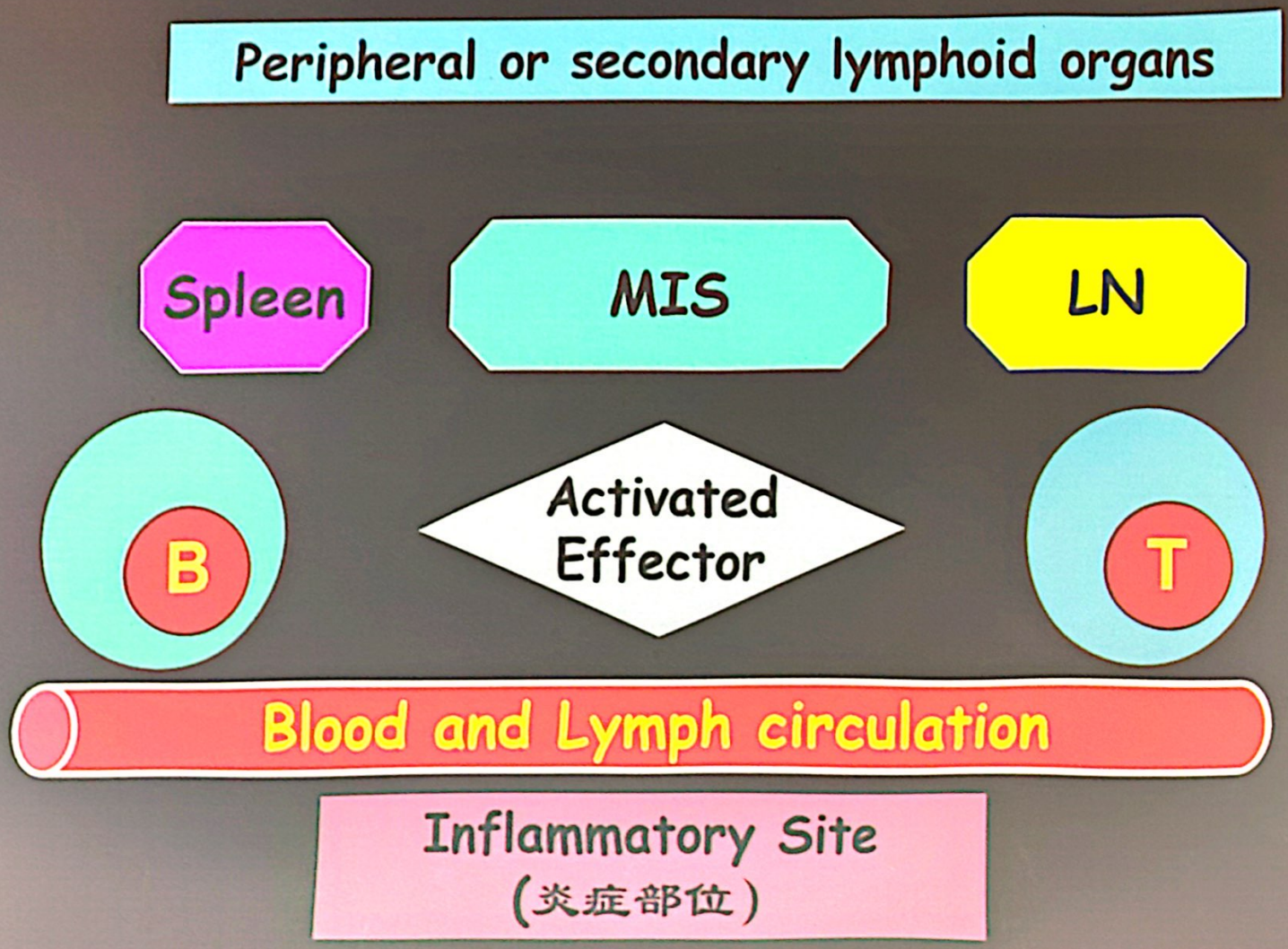
Thy

Peripheral or secondary lymphoid organs

Spleen

MIS

LN


Peripheral or secondary lymphoid organs
Spleen
MIS
LN
B
Activated
Effector
T
Blood and Lymph circulation
Inflammatory Site
(炎症部位)

Lecture-02

Kenneth M. Murphy and Casey Weaver

Immunobiology (9ed)

PART I An introduction to immunobiology and innate immunity

Chapter 2 Innate Immuntity:The First Line of Defense

Section-1 Anatomic barriers and initial chemical defenses

Ma Hongdi

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Institute of Immunology

viruses,
bacteria
fungi,
protozoa,
worms.

Innate Immune System

Innate immunity

(immediate:0-4h)

The first lines of defense

Innate Immune Barrier

Mechanical, Chemical, Microbiological

Innate immune molecules

Lysozyme, Antimicrobial peptides: (Defensins, cathelicidins, RegIII, histatins)

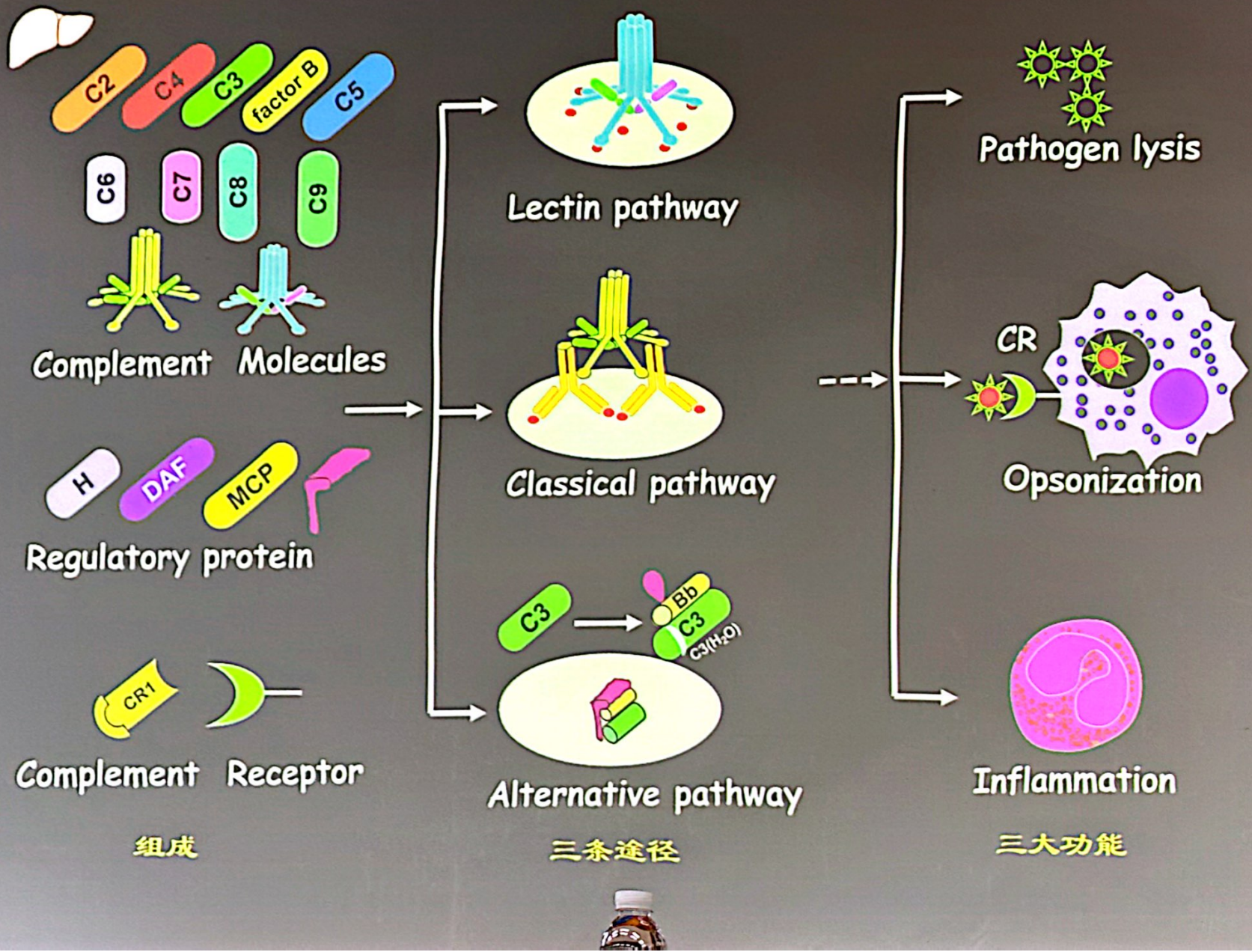
Complement system

viruses, bacteria fungi, protozoa, worms.

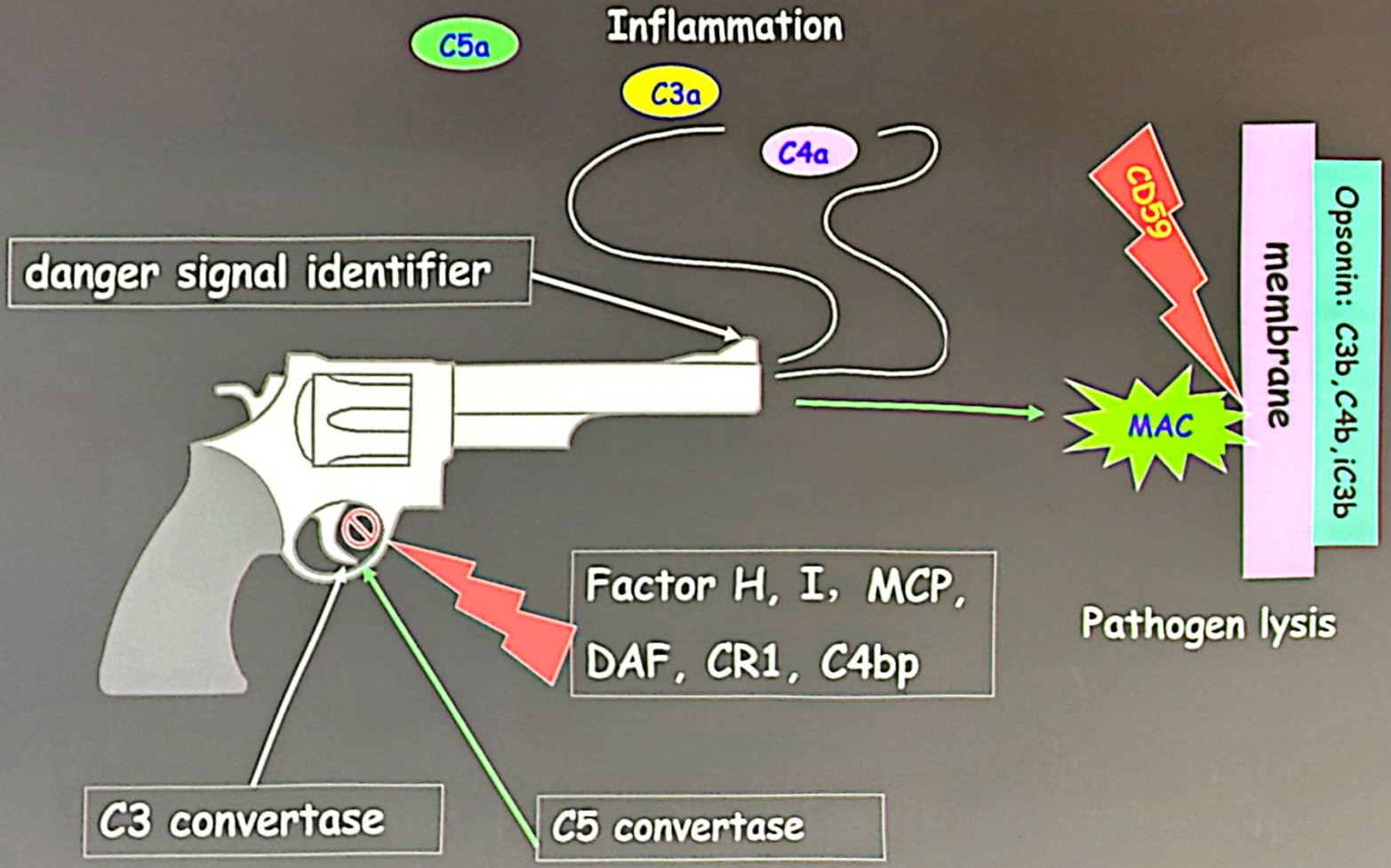
first barrier against infection

	Skin	Gut	Lungs	Eyes/nose/oral cavity
Mechanical	Epithelial cells joined by tight junctions			
	Longitudinal flow of air or fluid	Longitudinal flow of air or fluid	Movement of *mucus* by cilia	Tears Nasal cilia
Chemical	Fatty acids	Low pH	Pulmonary surfactant	Enzymes in tears and saliva (lysozyme)
		Enzymes (pepsin)		
	β-defensins Lamellar bodies Cathelicidin	α-defensins (cryptdins) RegIII (lecticidins) Cathelicidin	α-defensins Cathelicidin	Histatins β-defensins
Microbiological	Normal microbiota			

The main component and effector actions of complement



The Complement System



viruses,
bacteria
fungi,
protozoa,
worms.

Innate Immune System

Innate immunity

(immediate:0-4h)

The first lines of defense

Innate Immune Barrier

Mechanical, Chemical, Microbiological

Innate immune molecules

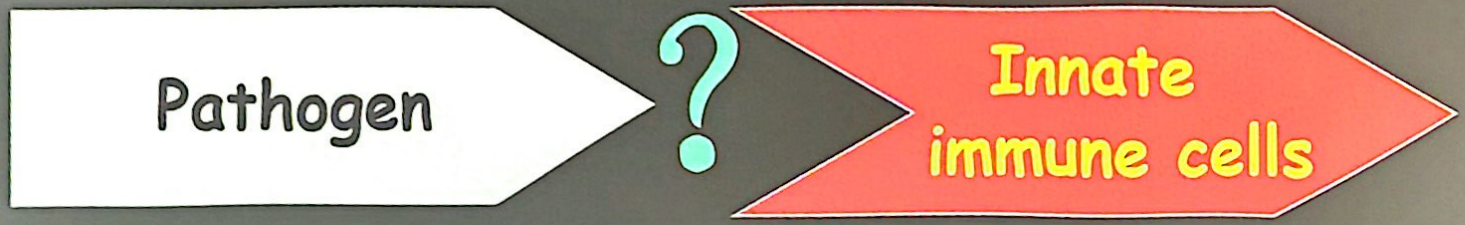
Lysozyme, Antimicrobial peptides: (Defensins, cathelicidins, RegIII, histatins)

Complement system

Innate immune cells

Innate Immune Response

Innate immunologic recognition



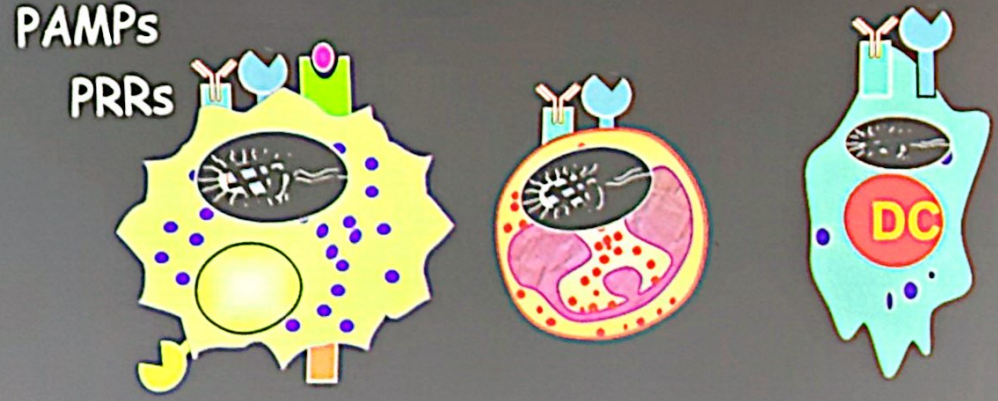
Effector function, Regulation

固有免疫系统是怎样识别和发挥效应的？

Process of phagocytosis

Phagocytes

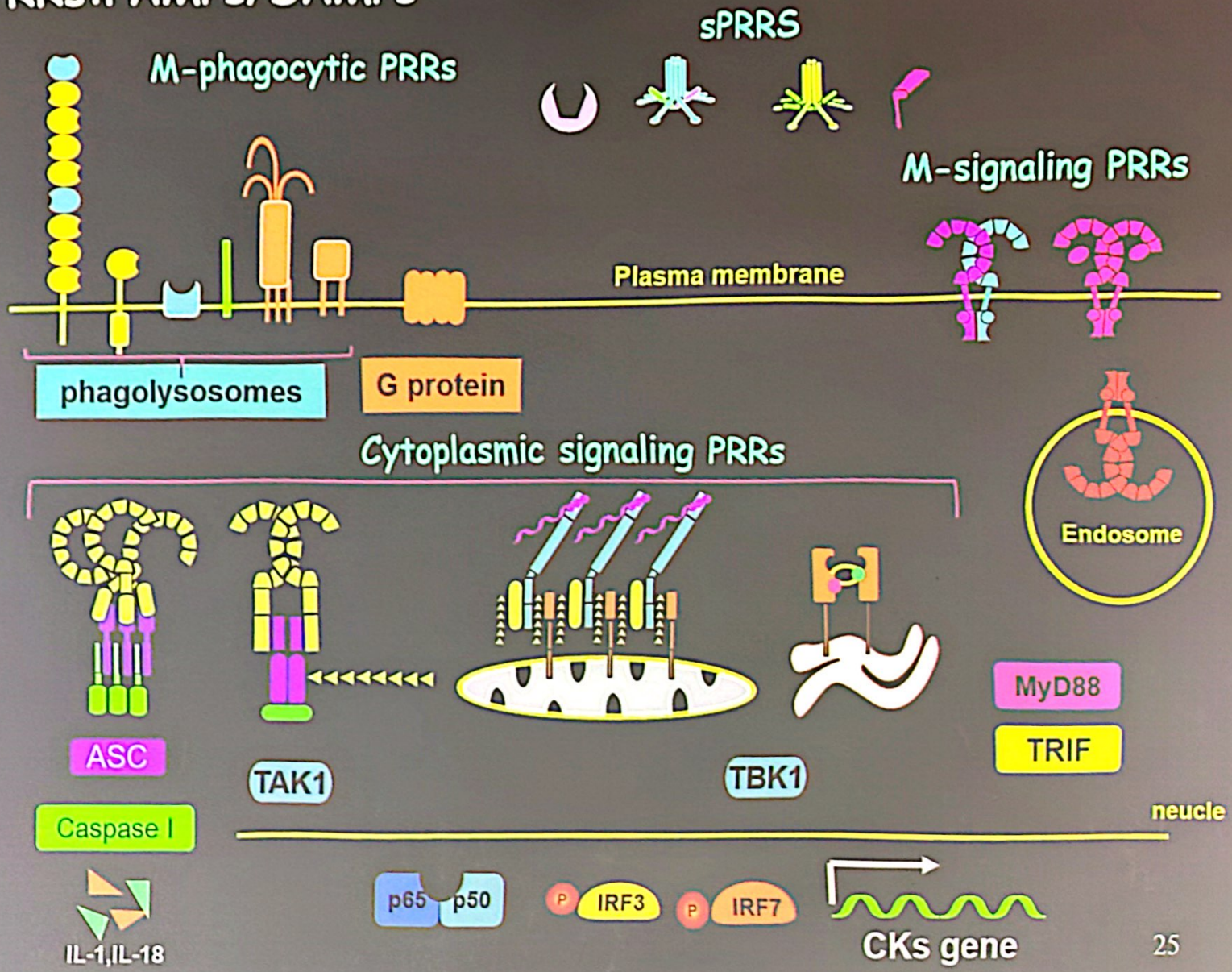
Process of phagocytosis



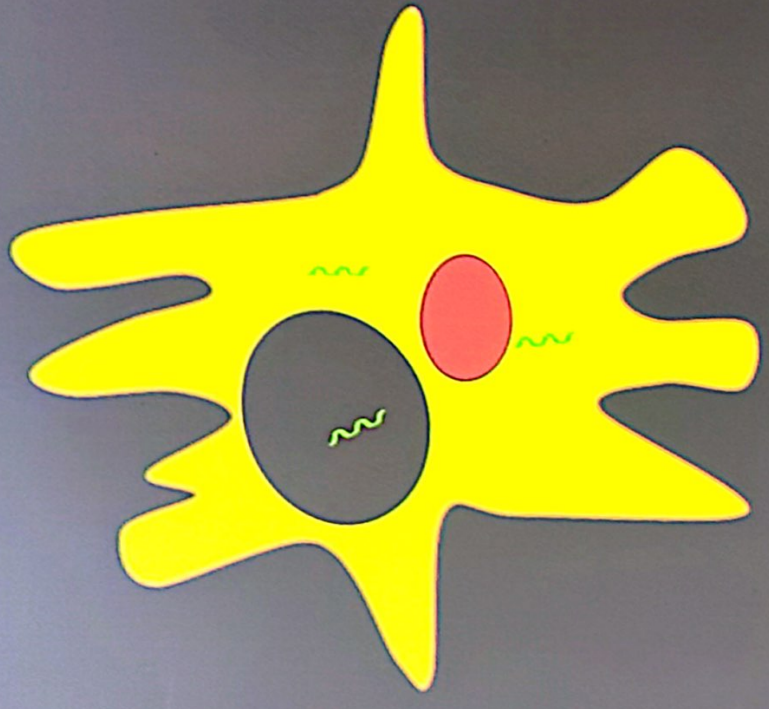
Recognition, ingestion, killed (digestion)

Mechanism Respiratory burst, Acidification, NO

PRRs:PAMPs/DAMPs



Sensors of virus



TLR-3 (dsRNA),

TLR-7,8 (ssRNA),

TLR-9 (CpGDNA)

detect viral RNAs and DNAs of extracellular material entering the endocytic pathway

cGAS (dsDNA)

RIG-I (ssRNA)

MDA-5 (dsRNA),

detect nucleic acids present in the cytoplasm of a virus-infected cell as a result of viral replication

Immune system具有区分“self”和“non-self”的能力

Innate immunological recognition

PAMPs → PRRs

Germline-encoded receptor
Pattern Recognition

effector function, regulation

Innate immune response

viruses,
bacteria
fungi,
protozoa,
worms.

