



**MIKRONUTRIEN PENTING
UNTUK IMUNITAS DAN
PENCEGAHAN PENYAKIT**

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PENGERTIAN Mikronutrien Sistem Imun



MIKRONUTRIEN

- Micronutrients are vitamins and minerals needed by the body in very small amounts. However, their impact on a body's health are critical, and deficiency in any of them can cause severe and even life-threatening conditions.
- They perform a range of functions, including enabling the body to produce enzymes, **IMMUNE SYSTEM**, hormones and other substances needed for normal growth and development

TEMUAN DALAM IMUNOLOGI



- It has established that the complex, integrated immune system needs multiple specific micronutrients, including **vitamins A, D, C, E, B6, and B12**, folate, zinc, iron, copper, and selenium, which play vital, often synergistic roles at **every stage of the immune response**
- daily micronutrient intakes necessary to support immune function may be higher than current recommended dietary allowances

PERAN MIKRONUTRIEN

- Micronutrients (i.e., vitamins and nutritionally essential minerals) influence and **support every stage of the immune response**
- Deficiencies of micronutrients can affect both **innate and adaptive** immunity, causing immunosuppression and thus increasing the susceptibility to infections

CONTOH MIKRONUTRIEN

- **Vitamin A**
- **Vitamin D**
- **Vitamin C**
- **Vitamin B6.** Also called pyridoxine, Foods include chickpeas, tuna and potatoes.
- **Vitamin B12.** Also called cobalamin, vitamin B12 helps with red blood cell formation and proper nervous system and brain function. Foods include beef liver, salmon, milk and yogurt.
- **Vitamin C.** Also known as ascorbic acid, vitamin C is required for the creation of neurotransmitters and collagen. Foods include red peppers, oranges, grapefruits and kiwis.

MIKRONUTRIENT DARI MINERAL

- **Calcium.** This mineral helps build strong bones and teeth and helps with muscle function. Foods include yogurt, orange juice, cheese and milk.
- **Magnesium.** Found in foods like pumpkin seeds, almonds and spinach, this mineral aids in the regulation of blood pressure.
- **Sodium.** You need sodium for optimal fluid balance and to maintain your blood pressure.
- **Potassium.** Potassium helps with muscle function and nerve transmission. You can find potassium in foods like apricots, lentils, prunes and raisins.

MIKRONUTRIEN HARUS DIMASUKKAN TUBUH MELALUI MAKANAN

- Mayoritas mikronutrien tidak diproduksi oleh tubuh kita sendiri sehingga dibutuhkan asupan dari luar tubuh terutama dari bahan makanan atau pun suplemen.
- Walaupun jumlah yang dibutuhkan sangat kecil tetapi banyak yang tidak tercukupi.
- Penyebab:
 - kurangnya komponen mikronutrien dalam makanan yang dikonsumsi,
 - kondisi penyakit tertentu yang menyebabkan gangguan penyerapan zat gizi
 - Atau radikal bebas dalam tubuh menyebabkan micronutrient yang berfungsi sebagai antioksidan menjadi defisiensi

MIKRONUTRIEN ESENSIAL



Iron helps develop the brain of a fetus and child. Iron deficiency is a leading cause of anemia. Severe anemia during pregnancy can result in poor fetal growth, preterm birth, or low birth weight. Anemia during pregnancy also increases the risk of death for both the mother and baby. In addition, iron deficiency limits physical productivity and work capacity.



Folate is a general term for many different forms of vitamin B9, which is essential in the earliest days of fetal growth. Folic acid, the form of folate found in supplements and fortified foods, is the only form shown to prevent serious birth defects of the brain, spinal cord, and skull. These birth defects are often preventable if women get enough folic acid before and during early pregnancy.

MIKRONUTRIEN ESENSIAL (LANJUTAN)



Vitamin A supports healthy eyesight and immune system functions. Children who are deficient face an increased risk of blindness and death from infections such as measles and diarrhea.



Iodine is also required during pregnancy and early infancy for brain and cognitive development. Iodine deficiency can lead to developmental delays and is the most common cause of preventable mental retardation.