Barrier
Mechanical, Chemical, Microbiological
Innate immune molecules
Lysozyme, Antimicrobial peptides
Complement system

Innate immunity
(immediate:0-4h)

PAMP

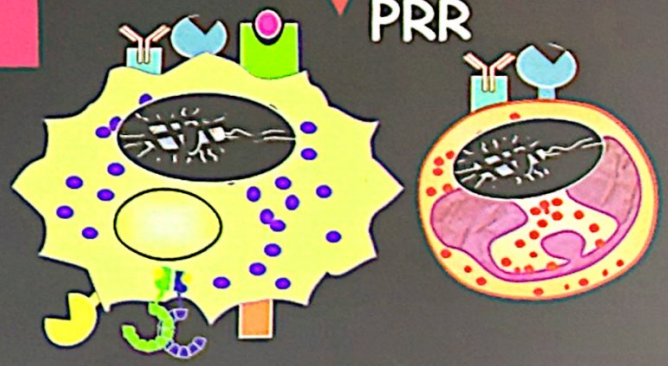
PRR

0-4h

inflammatory response

PAMP

PRR



Early induced
Innate response
(early: 4-96h)

How to induce innate immune response?

Lecture-05

Kenneth Murphy, Paul Travers, Mark Walport

Immunobiology (9ed)

PART I An introduction to immunobiology and innate immunity

Chapter 3 Induced responses to Innate Immunity

Section-2 Induced innate responses to infection

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Immune Molecules

1.Cytokines (CKs):是由免疫细胞及组织细胞分泌的在细胞间发挥相互调控作用的一类小分子可溶性多肽蛋白。

a.按结构分类：① IL-1 family； ② Hematopoietin superfamily (IFN family)； ③TNF family； ④ Chemokine family。

b.作用方式：① 自分泌(autocrine)； ② 旁分泌(paracrine)； ③内分泌(endocrine)

c.作用特点：① 多效性 (pleiotropy)； ② 重叠性(redundancy)； ③ 协同性(synergy)； ④ 拮抗性(antagonism)； ⑤ 网络性 (Network)。

2.Chemokines：能使细胞发生趋化运动的小分子细胞因子.

a.结构：均含有4个半光氨酸（cysteine，C）并形成2个内部的二硫键。

b.受体结构：均为与G蛋白相结合的穿膜7次的跨膜蛋白。

3.Cell-Adhesion molecules (CAM):是介导细胞与细胞之间、细胞与基质之间相互附着的分子的总称。

招募immune cells最重要的3个CAM家族为① selectin family； ② integrin family;③ Ig superfamily (IgSF)。

Innate immune cells

1.Neutrophils: are first wave to enter an inflamed site

2.ILCs: produced CKs to provide protection in early infection.

ILCs: NK,ILC1,ILC2,ILC3,TLi

ILC1:IFNγ

ILC2:IL-5,IL-13

ILC3:IL-22,IL-17

3.NK cells: receptors: recognition of altered/missing self

Activating receptors : ITAM: NCRs and NKG2D

NCRs: NKp30, NKp44,NKp46

NKG2D: ligand: MICA/B

} (altered self)

Fc receptors (CD16) : ADCC.

Inhibitory receptors : ITIM ; MHC class I molecules;
prevent NK cells from killing normal host cells. (missing self)

Killing mechanisms: 1. NCR/NKG2D-cytotoxic granules;
2. TRAIL/Fas; 3.ADCC.

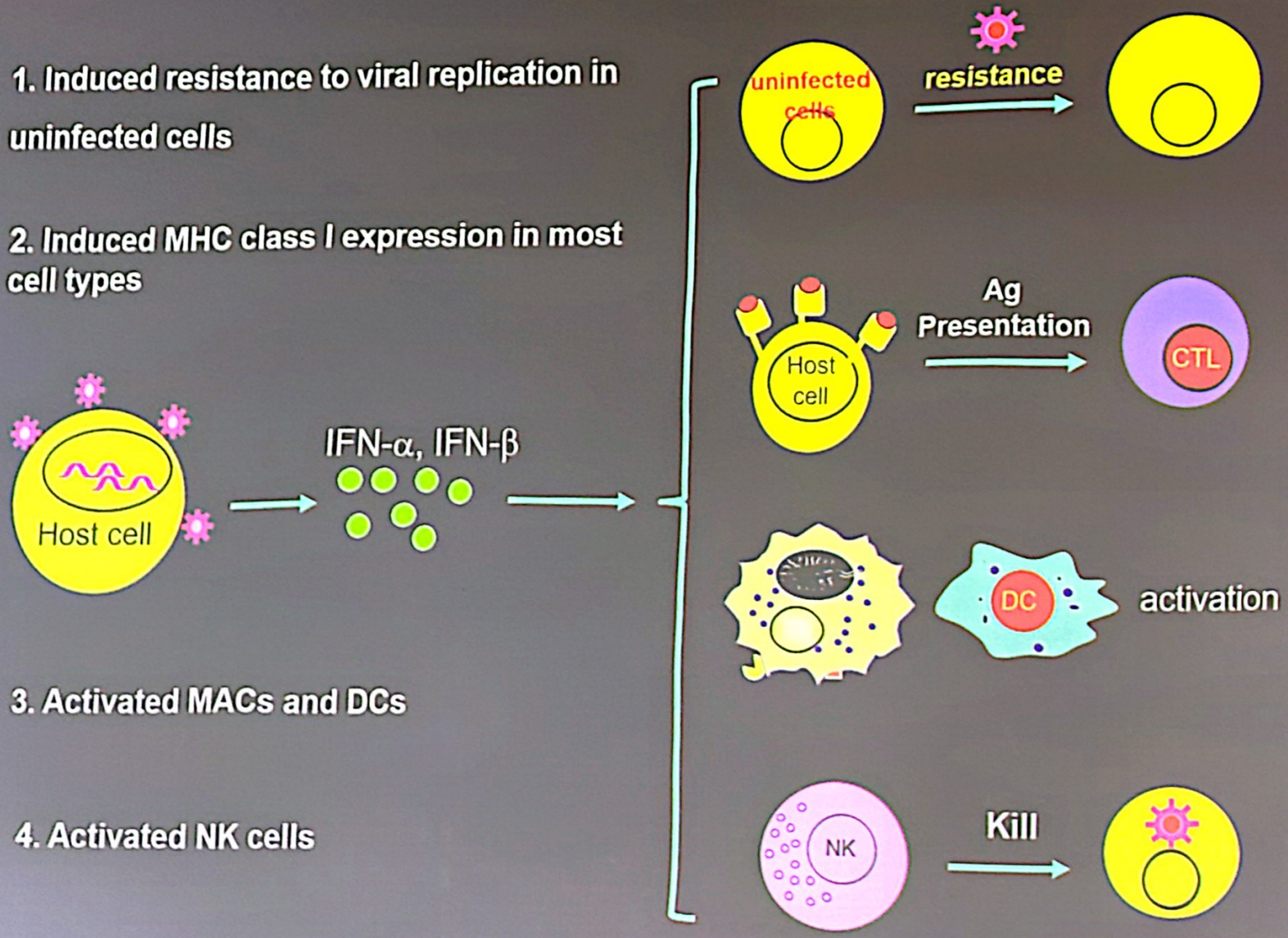
major functions of IFNα/β

1. Induced resistance to viral replication in uninfected cells

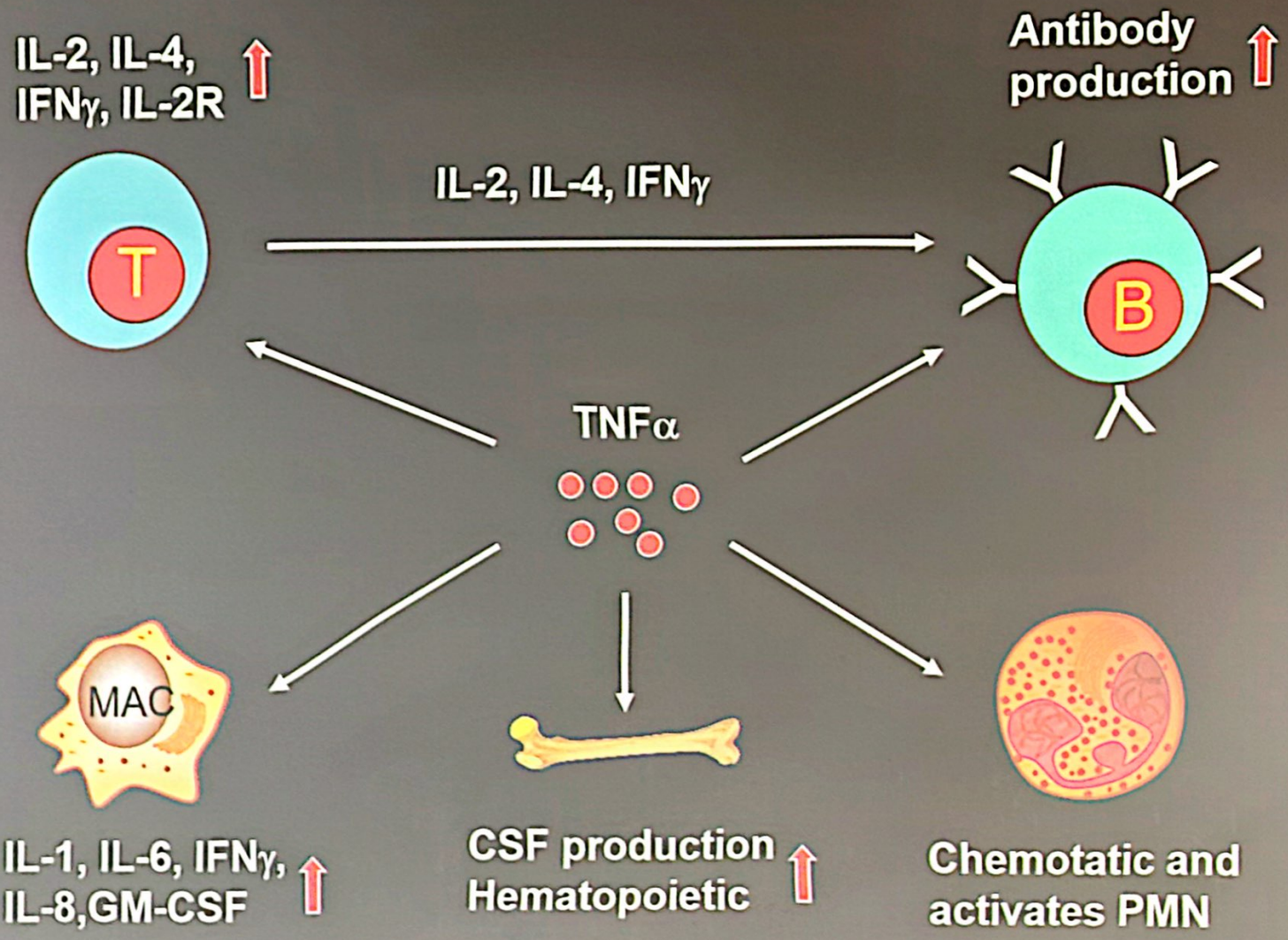
2. Induced MHC class I expression in most cell types

3. Activated MACs and DCs

4. Activated NK cells



major functions of TNFα



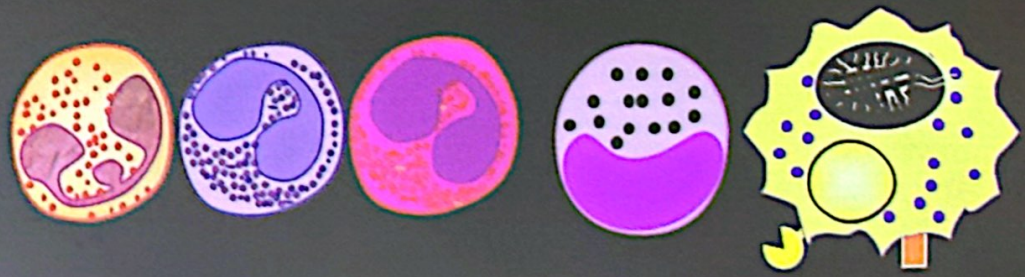
Innate Immune System

viruses,
bacteria
fungi,
protozoa,
worms.

Epithelial Barrier
Mechanical, chemical, microbiological

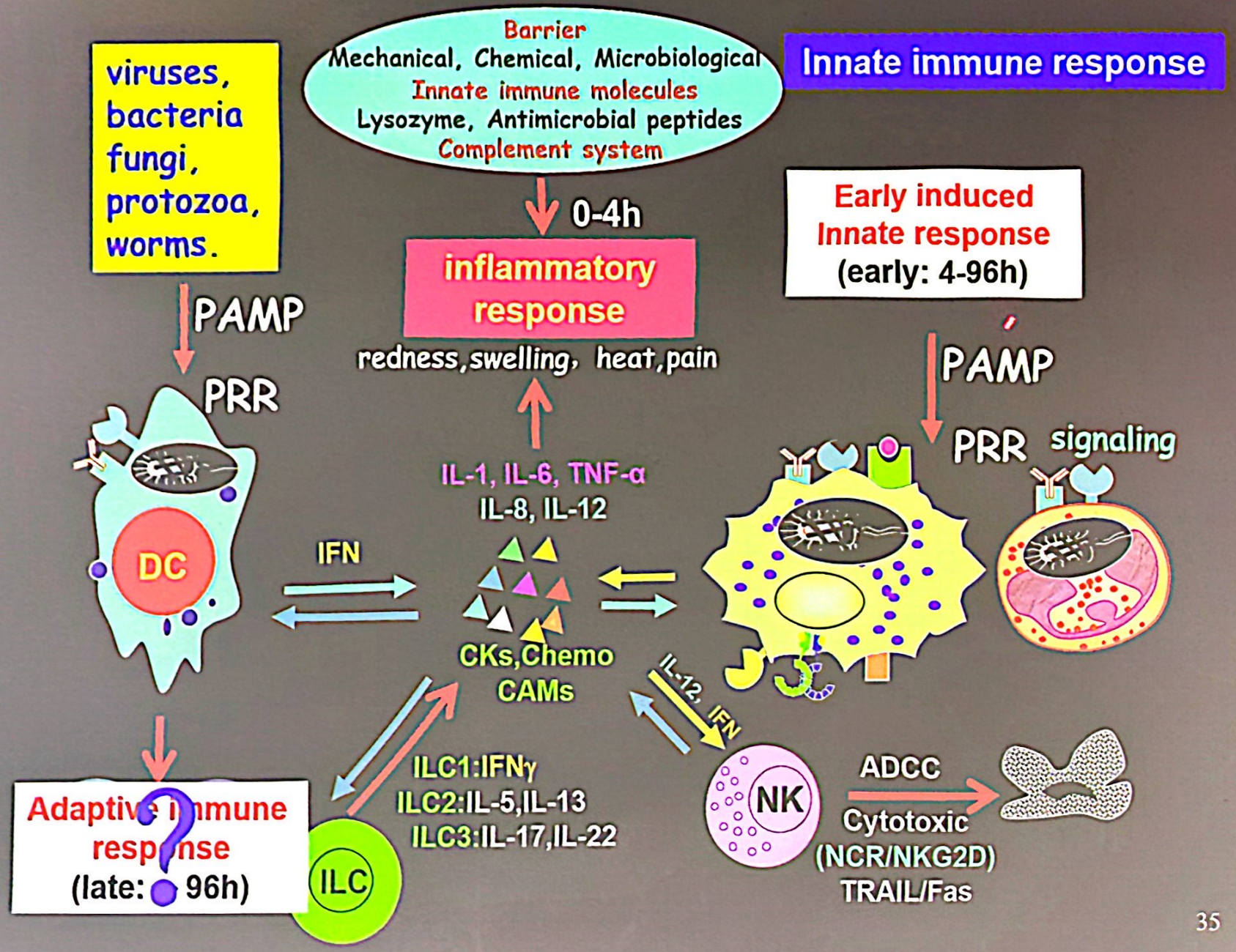
Innate immunity
(immediate:0-4h)

Innate Immune molecules
Lysozyme, Antimicrobial peptides
Complement, CKs, Chemo, CAMs



Early induced Innate response
(early: 4-96h)

Immunedefense, Immunesurveillance, Homeostasis


Barrier
Mechanical, Chemical, Microbiological
Innate immune molecules
Lysozyme, Antimicrobial peptides
Complement system
Innate immune response
viruses,
bacteria
fungi,
protozoa,
worms.
0-4h
inflammatory response
redness,swelling, heat,pain
Early induced
Innate response
(early: 4-96h)
PAMP
PRR
PAMP
PRR
signaling
IL-1, IL-6, TNF-α
IL-8, IL-12
DC
IFN
CKs,Chemo
CAMs
IL-12, IFN
ILC1:IFNγ
ILC2:IL-5,IL-13
ILC3:IL-17,IL-22
ILC
NK
ADCC
Cytotoxic
(NCR/NKG2D)
TRAIL/Fas
Adaptive immune
response
(late: 96h)

Adaptive Immune Response

BCR/TCR
Immune Recognition

Immune system具有区分“self”和“non-self”的能力

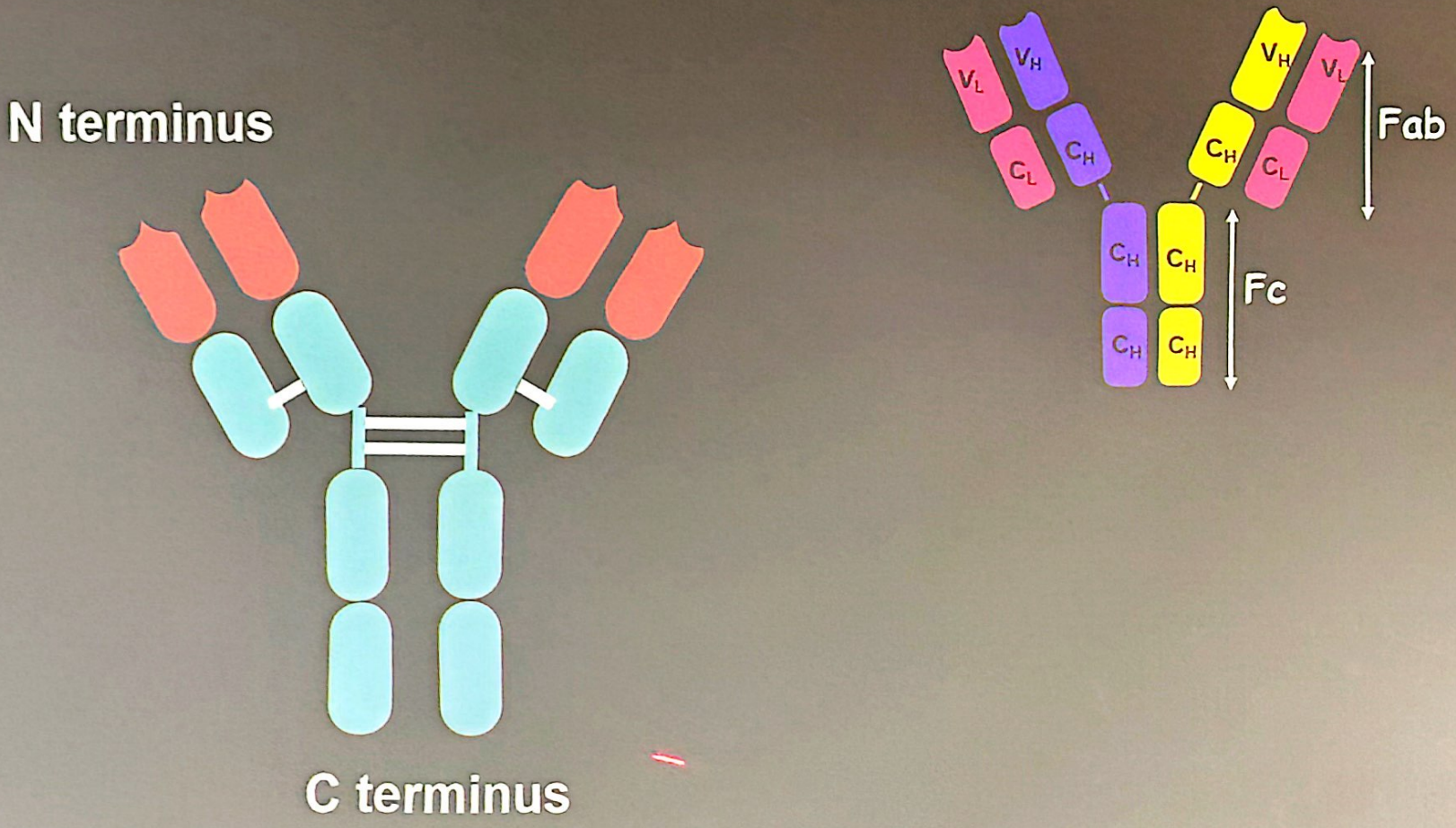
Adaptive Immune Response

Adaptive immunologic recognition

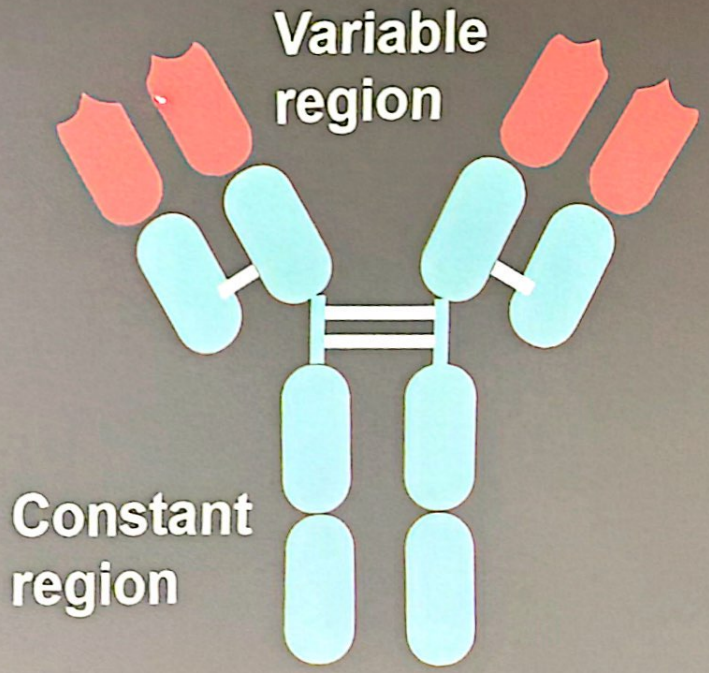
Specificity

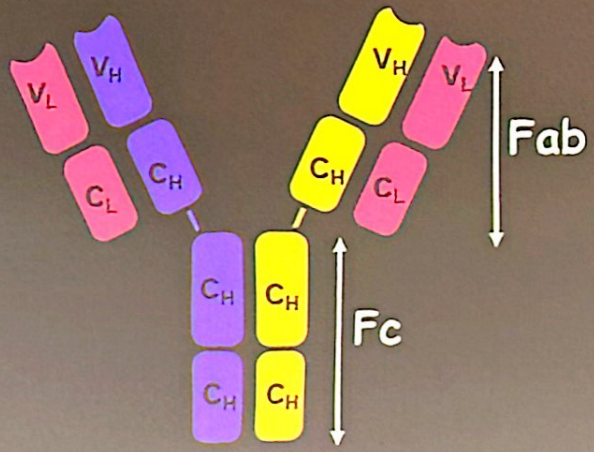
effector function, regulation, memory

A structure of a typical antibody molecule

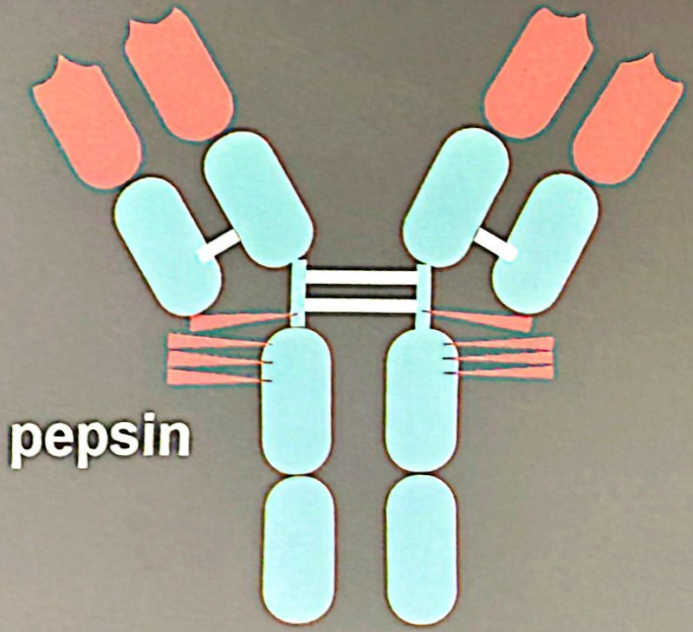


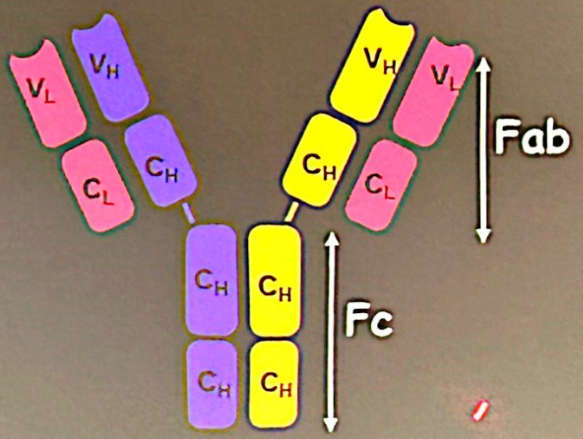
A structure of a typical antibody molecule



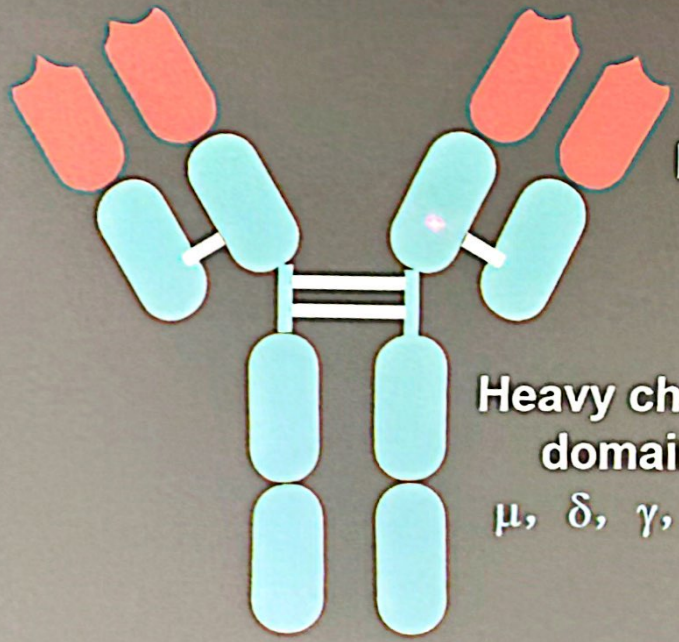


A structure of a typical antibody molecule





A structure of a typical antibody molecule

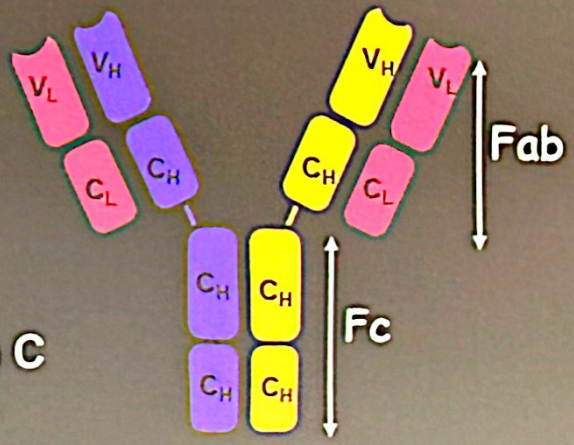


Light chain C domains

κ or λ

Heavy chain C domains

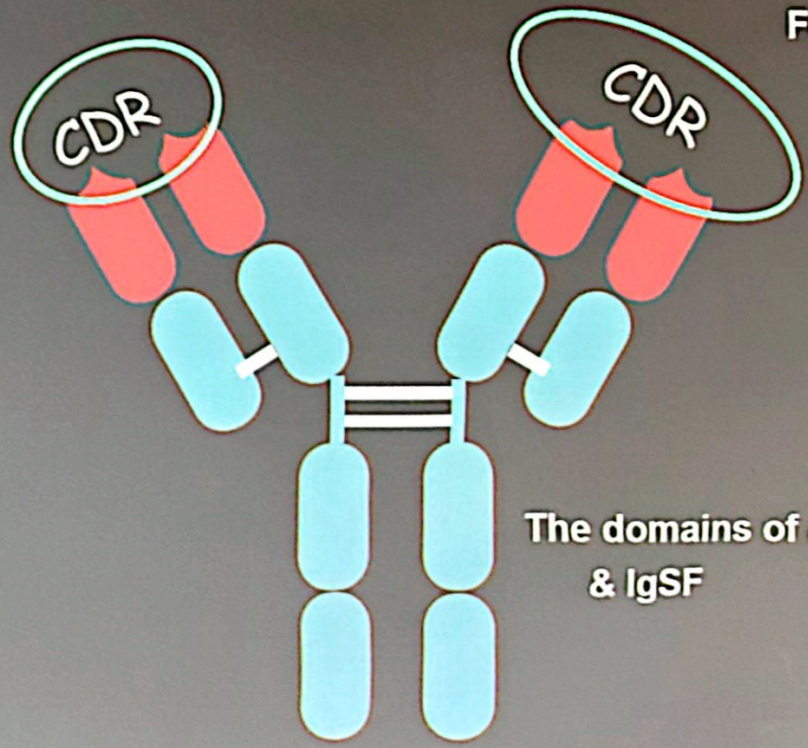
μ, δ, γ, α, ε



The interaction of the antibody molecule with specific antigen

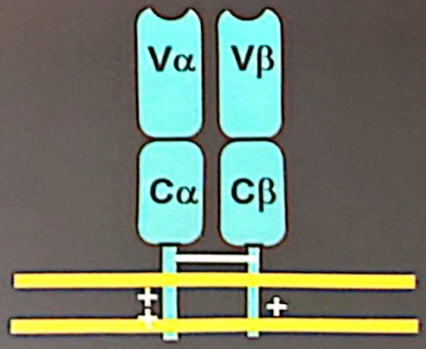
Antigen and hapten

AD (epitope),
linear epitope
conformational epitope



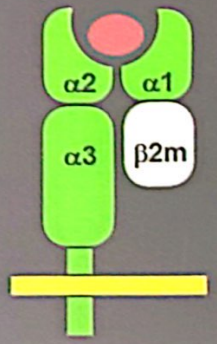
Forces of Ag-Ab interactions

The domains of an Ig & IgSF

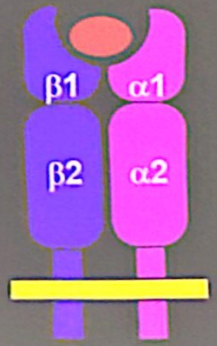


The structure of TCR

MHC-I



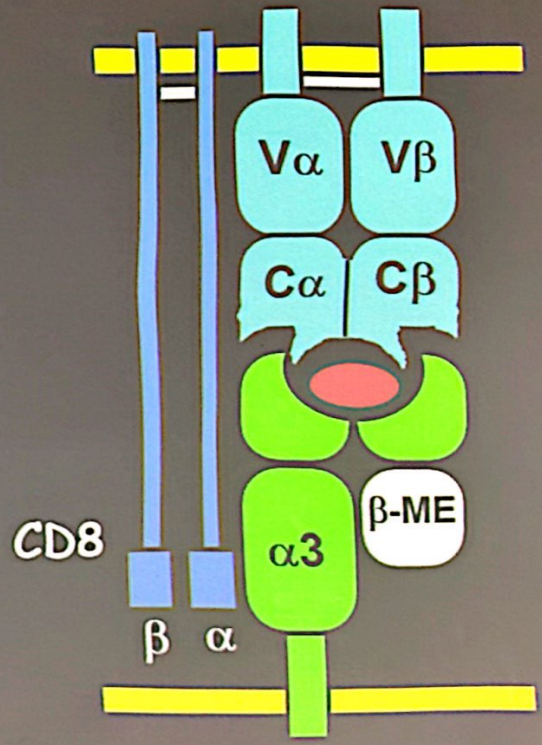
MHC-II



The structure of MHC

TCR recognition——
双识别限制性

TCR



Specific recognition

viruses,
bacteria
fungi,
protozoa,
worms.

AD:BCR

B

PAMP

PRR

DC

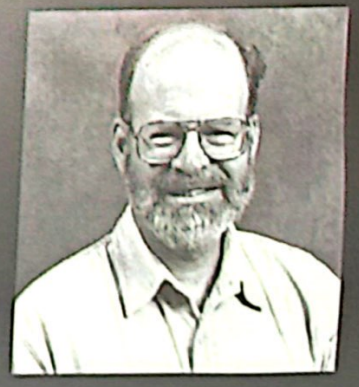
Naive CD4T

Naive CD8T

pMHC:TCR

CKs

MAC



Lecture-07

Kenneth Murphy, Paul Travers, Mark Walport

Immunobiology (8ed)

PART II The recognition of antigen

Chapter 5 The Generation of Lymphocyte Antigen Receptors

Section-1 Primary immunoglobulin gene rearrangement

Prof. Wei Haiming
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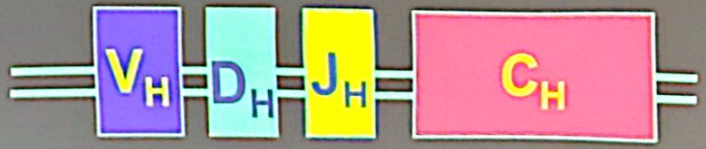
Institute of Immunology

How does generate complete genes that encode Ig?

Development

Lymphocyte-specific: RAG1/2: RSS

Ig H chain



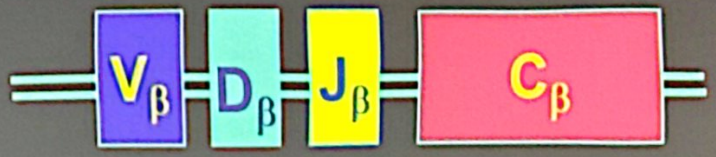
Ig Lκ chain

How does generate complete genes that encode TCR?

Development

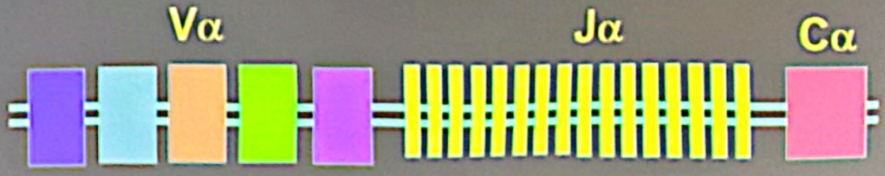
Lymphocyte-specific: RAG1/2: RSS

TCR β chain



D_β to J_β, $D_\beta J_\beta$ to V_β and $V_\beta D_\beta J_\beta$ to C_β

TCR α chain



V_α to J_α and $V_\alpha J_\alpha$ to C_α

How does generate the diversity of the immunoglobulin/TCR repertoire?

1. Combinatorial diversity
2. Junctional diversity
3. Source of diversity
4. Somatic hypermutation

How does generate the diversity of the immunoglobulin/TCR repertoire?

1. Combinatorial diversity 

2. Junctional diversity 

3. Source of diversity 

4. Somatic hypermutation 

How many immunoglobulin classes in human?

5 domain IgM: pentamers and hexamers

4 domain IgD

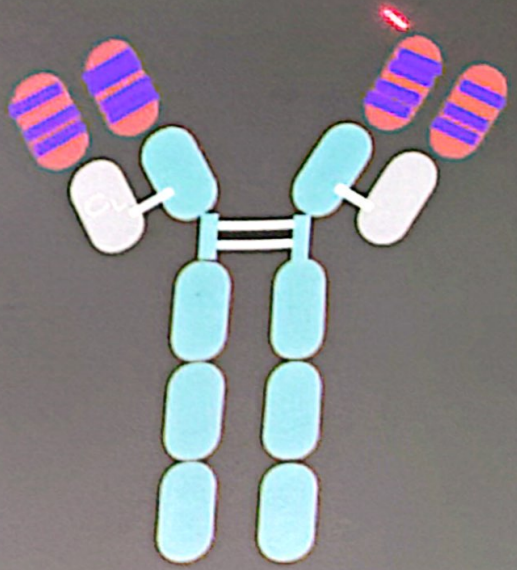
4 domain IgG: IgG1, IgG2, IgG3, IgG4

4 domain IgA: IgA1, IgA2, dimerisation

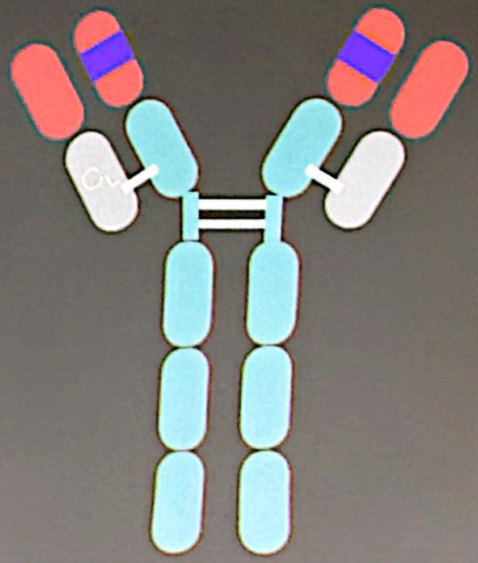
5 domain IgE

How does generate the secondary diversification of the antibody repertoire?