MIKRONUTRIEN ESENSIAL (LANJUTAN)



Zinc promotes immunity, resistance to infection, and proper growth and development of the nervous system. This mineral is also important for healthy pregnancies.



Vitamin D is essential for bone health as well as muscle and nerve functions. Vitamin D also helps the immune system fight off bacteria and viruses.

IMMUNE RESPONSE



**PRINSIP
INFECTIOUS
DISEASE**

**PAPARAN
MIKROORGANISME**

**INVASI
MIKROORGANISME**

**TUBUH MEMBUAT REAKSI
IMUN (PERLAWANAN)**

**REAKSI RADANG
(INFLAMASI)**

**TUBUH
BERHASIL
MENGELIMINA
SI MIKROBA**

INFEKSI

SAKIT

**SEHAT/TIDAK
TERINFEKSI**

AKUT

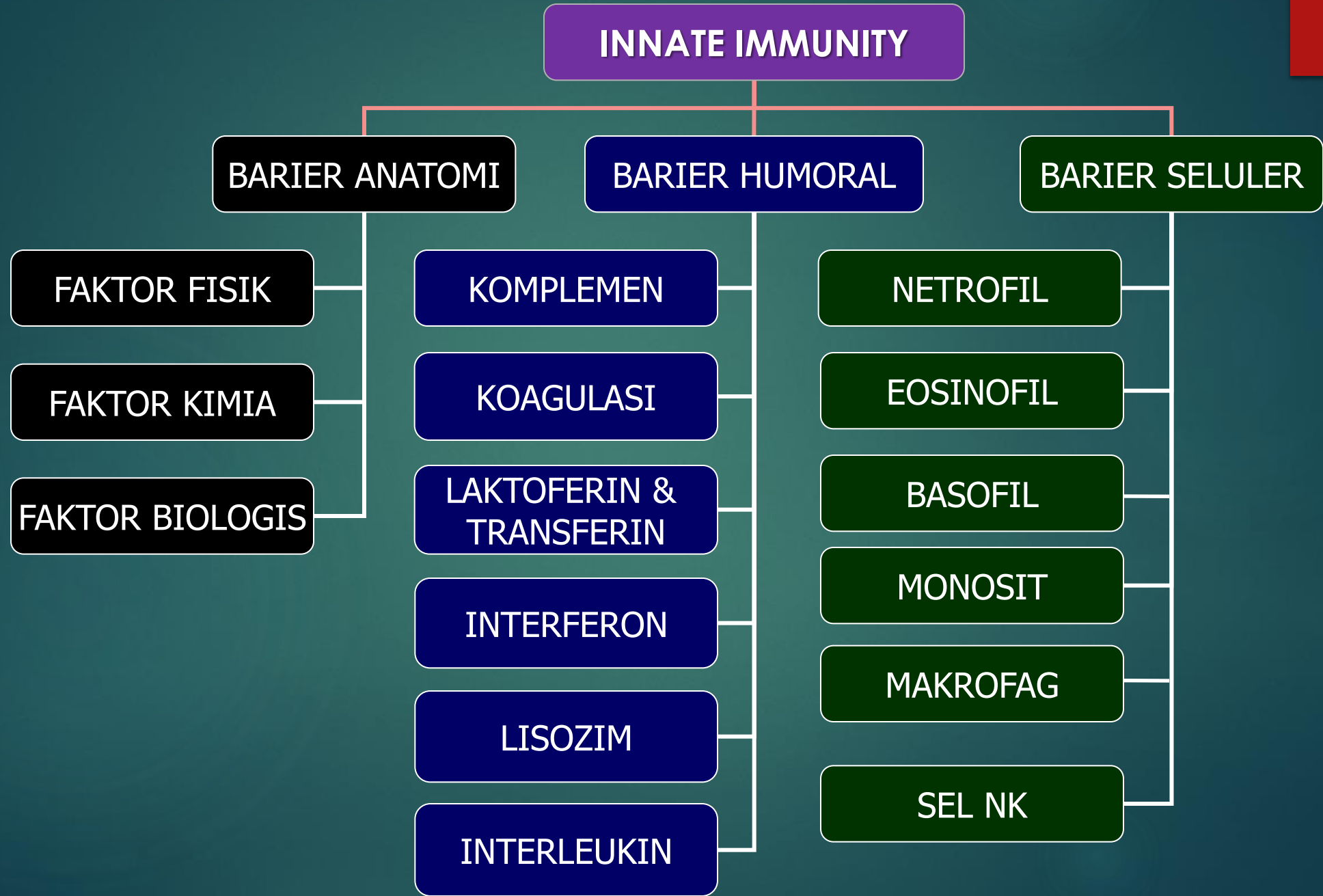
KRONIS

CARRIER

CURED/SEHAT

Reaksi imun / respon imun menghasilkan rx antibodi, perubahan jumlah sel lekosit, limfosit, sitokin, dll dalam darah → bisa dimanfaatkan utk diberi zat modulasi atau test lab

IKHTISAR IMUNITAS BAWAAN



Sistem Imun

Sistem imun non spesifik (innate immunity)

Komponen Anatomik

FISIK
KIMIA
BIOLOGI

Komponen humoral

Complemen
Sitokin/
Interleukin

Komponen seluler

Fagosit
Dentritic cells
NK cells

Sistem imun spesifik (adaptive immunity)

Komponen humoral

Antibodi:
IgM, IgG, IgA,
IgE, IgD

Komponen seluler

Sel T (Th, Tc, Ts)

Respon imun

 ADAM

Immune Response

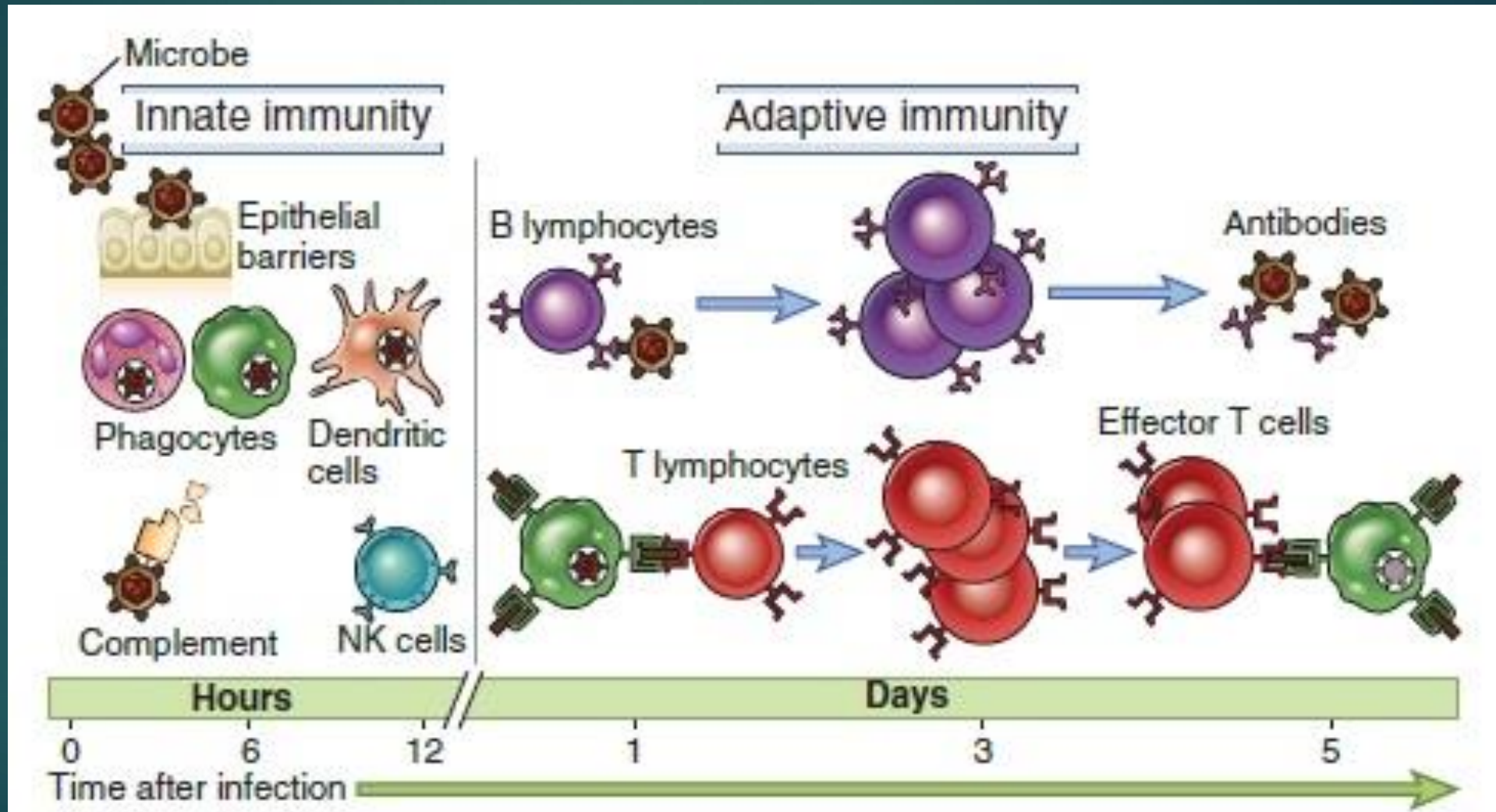
Perbedaan innate & adaptive immunity

Table 1-2. Features of Innate and Adaptive Immunity

	Innate	Adaptive
Characteristics		
Specificity	For structures shared by groups of related microbes	For antigens of microbes and for nonmicrobial antigens
Diversity	Limited; germline-encoded	Very large; receptors are produced by somatic recombination of gene segments
Memory	None	Yes
Nonreactivity to self	Yes	Yes
Components		
Physical and chemical barriers	Skin, mucosal epithelia; antimicrobial chemicals	Lymphocytes in epithelia; antibodies secreted at epithelial surfaces
Blood proteins	Complement	Antibodies
Cells	Phagocytes (macrophages, neutrophils), natural killer cells	Lymphocytes

This table lists the major characteristics and components of innate and adaptive immune responses. Innate immunity is discussed in much more detail in [Chapter 12](#).

Immune response



Adaptive immunity

- ▶ Sistem pertahanan tubuh **lapis kedua** bila innate immunity tdk mampu mengeliminasi agen penyakit.

Sistem humoral