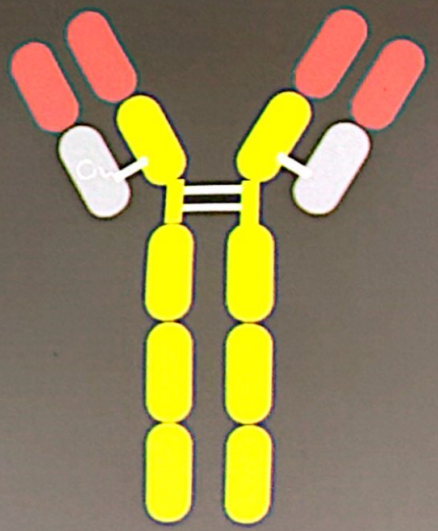
Somatic hypermutation

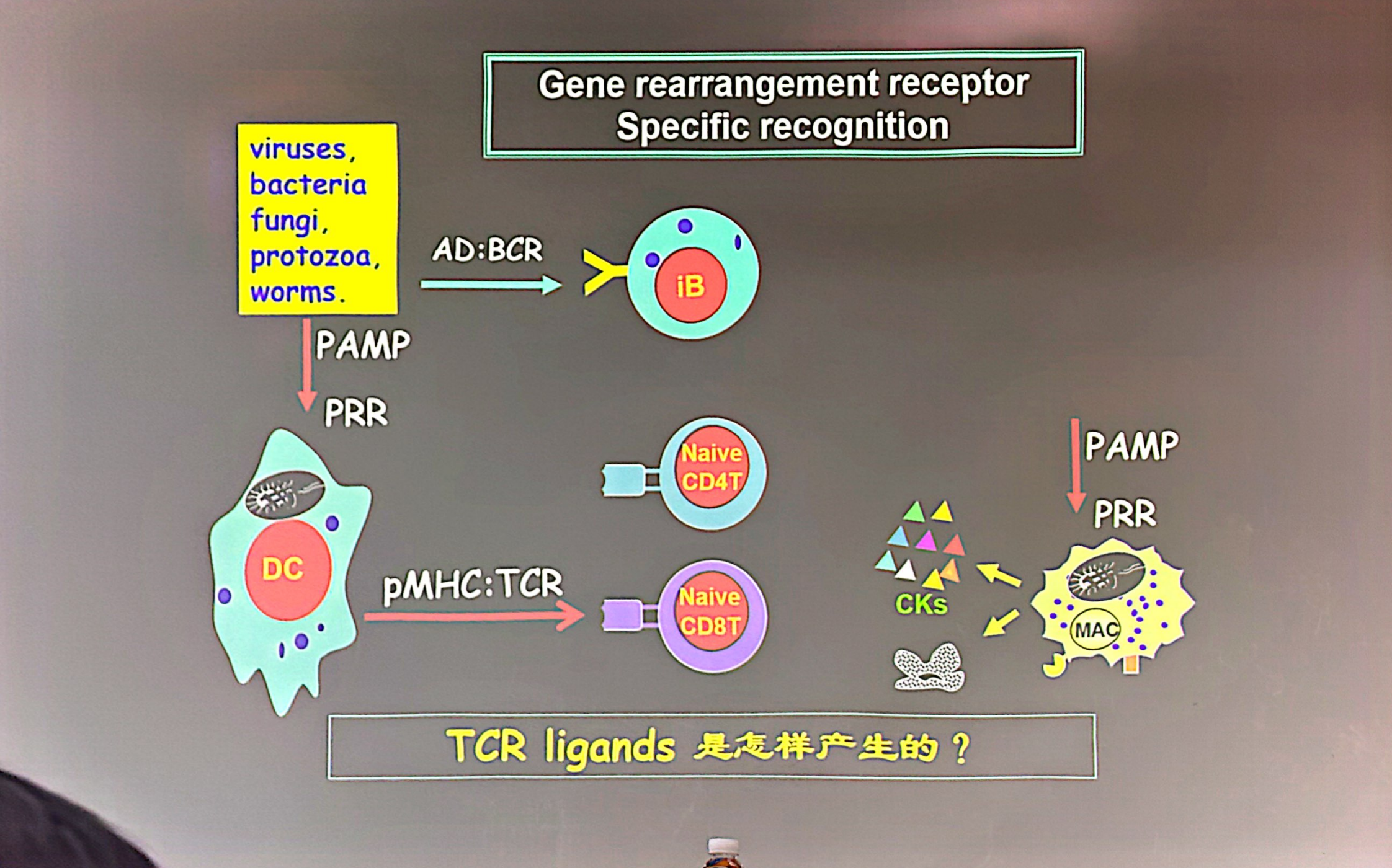


Gene conversion



class switch recombination




Gene rearrangement receptor
Specific recognition
viruses,
bacteria
fungi,
protozoa,
worms.
AD:BCR
iB
PAMP
PRR
DC
Naive
CD4T
pMHC:TCR
Naive
CD8T
PAMP
PRR
CKs
MAC
TCR ligands 是怎样产生的？

抗原加工和提呈

- Antigen processing：APC首先在感染或炎症局部摄取抗原，然后在细胞内降解抗原并将其加工处理成抗原多肽片段，在以抗原肽-MHC复合物形式表达于APC细胞表面。
- Antigen presentation：APC与TC接触时，抗原肽-MHC复合物被TC的TCR识别，从而将抗原信息传递给TC，引起TC的活化。
- APC所表达的I类和II类MHC分子是抗原多肽的载体，分别提呈内源性（endogenous)和外源性(exogenous）抗原
- APC摄取、加工和提呈抗原主要有有二条途径：

MHC-I途径： presented endogenous antigen

MHC-II途径： presented exogenous antigen

CD1分子途径: presented lipids antigen

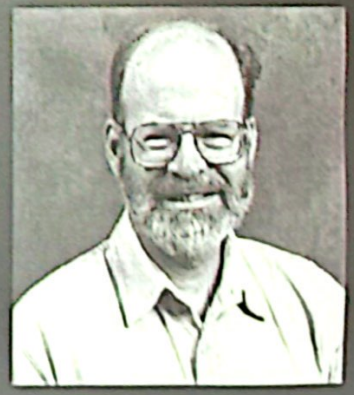
抗原提呈的两条途径

	MHC I pathway	MHC II pathway
Uptake	Intracellular	Extracellular
APCs	nucleated cells	cDC、BC、MAC
Degradated in	Cytosol (proteasome)	Endocytic vesicles (endosome-lysosomoe)
Antigenic Peptides	8-10aa	13-18aa
Peptides bind to	MHC class I	MHC class II
Peptides-MHC complex formation	ER	MIIC
Molecular chaperone	TAP1, 2, Er57, tapasin, calnexin, calreticulin	Ii,HLA-DM
Presented to	$CD8^+TC$	$CD4^+TC$

CD1分子：提呈的脂类/糖脂类抗原

cross-presentation：MHC II→MHC I

Autophagy：MHC I→MHC II



Lecture-10

Kenneth Murphy, Paul Travers, Mark Walport

Immunobiology (8ed)

PART II The recognition of antigen

Chapter 6 Antigen Presentation to T Lymphocytes

Section-2 The major histocompatibility complex and its functions

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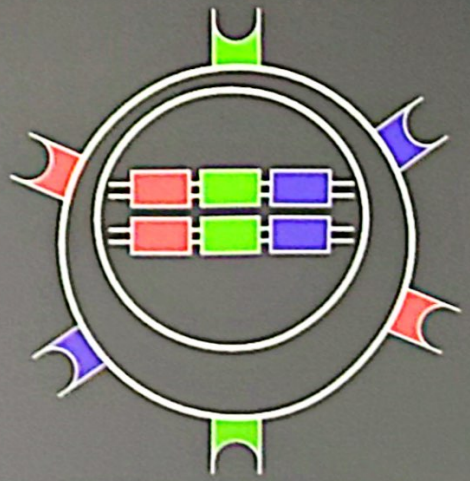
MHC的特点

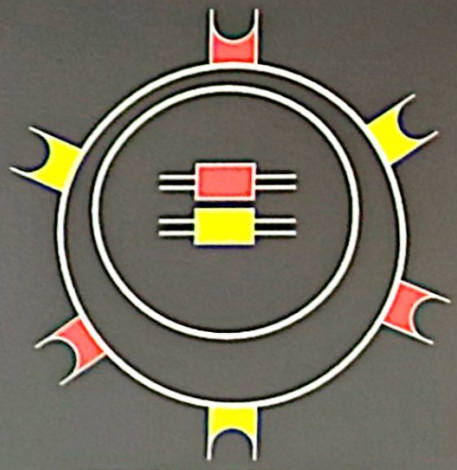
Codominance

Polygeny



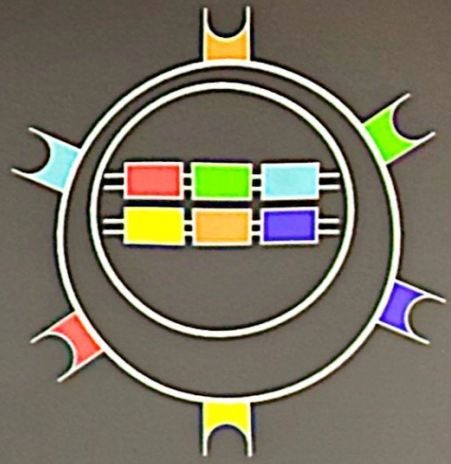
hMHC-I: HLA-A,B,C
hMHC-II: HLA-DR,DQ,DP

Polymorphism



hMHC-I: 6383 alleles
hMHC-II: 2050 alleles
2010

Polymorphism
Polygeny



Diversity of
MHC molecules

1.环境压力特别是病原压力在自然选择下，有利的遗传变异体被保留下来，是产生MHC分子高度多态性的主要因素。

2.多态性提高了人群整体对感染的抵抗力，避免了一个群体全体个体对病原菌易感。多基因和共显性则进一步扩大了个体免疫应答的范围。

Antigens, superantigens and Alloantigens

- Nominal antigens: 0.001% to 0.01% of T cells
- Alloantigens: 1% to 10% of T cells
- Superantigens: 2% to 20% of T cells

Specialized MHC class I molecules act as ligands for the activation and inhibition of NK cells.

T-cell recognition of antigens is MHC restricted

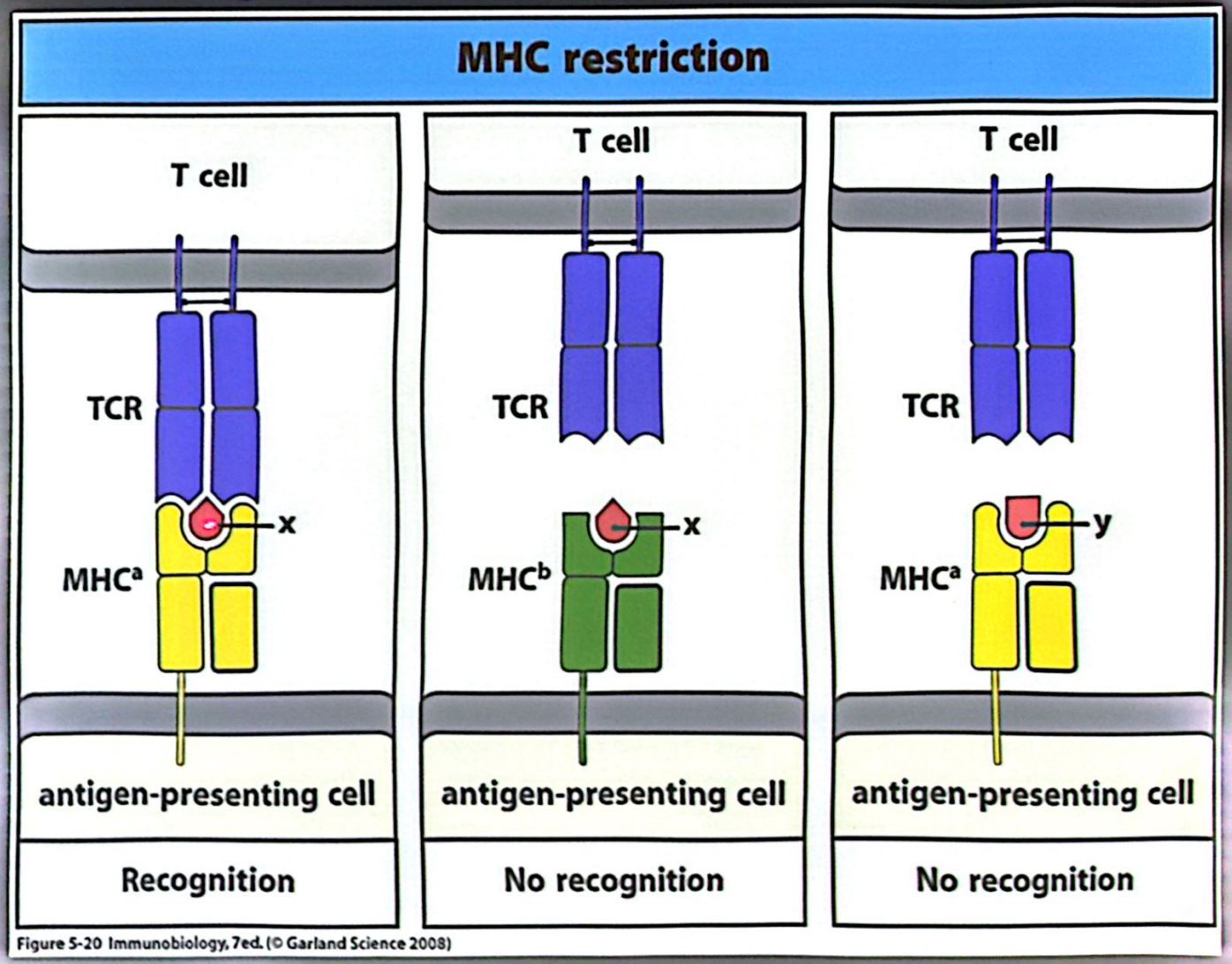


Figure 5-20 Immunobiology, 7ed. (© Garland Science 2008)

Questions?

- 按照MHC限制性理论，若同种（异体）移植(allogeneic transplantation)供者（donor）APC与受者（ recipient ）TC间MHC型别不同，二者理论上不能发生相互作用。

- 无关个体间allogeneic transplantation中，宿主（host）与移植物所表达的MHC抗原型别不一致，recipient TC对移植Ag的识别是如何跨越MHC限制性而得以实现？

- MLR研究显示大约有占TC总数1-10%的TC将对从另外一个无关的、同种族的个体的刺激有反应。这种类型的TC可对异基因MHC分子等位基因直接识别，称为同种反应性T细胞（alloreactive TC），其应答被称为同种反应性。

- 直接识别导致的排斥反应具有两个特点：速度快和强度大

- 同一TCR可识别不同的肽-MHC分子复合物（pMHC）。具有直接识别能力的recipient 的alloreactive TC并非一个独立的群体，它们实际上是recipient体内识别外源性抗原、但同时可交叉识别（crossreactive recognition ）Allogeneic Ag的TC。其机制：

- 1、TCR与pMHC结合界面的结构特征

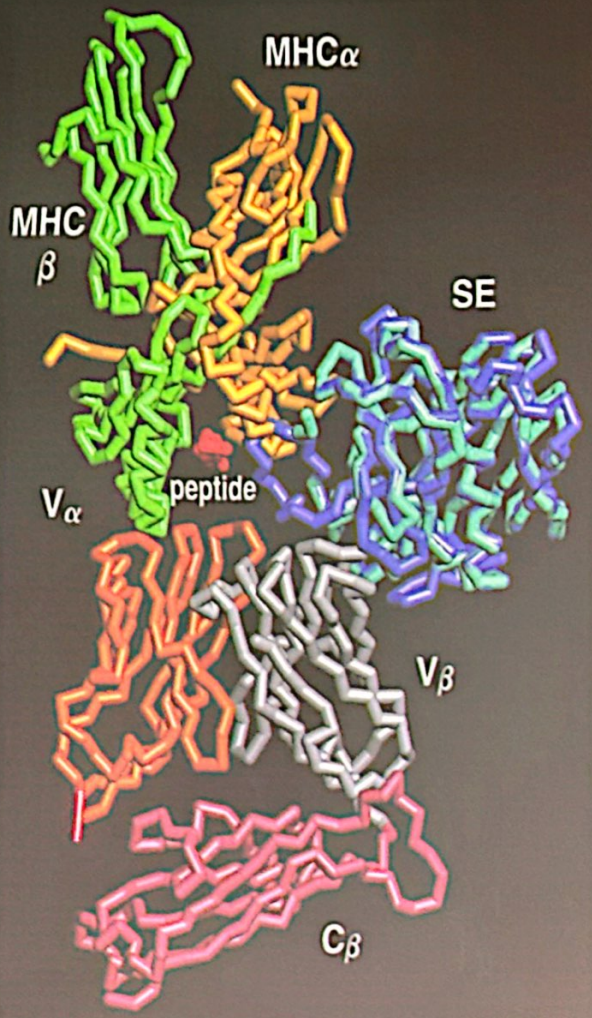
- 2、 肽的优势结合

- 3、 MHC分子优势结合

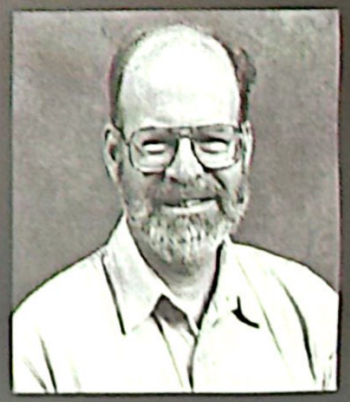
5-15. Many T cells respond to superantigens

Superantigen, SAg

* SAg:指那些同时与MHC分子及TCR多肽链结合，从而非特异地激活多克隆T细胞的蛋白质大分子。
* Endogenous SAg: 逆转录病毒和棒状病毒编码的模型蛋白质分子。
* Exogenous SAg:为细菌分泌的可溶性外毒素。



抗原识别R是怎样传递信号的？



Lecture-11

Kenneth Murphy, Paul Travers, Mark Walport

Immunobiology (9ed)

PART III The development of mature lymphocyte receptor repertoires

Chapter 7 Lymphocyte Receptor Signaling

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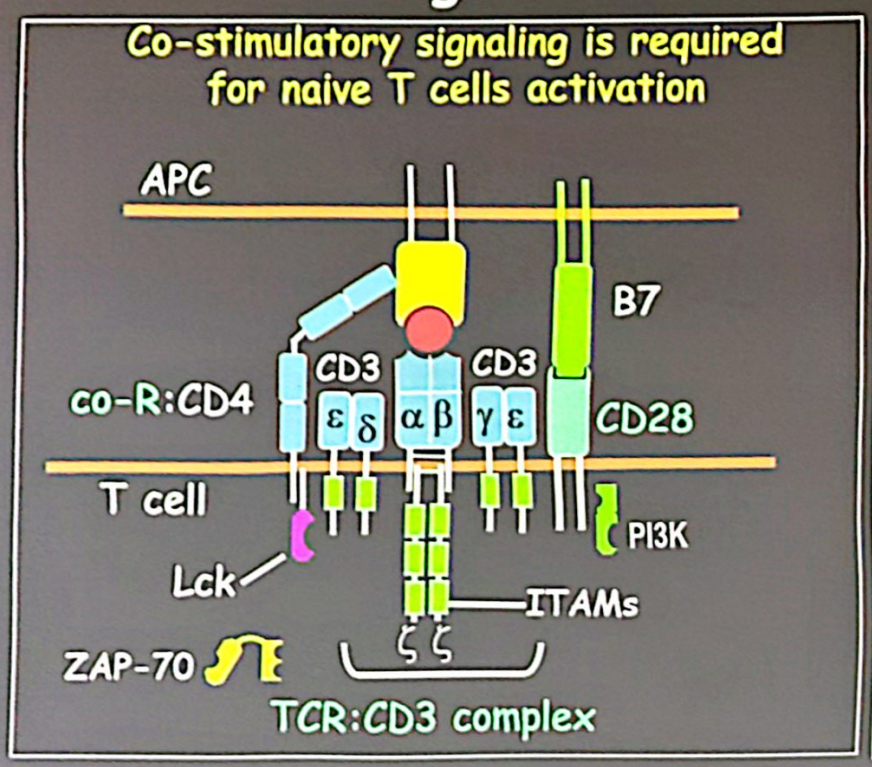
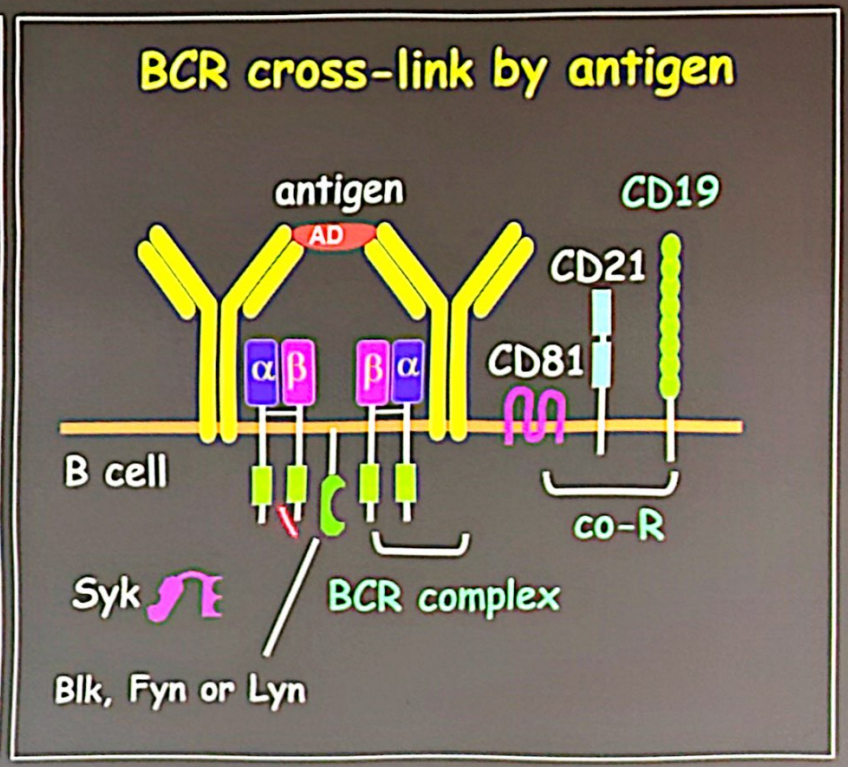
Immunologic Recognition

Signaling R	BCR complex	TCR-CD3 complex (ITAM)
TLRs,NLRs	(ITAM)	TC co-receptor
RLRs, STING	BC co-receptor	Co-stimulatory molecules
		inhibitory receptors

1.the synthesis of new proteins
2.induce cell division and differentiation
3.induce cell death

Signal transduction of TCR and BCR



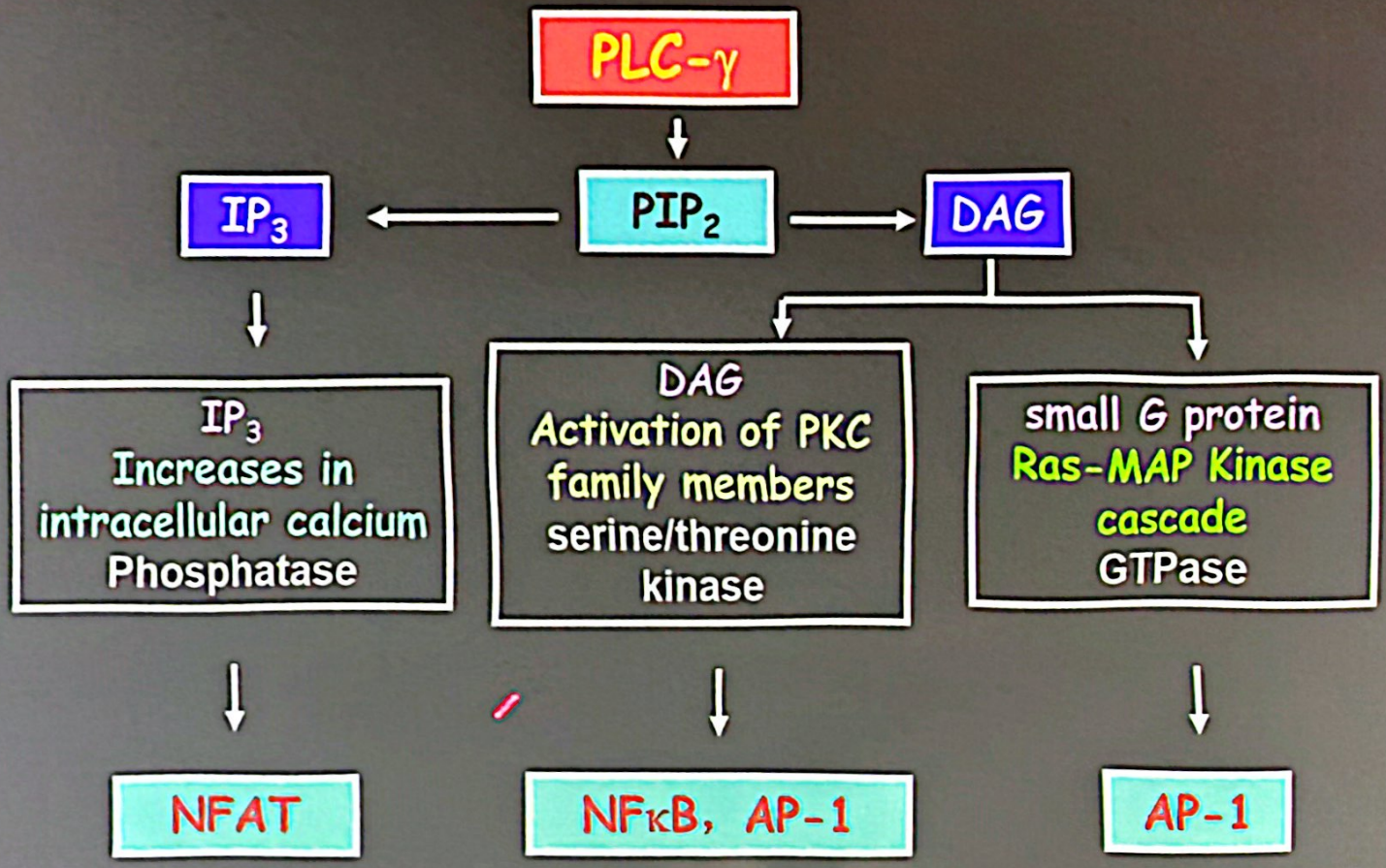


PTK family	TCR	BCR
1. Src-family:	Lck	Blk, Fyn or Lyn
2. Syk-family:	ZAP-70	Syk
4. Tec-family:	Itk	Btk

Lipid kinase
3. PI3K

Phospholipase
5. PLC-γ

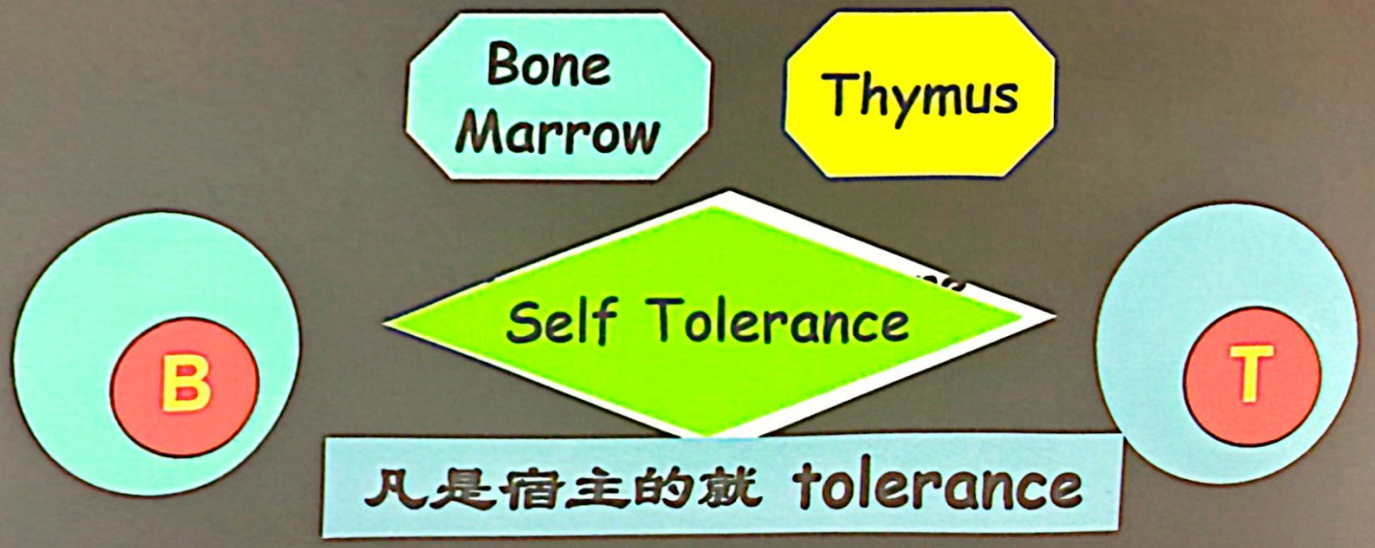
Signal pathway & transcription factors in T and B cells activation



Inhibitory signaling receptor on LC downregulate immune responses

Checkpoint Blockade: Approach to tumor therapy that attempts to interfere with the normal inhibitory signals that regulate lymphocytes.

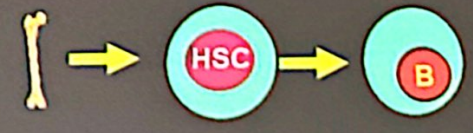
Central or primary lymphoid organs



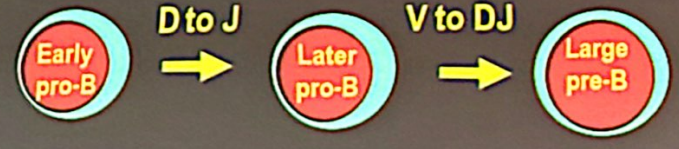
Blood and Lymph circulation

The Development and Survival of B/T cells

Development of B lymphocytes

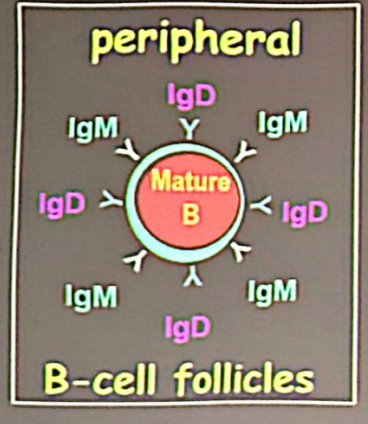
1. 

2.begins heavy -chain rearrangement



① inhibits further heavy-chain rearrangement
② enforces allelic exclusion.
③ cell proliferation

3.light-chain rearrangement



4.iB cells central tolerance-negative selection of B cells
① Deletion ② Receptor Editing ③ Anegry ④ Ignorant

5.B cells peripheral tolerance
① Apoptosis ② Anegry ③ Ignorant

6.B cells subset
① B-1 ② B-2 (FBC) ③ MZB (B-2)

Lecture-13

Kenneth Murphy, Paul Travers, Mark Walport

Immunobiology (9ed)

PART III The development of mature lymphocyte receptor repertoires

Chapter 8 The Development of B and T Lymphocytes

Section-2 Development of T lymphocytes
Section-3 Positive and negative selection of T cells

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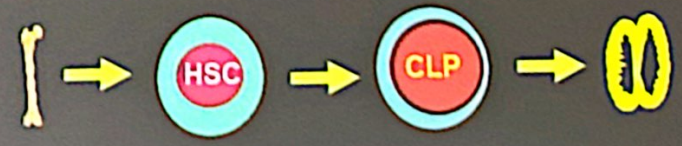
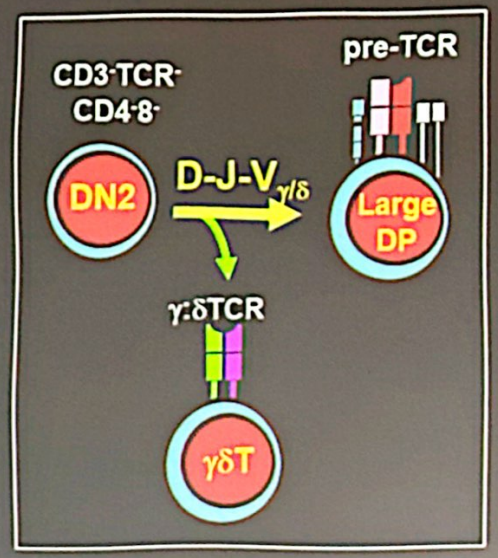
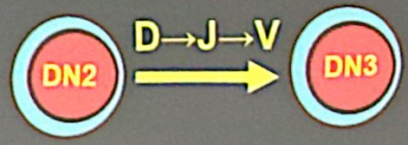
Development of T lymphocytes

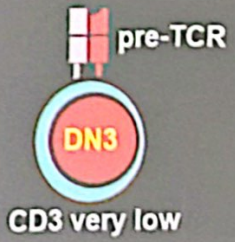
1. 

2.begins 

3.γδTC or αβTC: a common progenitor →

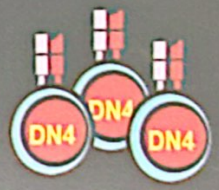


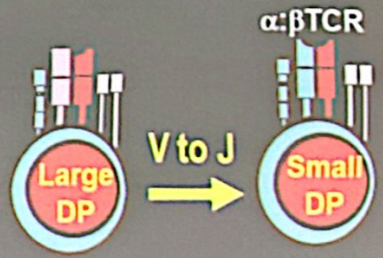
4.β-chain rearrangement 



① shuts off β rearrangement on 2nd chromosome

② Ensures only one specificity of TCR expressed per cell

5. DN4: cell proliferation 

6.CD4/8 and α-chain rearrangement 

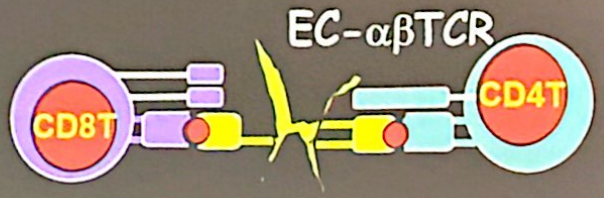
selective events begin

Development T lymphocytes

7. T cells-Positive selection

① Thymic cortex

② MHC-restricted:

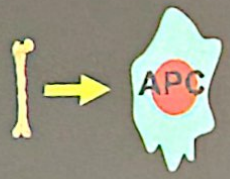


③ TF: ThPOK → CD4T Runx3 → CD8T FoxP3 → Treg

8. T cells-negative selection

① Thymocytes: cortex or medulla

② SP T cells : BM-derived APC

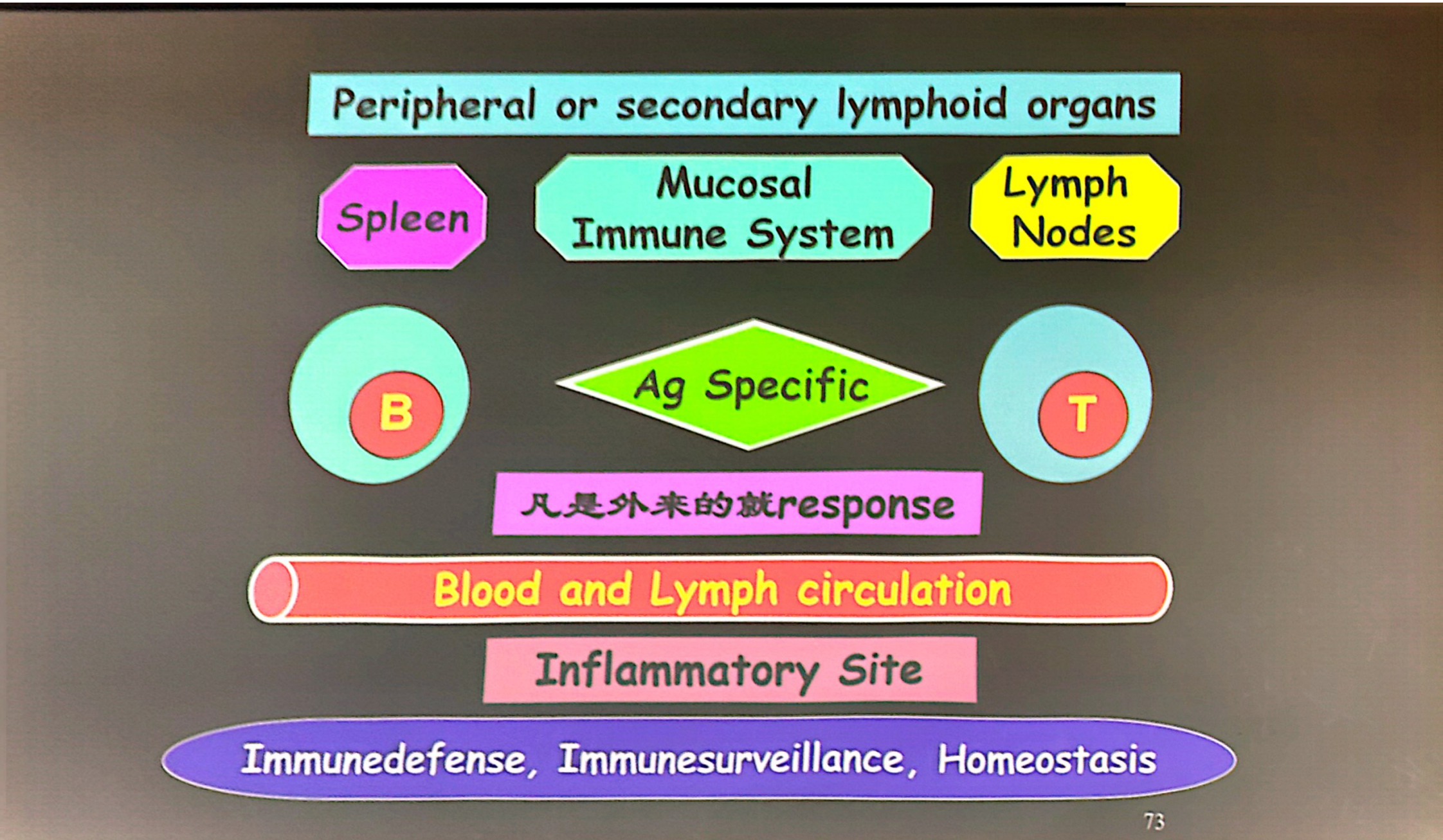


③ Central tolerance: Deletion

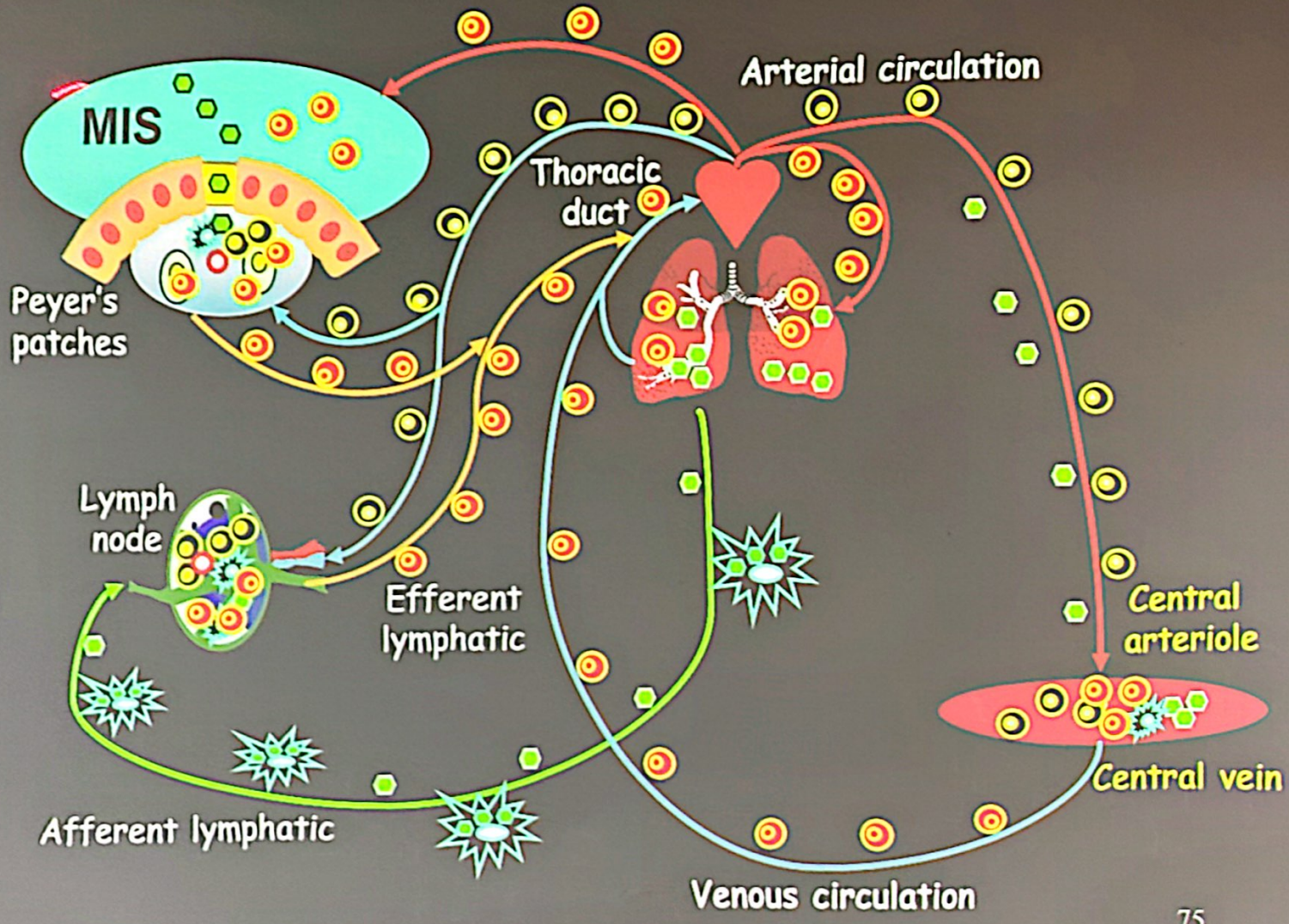
9. Final T cells maturation: Thymic medulla T cells-S1PR1↑ → peripheral