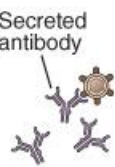
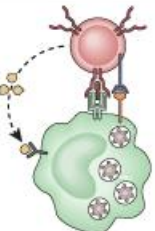

- Diperankan oleh limfosit B
- Rangsangan antigen → sel B proliferasi & diferensiasi → sel plasma → membentuk antibody
- Pertahanan thd bakteri ekstra seluler, netralisasi toksin

Sistem seluler (**Cell Mediated Immunity/ CMI**)

- Diperankan oleh limfosit T
- pertahanan thd bakteri intraseluler, virus, jamur, parasit, keganasan

Adaptive immunity

Figure 1-2 Types of adaptive immunity.

	Humoral immunity	Cell-mediated immunity	
Microbe	 <p>Extracellular microbes</p>	 <p>Phagocytosed microbes in macrophage</p>	 <p>Intracellular microbes (e.g., viruses) replicating within infected cell</p>
Responding lymphocytes	 <p>B lymphocyte</p>	 <p>Helper T lymphocyte</p>	 <p>Cytolytic T lymphocyte</p>
Effector mechanism	 <p>Secreted antibody</p>		
Transferred by	Serum (antibodies)	Cells (T lymphocytes)	Cells (T lymphocytes)
Functions	Block infections and eliminate extracellular microbes	Activate macrophages to kill phagocytosed microbes	Kill infected cells and eliminate reservoirs of infection