10. T cells peripheral tolerance: ① AICD ② Anegry

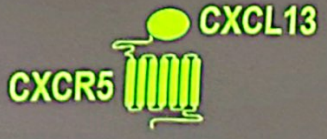
11. T cells subset: ① αβT ② γδT, dETCs (γδT) ③ NKT


Peripheral or secondary lymphoid organs
Spleen
Mucosal Immune System
Lymph Nodes
B
Ag Specific
T
凡是外来的就response
Blood and Lymph circulation
Inflammatory Site
Immunedefense, Immunesurveillance, Homeostasis

LYMPHOCYTE RECIRCULATION

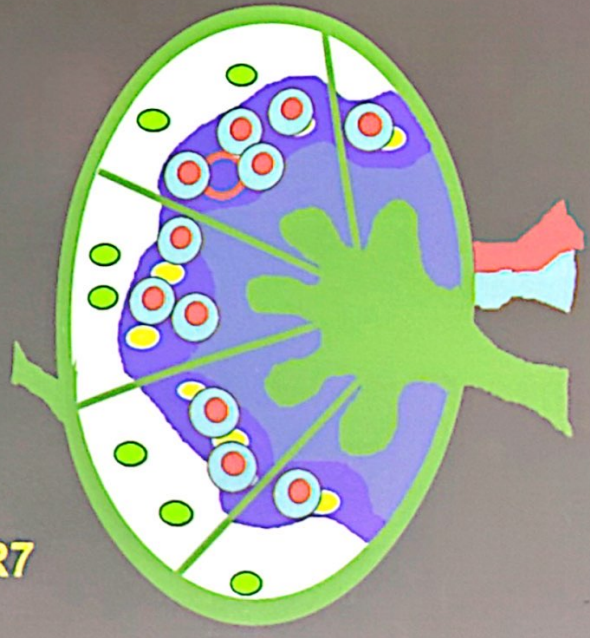


Development and function of secondary lymphoid organs



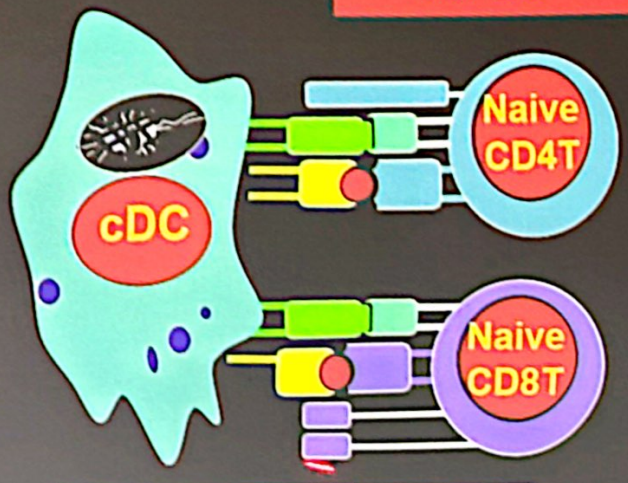
naïve T cells

naïve B cell

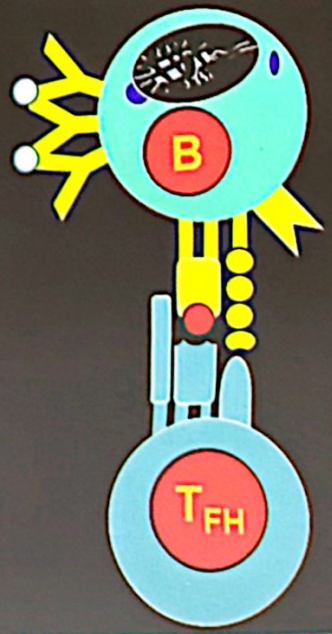


The organizing the T-cell zone: CCL21, CCL19: CCR7

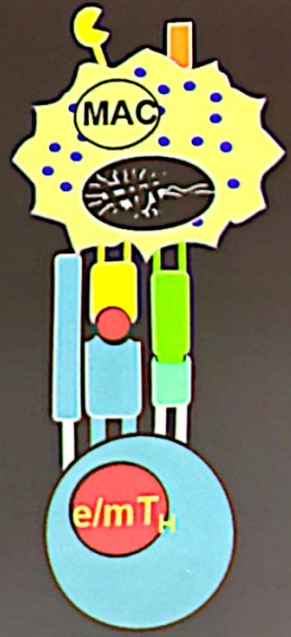
APCs



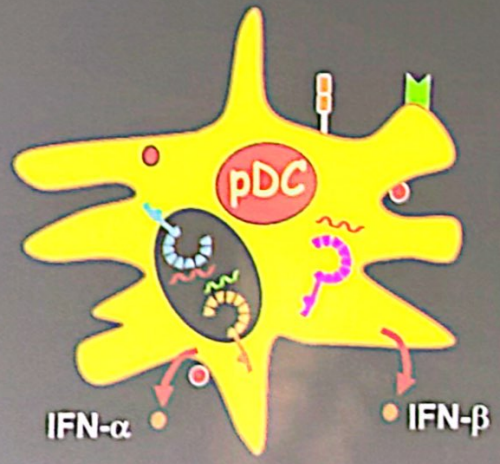
cDC: activation of naïve T cells



B cells are presenting antigens to T_{FH}

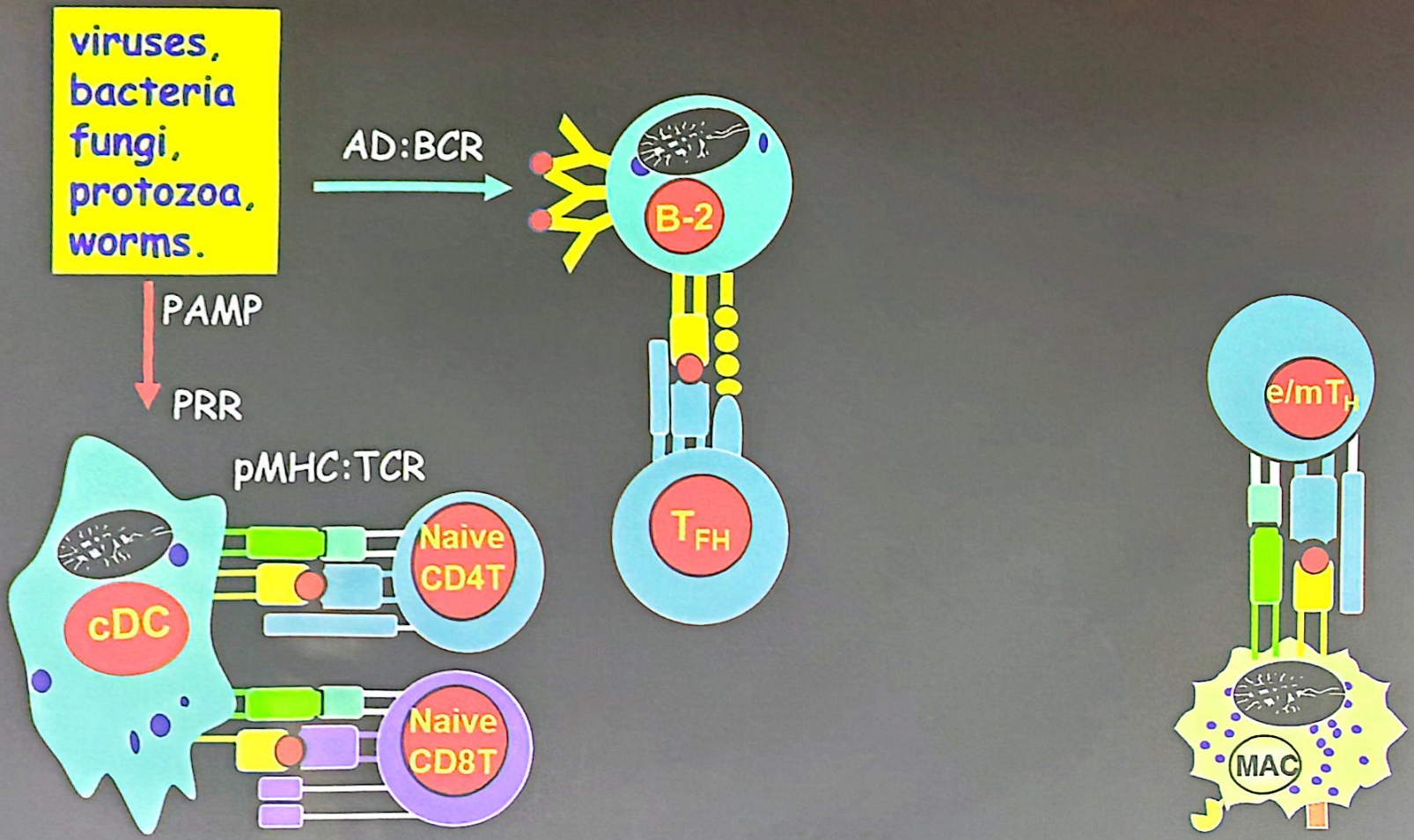


MAC are scavenger cells and is important for the maintenance and functioning of effector or memory T cells.



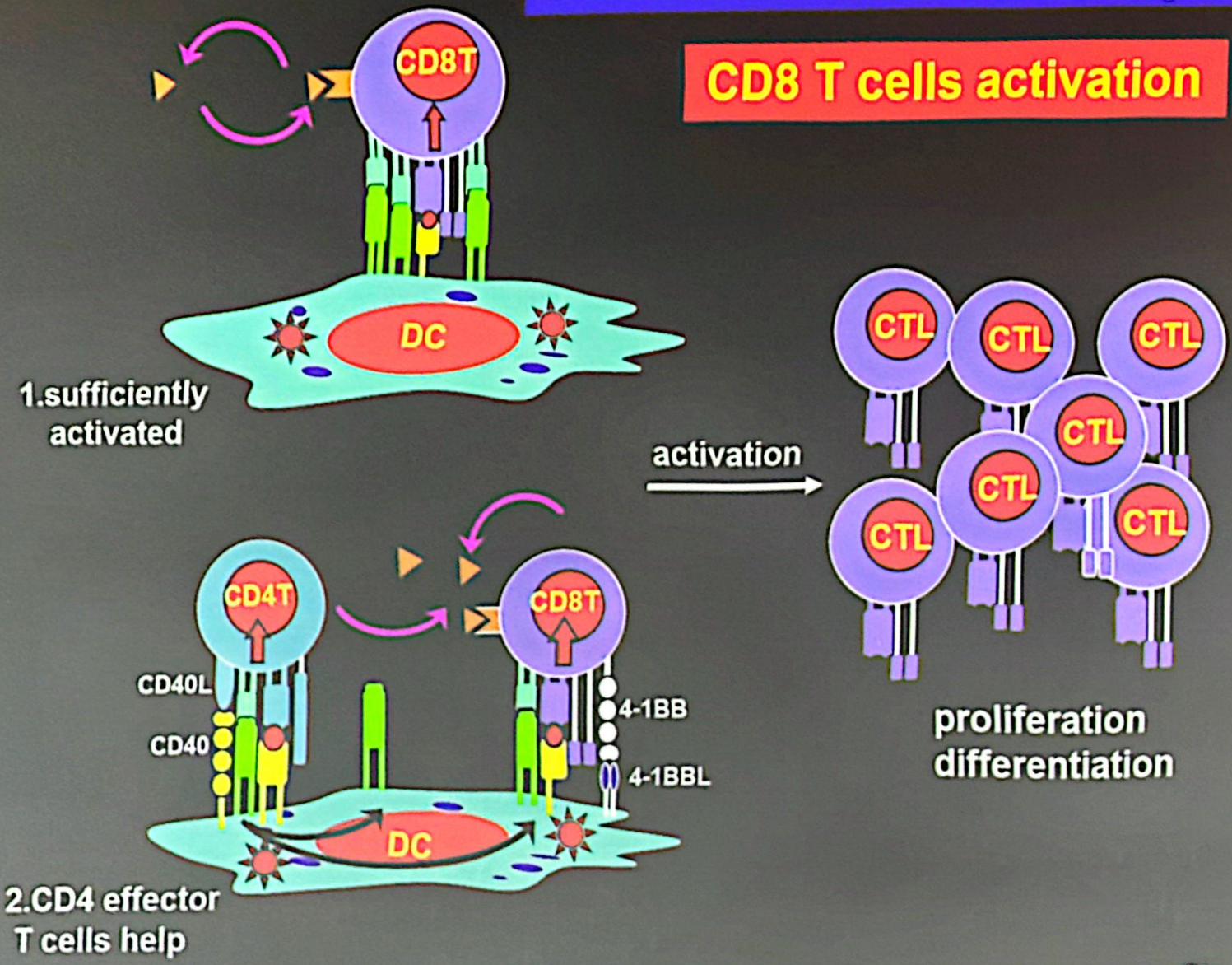
pDC: produce abundant IFN-I and against viral infection