Organ yang berperan dalam Adaptive Immunity

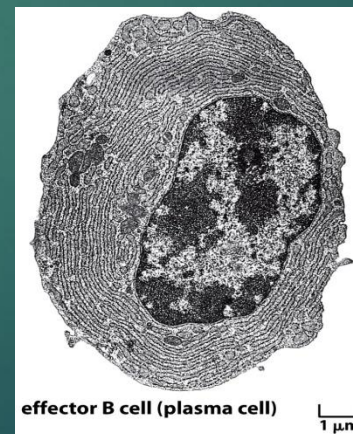
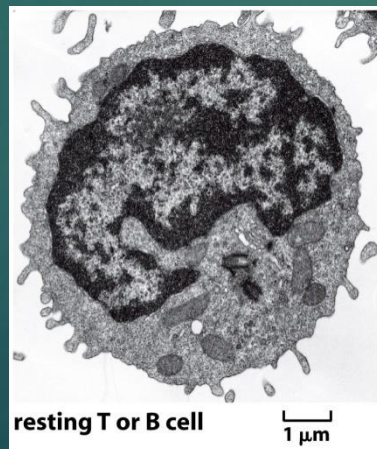
- Organ limfoid berdasarkan fungsinya dlm sistem imun dibedakan:
 - organ limfoid primer (sentral)
 - organ limfoid sekunder (periferal).
- Limfosit imatur akan mengalami maturasi shg menjadi matur didalam organ limfoid primer (Timus) → menjadi sel imunokompeten
- Pada mamalia organ limfoid primer adalah:
 - sumsum tulang (*bone marrow*)
 - timus → maturasi sel T

Organ yang berperan dalam Adaptive Immunity (lanj)

- Organ limfoid sekunder → mengambil antigen dari jaringan atau dari darah (sirkulasi) & memberi tempat sel imunokompeten untuk berinteraksi secara efektif dengan antigen.
- Nodus limfatikus mengkoleksi antigen dari cairan intraseluler jaringan.
- Lien (limpa/spleen) menyaring antigen dalam darah & sirkulasi → sehingga dapat merespon infeksi sistemik
- *Mucosa associated lymphoid tissue* (MALT) pada traktus respiratorius, digestivus, genitourinarius — (Peyer's patch, tonsil, adenoid) menangkap Ag yang masuk via membran mukosa.

Limfosit B

- ▶ Limfosit diproduksi & berkembang dalam sumsum tulang. Mempunyai reseptor antigen mol. Ab yang terfiksasi membran sel pada C_h terminalnya. Bila sel B naive kontak dengan Ag, sel B berproliferasi & berdiferensiasi menjadi sel B memori yang mensekresi Ab spesifik, disebut sel plasma.



Sel Limfosit T

- ▶ Berkembang dari stem cells dalam sumsum tulang, bermigrasi ke dalam timus dan berdiferensiasi menjadi sel T matur.
- ▶ Sel T matur mengekspresikan “*antigen binding protein*” dipermukaan selnya, disebut reseptor sel T (TCR) – terdiri dari 2 protein subunit $\alpha\beta$ atau $\gamma\delta$, dihubungkan oleh ikatan disulfida.
- ▶ TCR mengenal Ag dipermukaan sel yang berasosiasi/ dipresentasikan molekul MHC (HLA).
- ▶ Bila sel T naive kontak dengan Ag → sel T berproliferasi & berdiferensiasi menjadi **sel T memori dan sel efektor**.

SEL LIMFOSIT T

1. Sel T helper / pembantu

- membantu mengaktivasi sistem imun dg memproduksi limfokin (mis. Interleukin 1-6, interferon γ)
- perangsangan pertumbuhan dan proliferasi sel T sitotoksik dan supresor
- perangsangan pertumbuhan dan diferensiasi sel B untuk membentuk sel plasma dan antibodi
- aktivasi sistem makrofag
- umpan balik, efek perangsangan pada dirinya sendiri (sel T pembantu itu sendiri)
- Ada Th1 dan Th2.
 - Th1 → aktivasi makrofag
 - Th2 → aktivasi sel Limfosit B

SEL LIMFOSIT T (lanj)

2. Sel Tc (cytotoxic/sitotoksik)

sel penyerang langsung yang mampu membunuh mikroorganisme, dan pada suatu saat bisa membunuh sel-sel tubuh sendiri

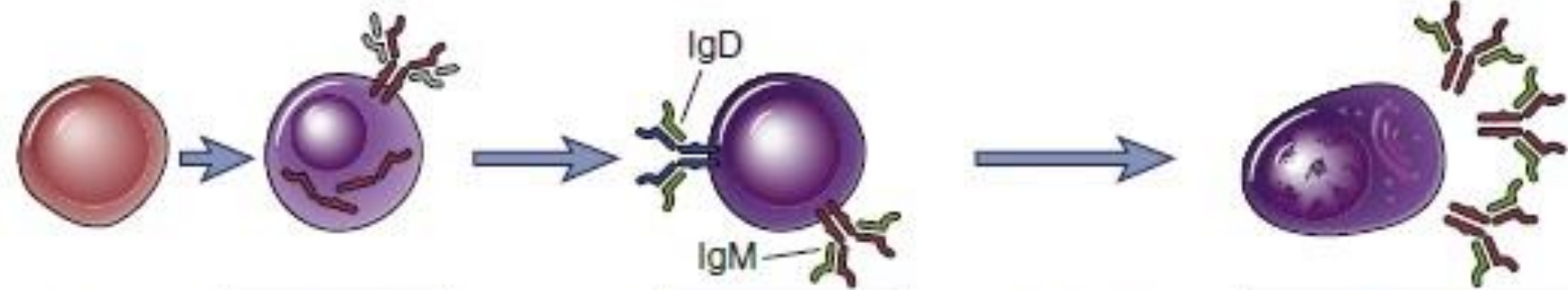
3. Sel Ts (suppressor) / Treg (regulator)

mempunyai kemampuan untuk menekan sel T sitotoksik dan pembantu, menjaganya agar jangan sampai menimbulkan reaksi imun yg berlebihan, yang bisa merusak tubuh sendiri (reaksi autoimun)

Sel Limfosit B

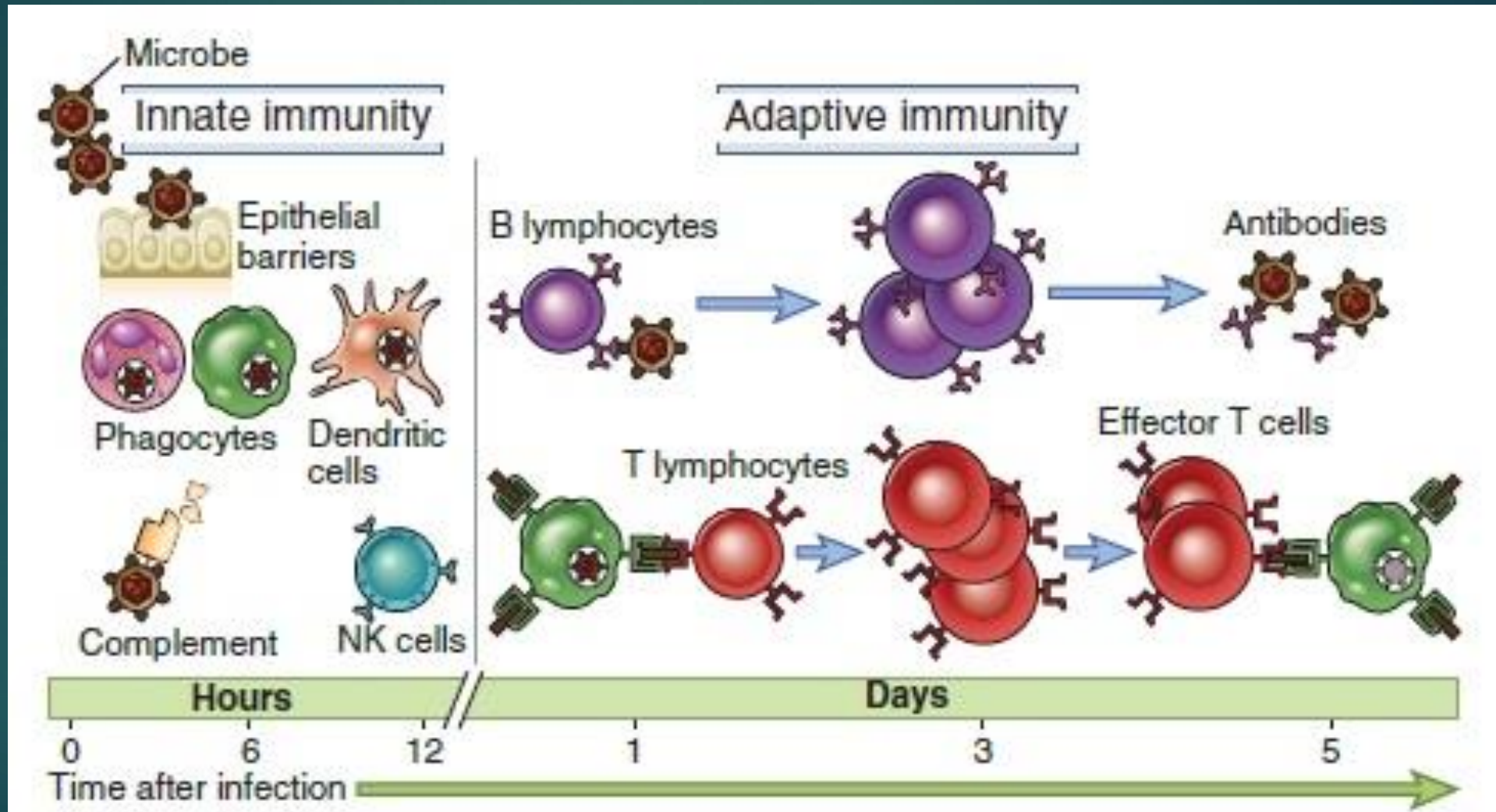
- ▶ Sel Limfosit B diproduksi & berkembang dalam sumsum tulang.
- ▶ Mempunyai reseptor antigen molekul Ab yang terfiksasi membran sel pada C_h terminalnya.
- ▶ Bila sel B naive kontak dengan Ag, sel B berproliferasi & berdiferensiasi menjadi sel B memori (= Sel Plasma) yang **mensekresi Antibodi spesifik**