Activation、proliferation and differentiation of T cell



Cell-mediated immune response

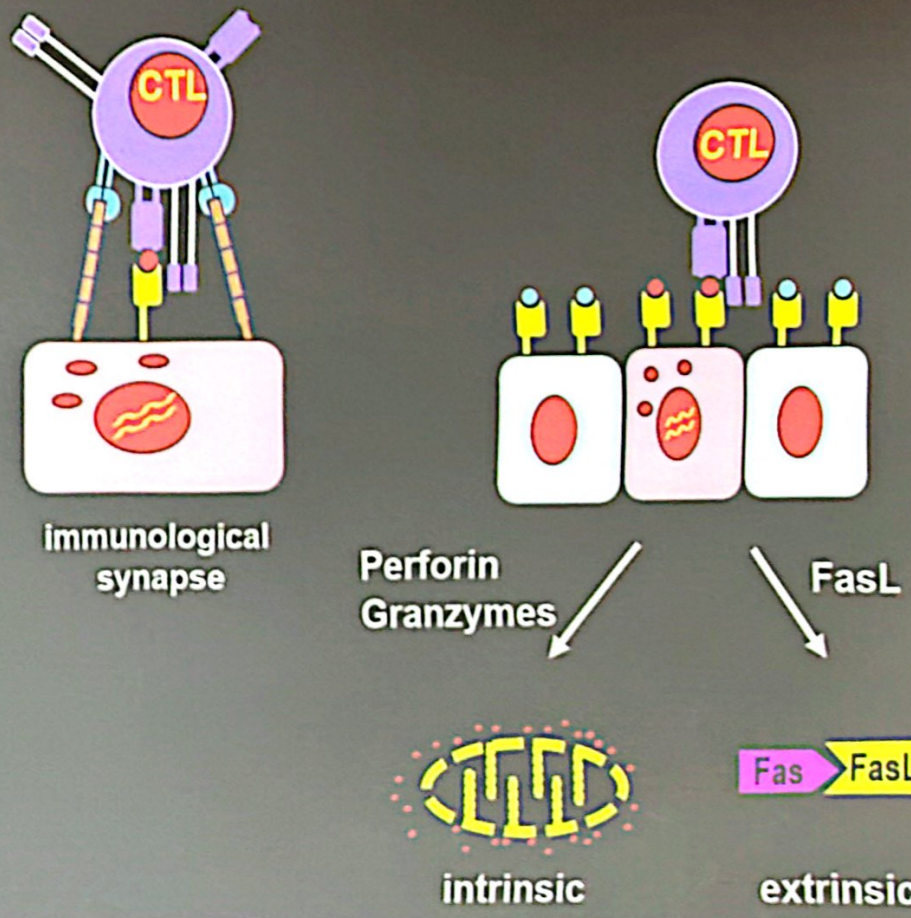
CD8 T cells activation



Three signals of T cells activation、proliferation and differentiation

Cell-mediated immune response

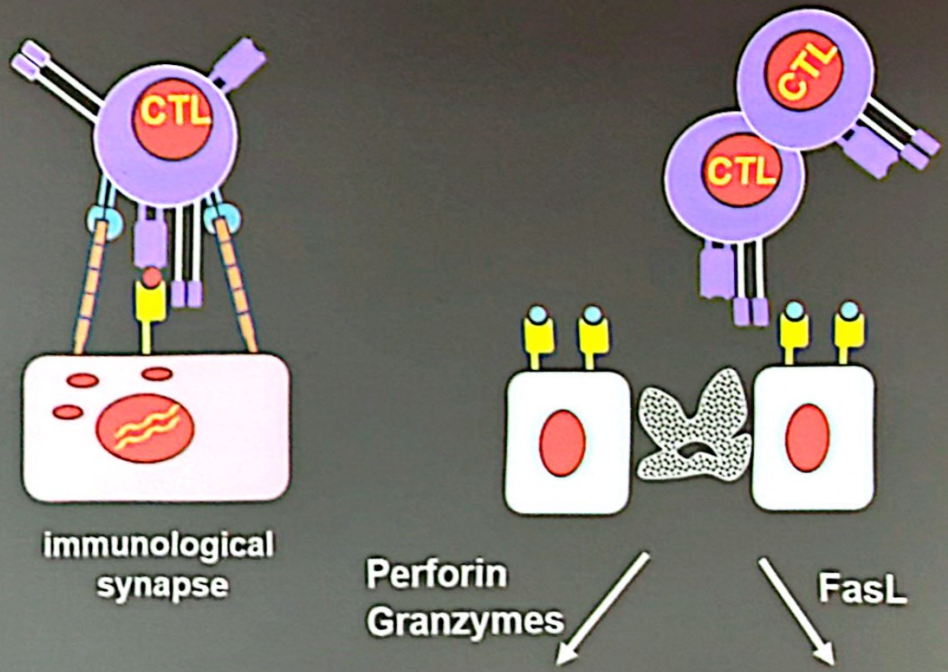
CD8 T cells function



Effector CD8 T cells can respond to their target cells without co-stimulation

Cell-mediated immune response

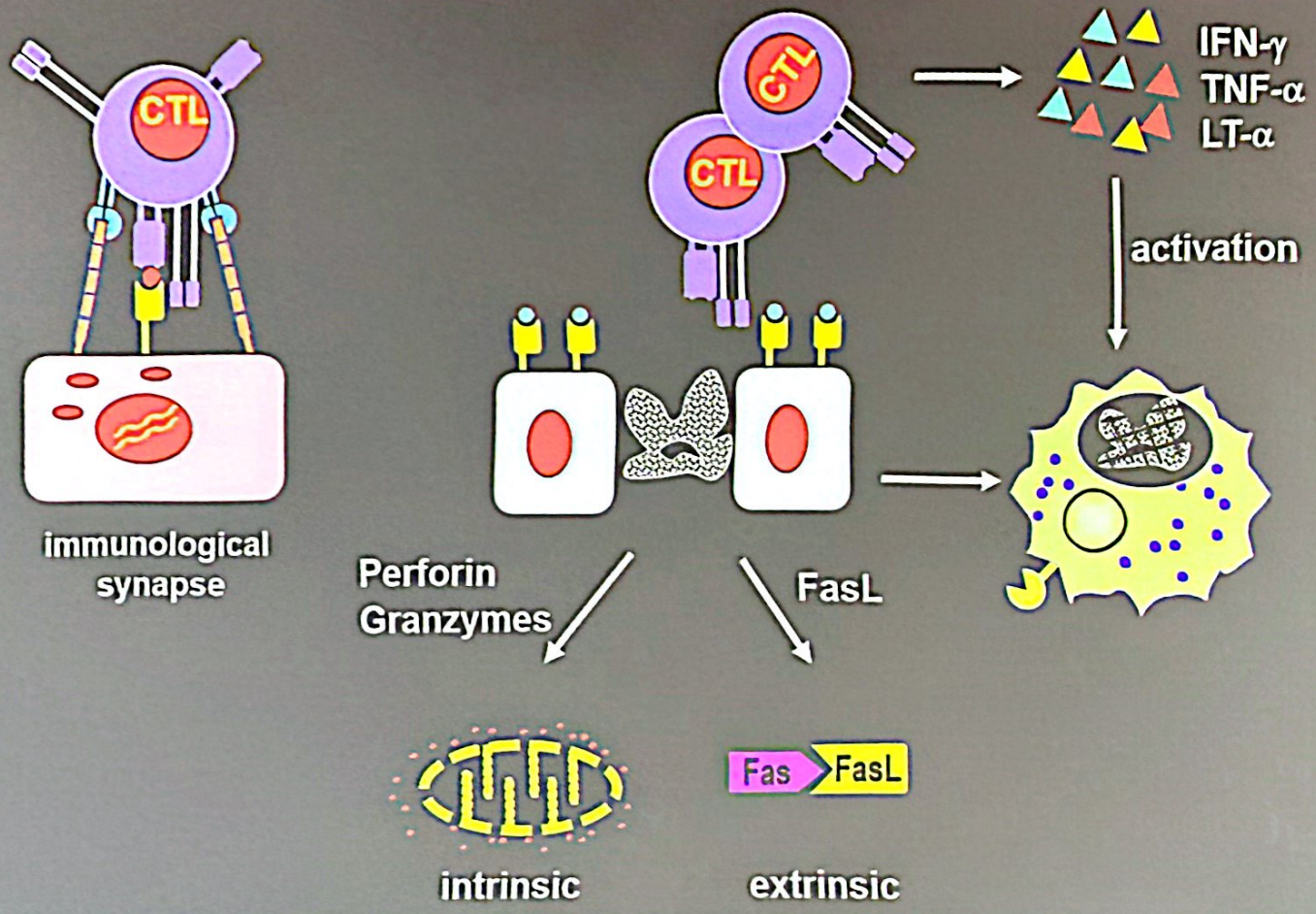
CD8 T cells function



Effector CD8 T cells can respond to their target cells without co-stimulation

Cell-mediated immune response

CD8 T cells function



Effector CD8 T cells can respond to their target cells without co-stimulation

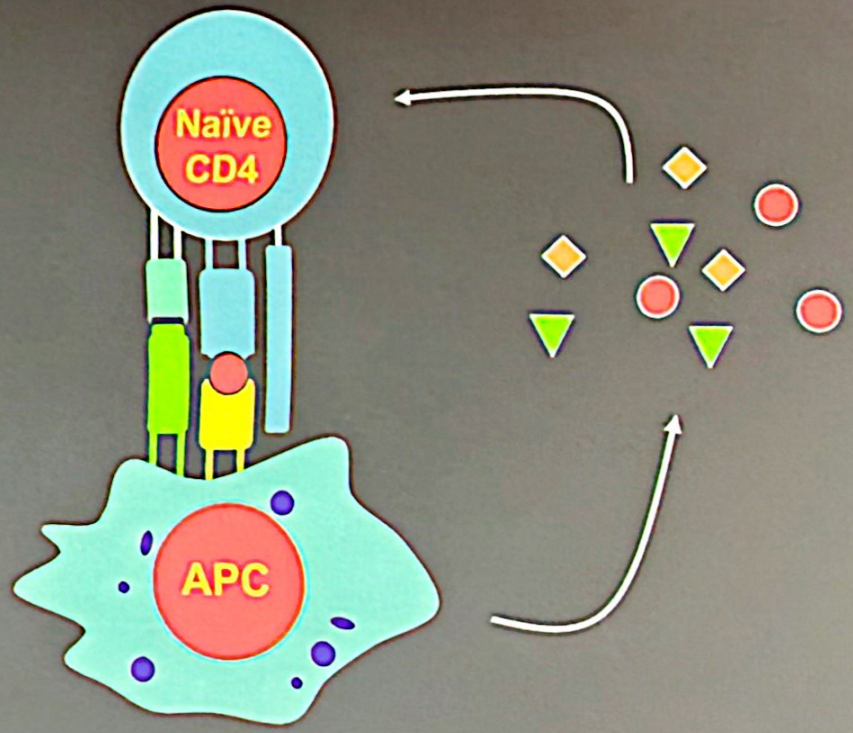
Cell-mediated immune response

CD4 T cells activation

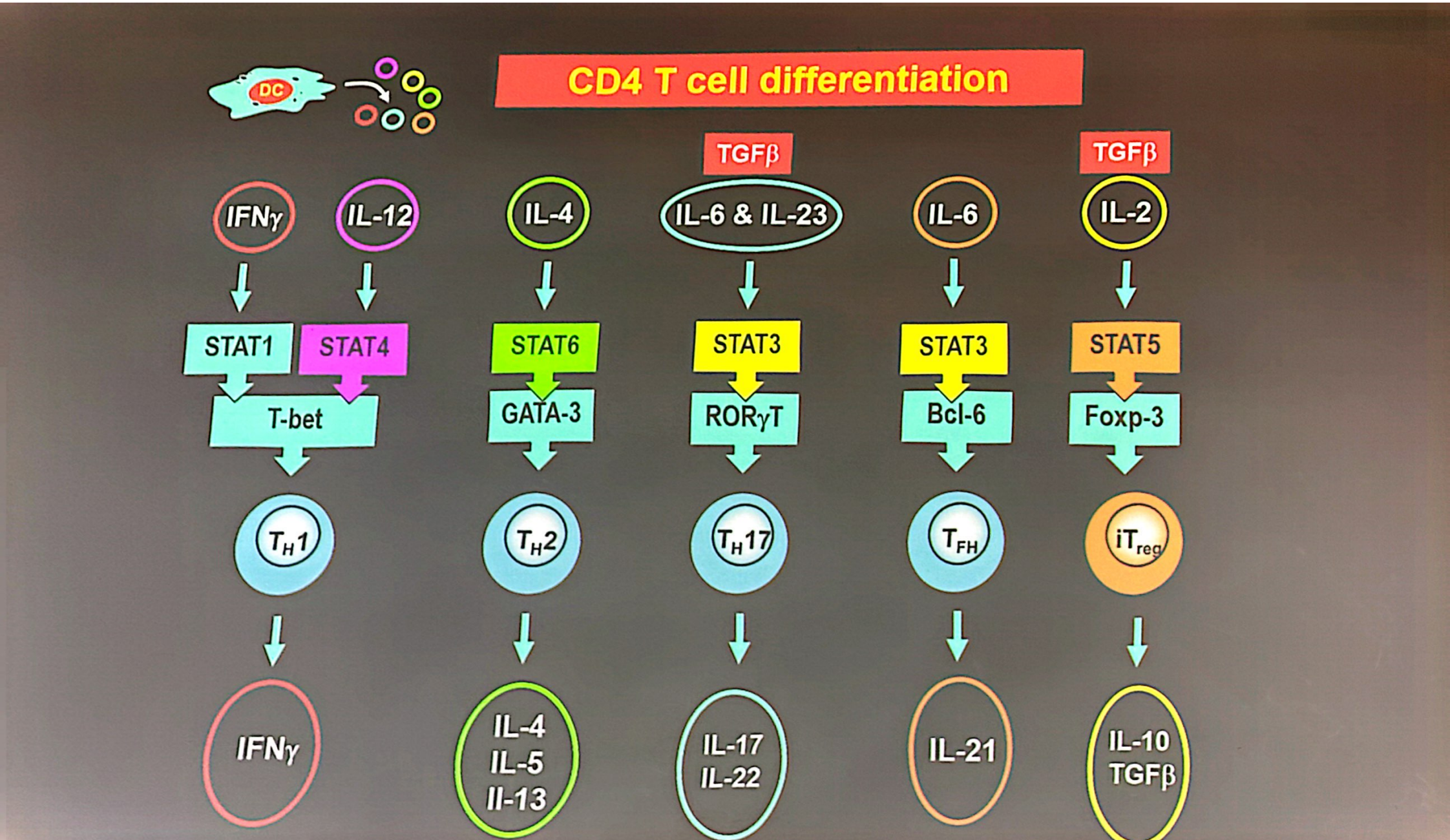
Signal 1:
Ag Recognition

Signal 2:
Co-stimulation

Signal 3:
Differentiation

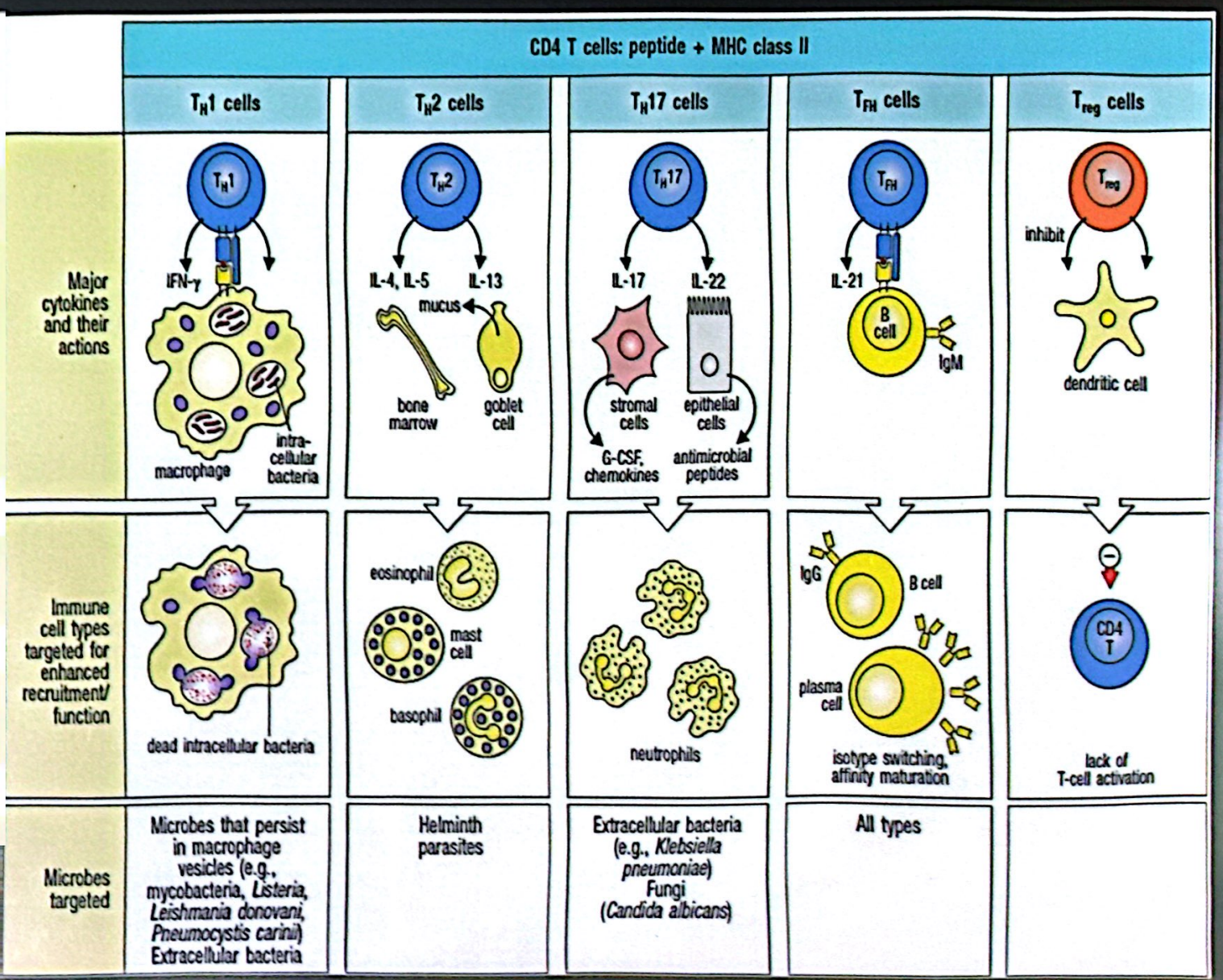


Three signals of T cells activation、proliferation and differentiation


DC
CD4 T cell differentiation
IFNγ
IL-12
IL-4
TGFβ
IL-6 & IL-23
IL-6
TGFβ
IL-2
STAT1
STAT4
STAT6
STAT3
STAT3
STAT5
T-bet
GATA-3
RORγT
Bcl-6
Foxp-3
T_H1
T_H2
T_H17
T_{FH}
iT_{reg}
IFNγ
IL-4
IL-5
Il-13
IL-17
IL-22
IL-21
IL-10
TGFβ