Maturasi dan aktivasi sel imun



Stage of maturation	Stem cell	Pre-B cell	Immature B cell	Mature B cell	Activated B cell	Antibody-secreting cell
Pattern of immunoglobulin production	None	Cytoplasmic μ heavy chain and pre-B receptor	Membrane IgM	Membrane IgM, IgD	Low rate Ig secretion; heavy chain isotype switching; affinity maturation	High rate Ig secretion; reduced membrane Ig

Immune response



timeline pembentukan Immunoglobulin

- ▶ Bila antigen pertama kali masuk ke dalam tubuh → respon imun primer → **Ig M**
- ▶ **Kadarnya mencapai puncak 7 hari**
- ▶ 6-7 hari pemaparan dalam serum dapat terdeteksi Ig G
- ▶ IgM mulai turun sebelum IgG mencapai puncak kadarnya 10-14 hari
- ▶ Kadarnya akan berkurang, 4-5 mngg setelah pemaparan

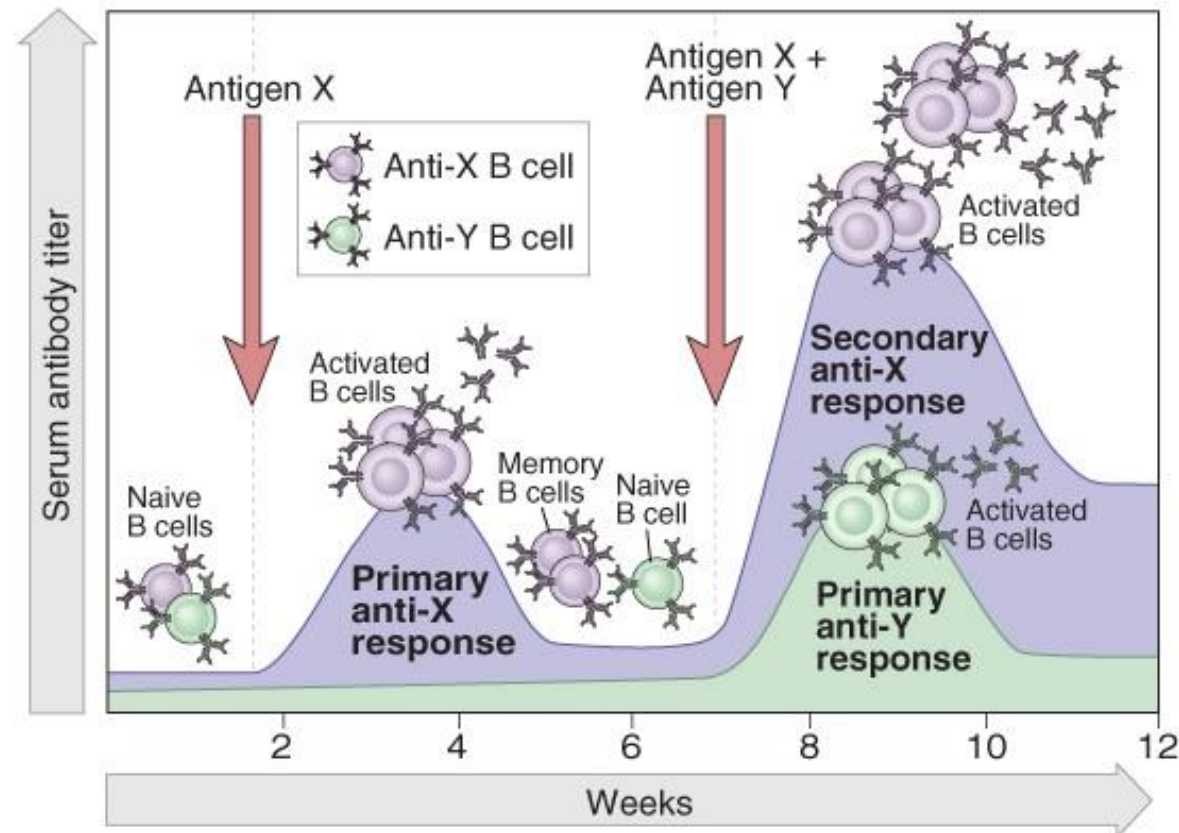
Antibodi sekunder

Hasil dari
Imunisasi pasif dan
Imunisasi aktif atau
sembuh dr sakit I

- ▶ Bila pemaparan antigen terjadi ke 2 kali, respon imun sekunder/respons berdasarkan memory sel T dan sebagian sel B/booster
- ▶ IgM maupun IgG cepat meningkat, **lag phasesnya pendek → sehari**
- ▶ Puncak kadar IgM pada respons sekunder < puncak kadar respon imun primer
- ▶ Kadar IgG lebih tinggi dan lebih lama
- ▶ Afinitas antibodi dan antigen makin besar kompleks Ab-Ag makin stabil

Immune response

Figure 1-4 Specificity, memory, and self-limitation of immune responses.



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Figure 1-4 Antigens X and Y induce the production of different antibodies (specificity). The secondary response to antigen X is more rapid and larger than the primary response (memory). Antibody levels decline with time after each immunization (self-limitation). The same features are seen in cell-mediated immune responses.