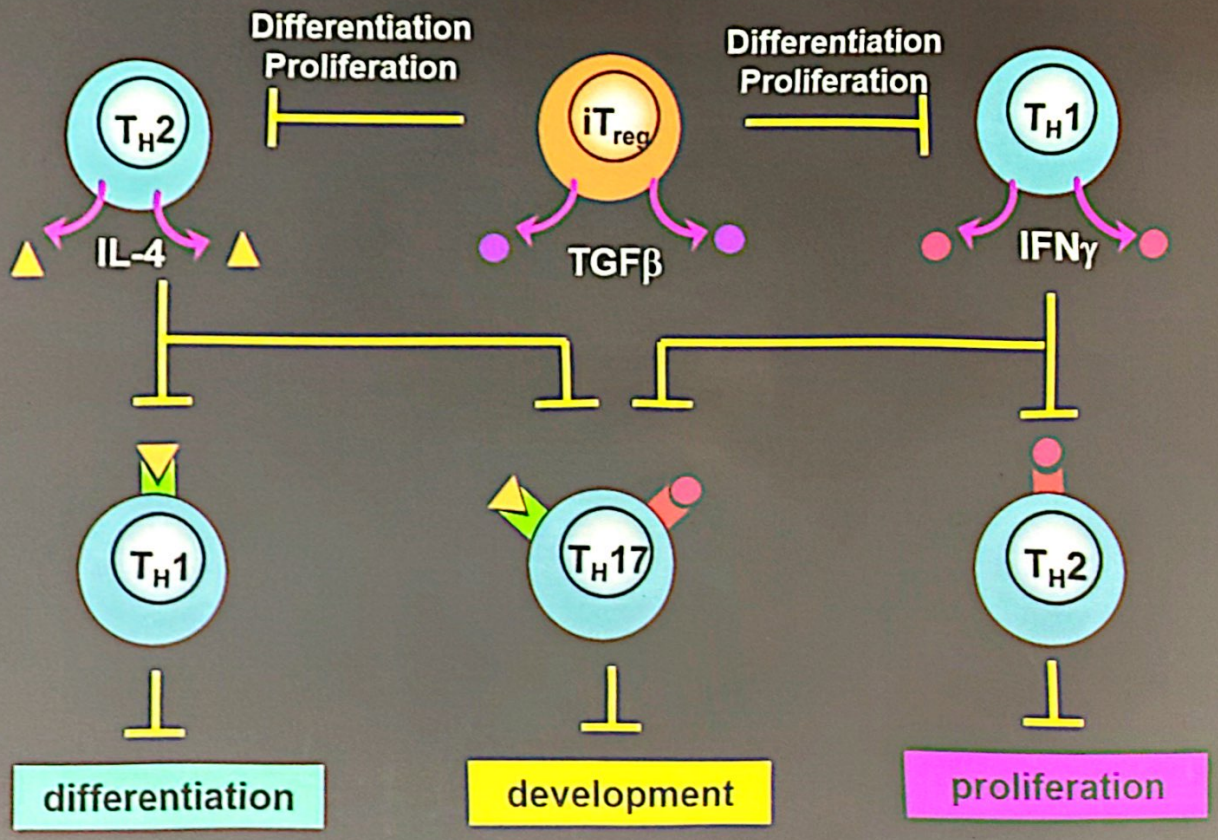
Cell-mediated immune response

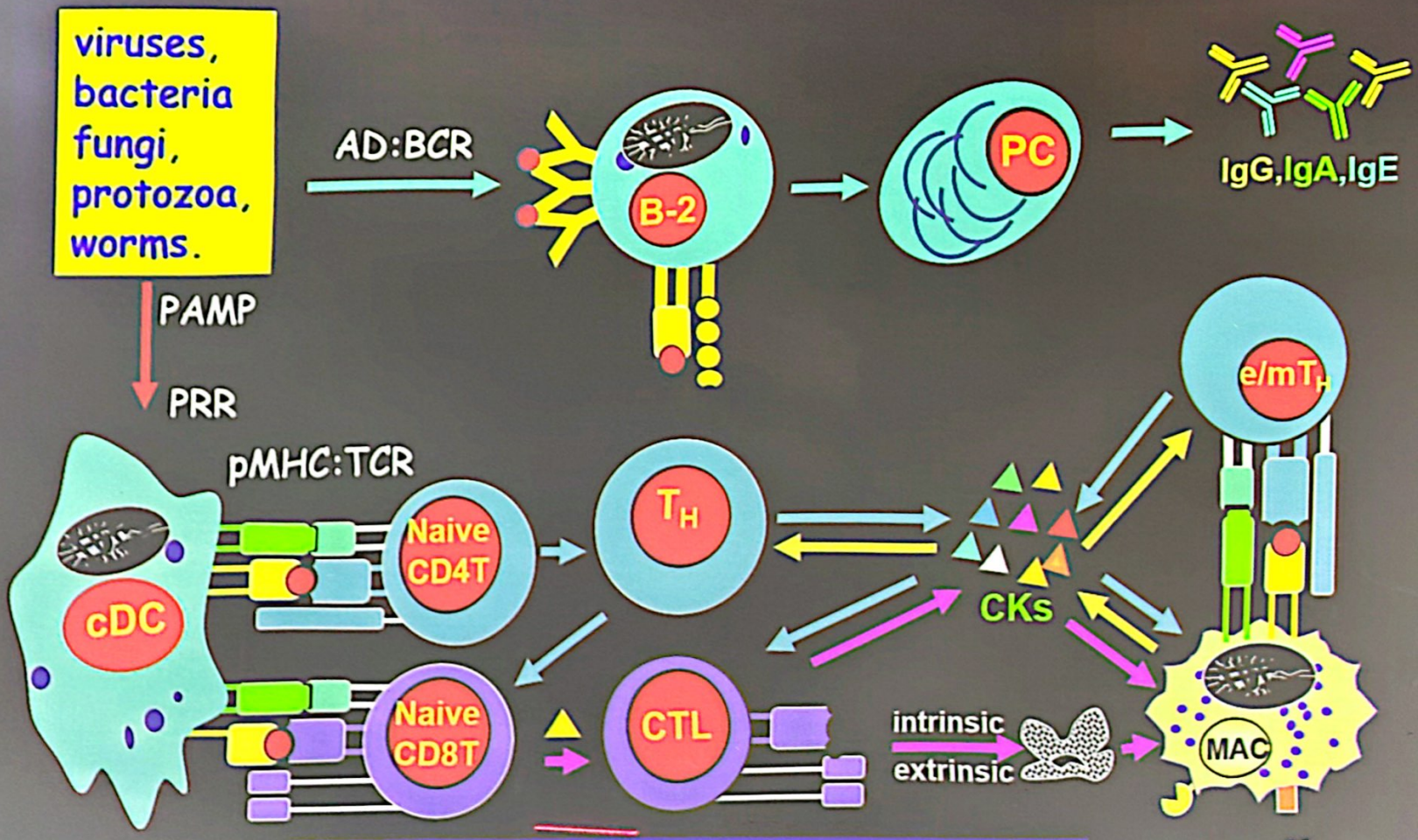
CD4 T cell function



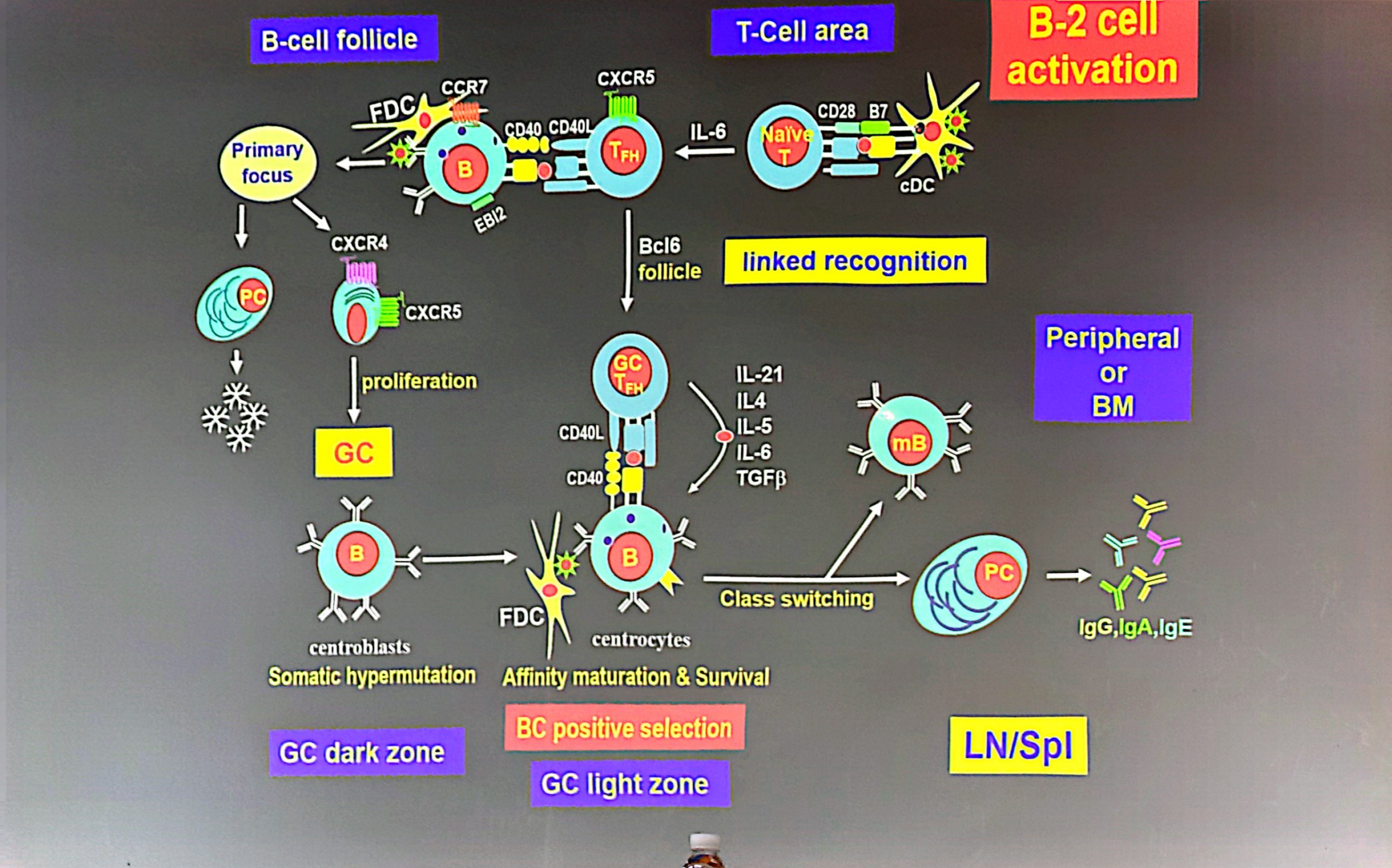
Cell-mediated immune response

CD4 T cell regulation



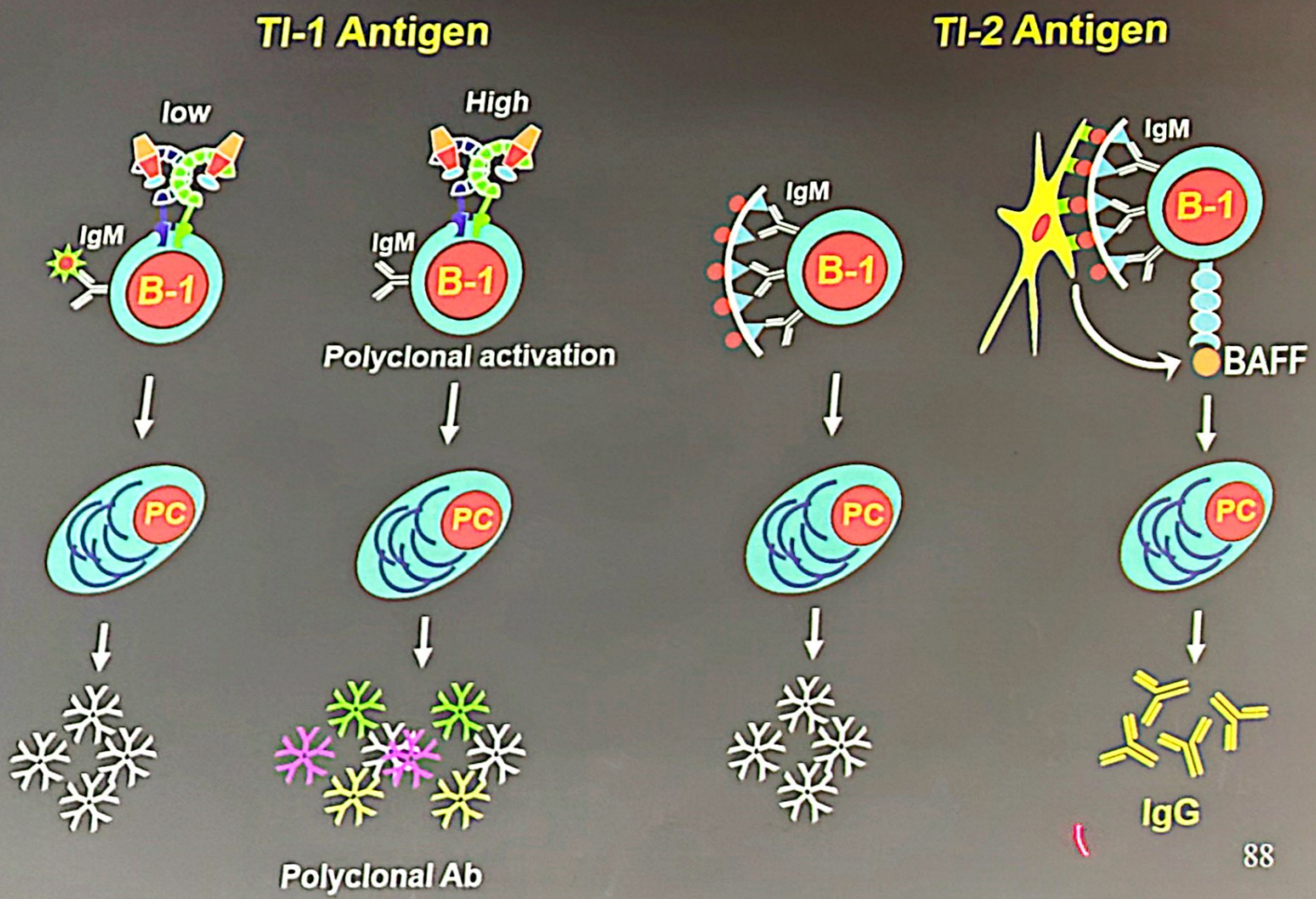


Cell-mediated immune response


B-cell follicle
T-Cell area
B-2 cell activation
FDC
CCR7
CXCR5
CD40
CD40L
IL-6
CD28
B7
Naïve T
cDC
Primary focus
B
T_{FH}
EBI2
CXCR4
CXCR5
PC
Bcl6
follicle
linked recognition
Peripheral or BM
proliferation
GC
GC T_{FH}
IL-21
IL4
IL-5
IL-6
TGFβ
mB
CD40L
CD40
B
FDC
B
PC
Class switching
IgG,IgA,IgE
centroblasts
Somatic hypermutation
centrocytes
Affinity maturation & Survival
BC positive selection
GC dark zone
GC light zone
LN/Spl

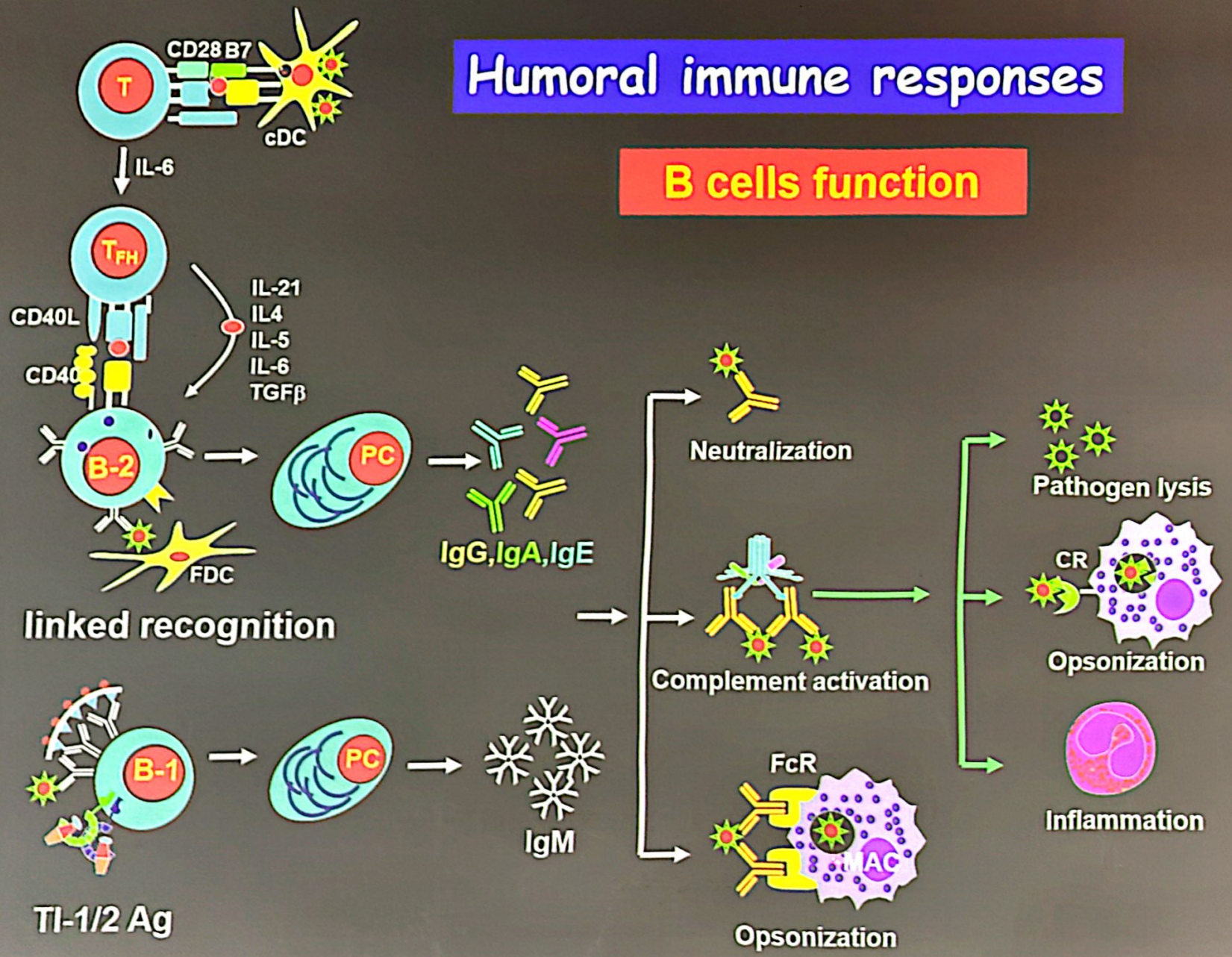
Humoral immune responses

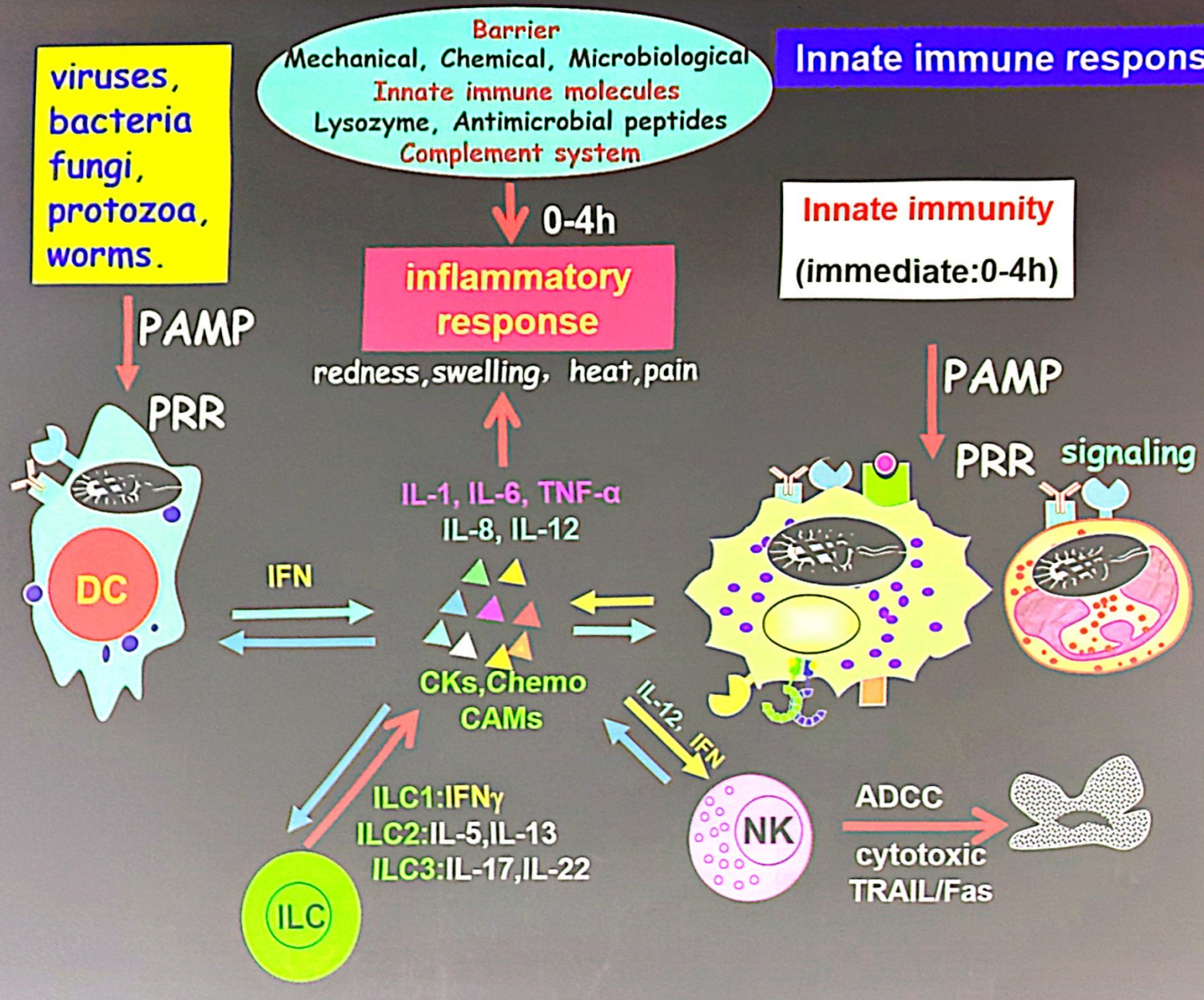
B-1 cells activation

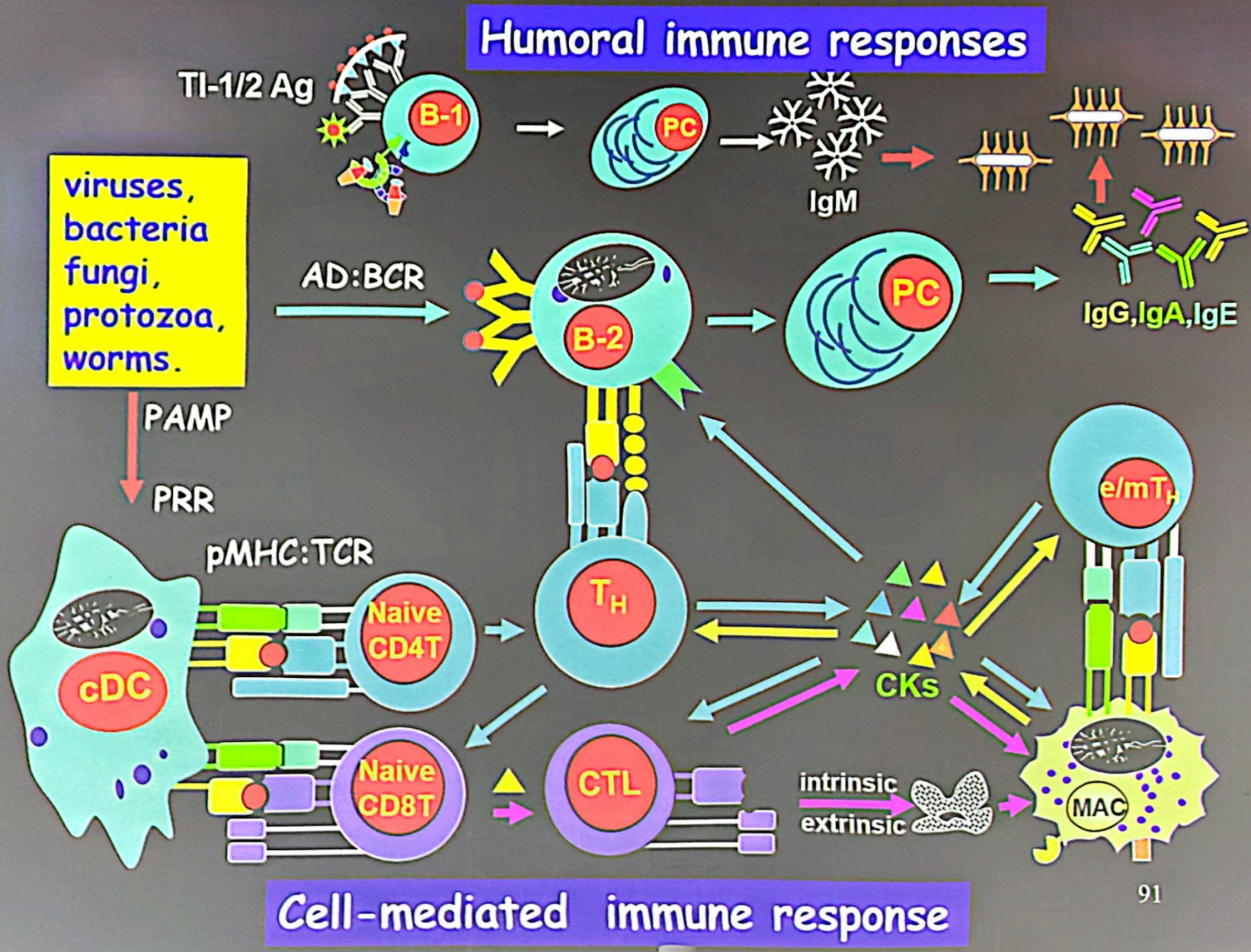


Humoral immune responses

B cells function




Barrier
Mechanical, Chemical, Microbiological
Innate immune molecules
Lysozyme, Antimicrobial peptides
Complement system
Innate immune response
viruses,
bacteria
fungi,
protozoa,
worms.
0-4h
inflammatory response
redness,swelling, heat,pain
Innate immunity
(immediate:0-4h)
PAMP
PRR
PAMP
PRR
signaling
IL-1, IL-6, TNF-α
IL-8, IL-12
DC
IFN
CKs,Chemo
CAMs
IL-12, IFN
ILC1:IFNγ
ILC2:IL-5,IL-13
ILC3:IL-17,IL-22
ILC
NK
ADCC
cytotoxic
TRAIL/Fas


Humoral immune responses
TI-1/2 Ag
B-1
PC
IgM
viruses,
bacteria
fungi,
protozoa,
worms.
AD:BCR
B-2
PC
IgG,IgA,IgE
PAMP
PRR
pMHC:TCR
cDC
Naive
CD4T
T_H
e/mT_H
CKs
Naive
CD8T
CTL
intrinsic
extrinsic
MAC
Cell-mediated immune response


The End
2024-12-29