Peran Mikronutrien pada Immune System

- ▶ Micronutrients, including several vitamins (vitamin A, B6, B12, folate, C, D, E) and trace elements (Zinc, Selenium, Copper, Magnesium), play important roles in supporting the immune system, and thus their deficiencies could increase the susceptibility of a host to infectious diseases

Peran mikronutrien pada innate & adaptive immunity

- ▶ The innate immunity, micronutrients play fundamental roles in **maintaining the structural and functional integrity of the physical barriers, such as skin and mucus membranes.**
- ▶ Micronutrients are also involved in supporting activity of antimicrobial proteins and chemotaxis of innate cells.
- ▶ Furthermore, several vitamins and minerals contribute to the **phagocytic and killing activities of neutrophils and macrophages.**
- ▶ Deficiencies of vitamins and select essential minerals also affect several aspects of the adaptive immunity, in particular the humoral response (antibody-mediated) and the cell-mediated immunity.

Example: to increase calcium and vitamin D intake

- ▶ Drink a fortified dairy beverage with your meals.
- ▶ Add sardines to your lunch once a week.
- ▶ Canned salmon is another great option.
 - ▶ Sardines and salmon with bones have more calcium than these products without bones.
 - ▶ Cook with spinach, collard greens, bok choy, mushrooms, and taro root.
- ▶ Look for foods that are fortified with calcium and vitamin D.
- ▶ Fortified foods may include soy beverages, soy yogurt, orange juice, and some whole-grain cereals.
- ▶ Just be sure they don't include added sugars!

