

# Allt er ónæmisfræði

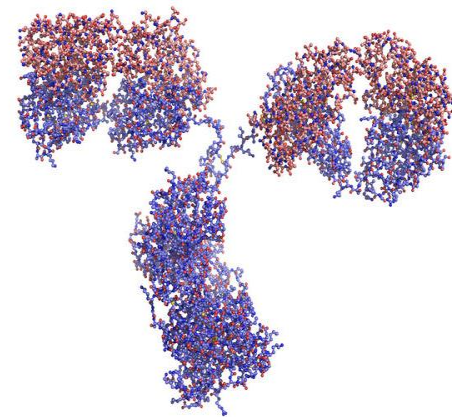
Inngangur

Helstu þættir ónæmiskerfisins

Ræsing ónæmiskerfisins

Helstu sjúkdómar í ónæmiskerfinu

Rannsóknir og nokkrir meðferðarmöguleikar



# Allt er ónæmisfræði

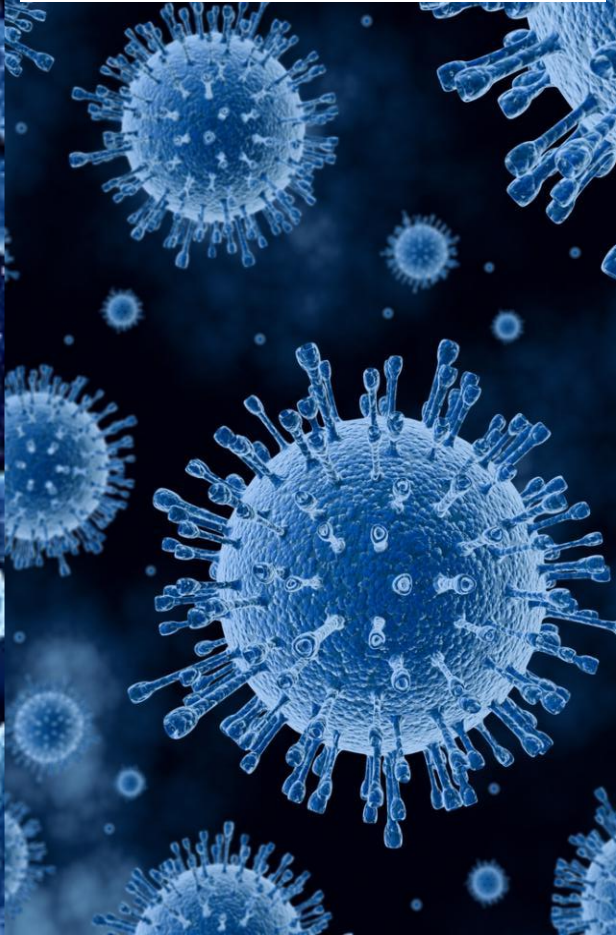
## Inngangur

(ath: útdráttur (og ekki tæmandi) úr  
ónæmisfyrirlestrunum sem eru á youtube)

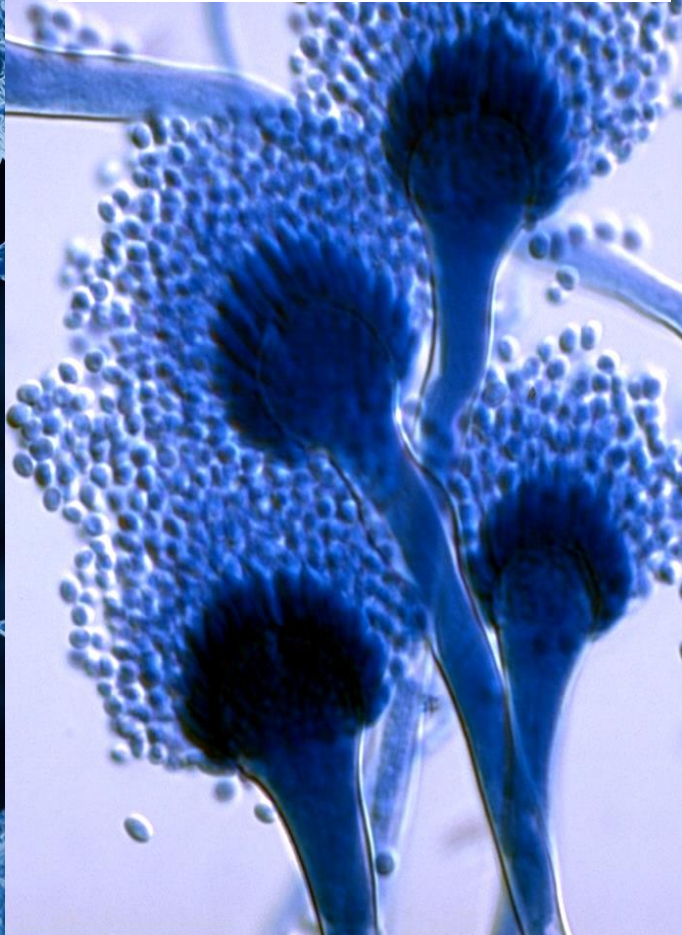
Bakteríur ...



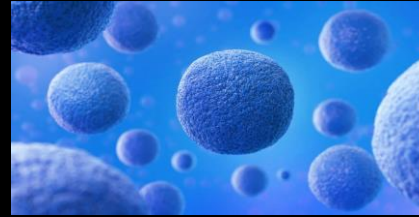
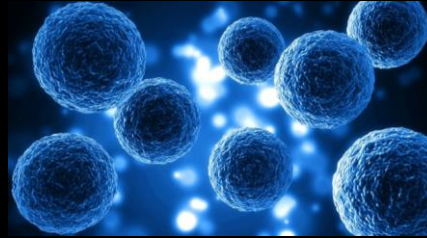
... vírusar!!!



... sveppir!!

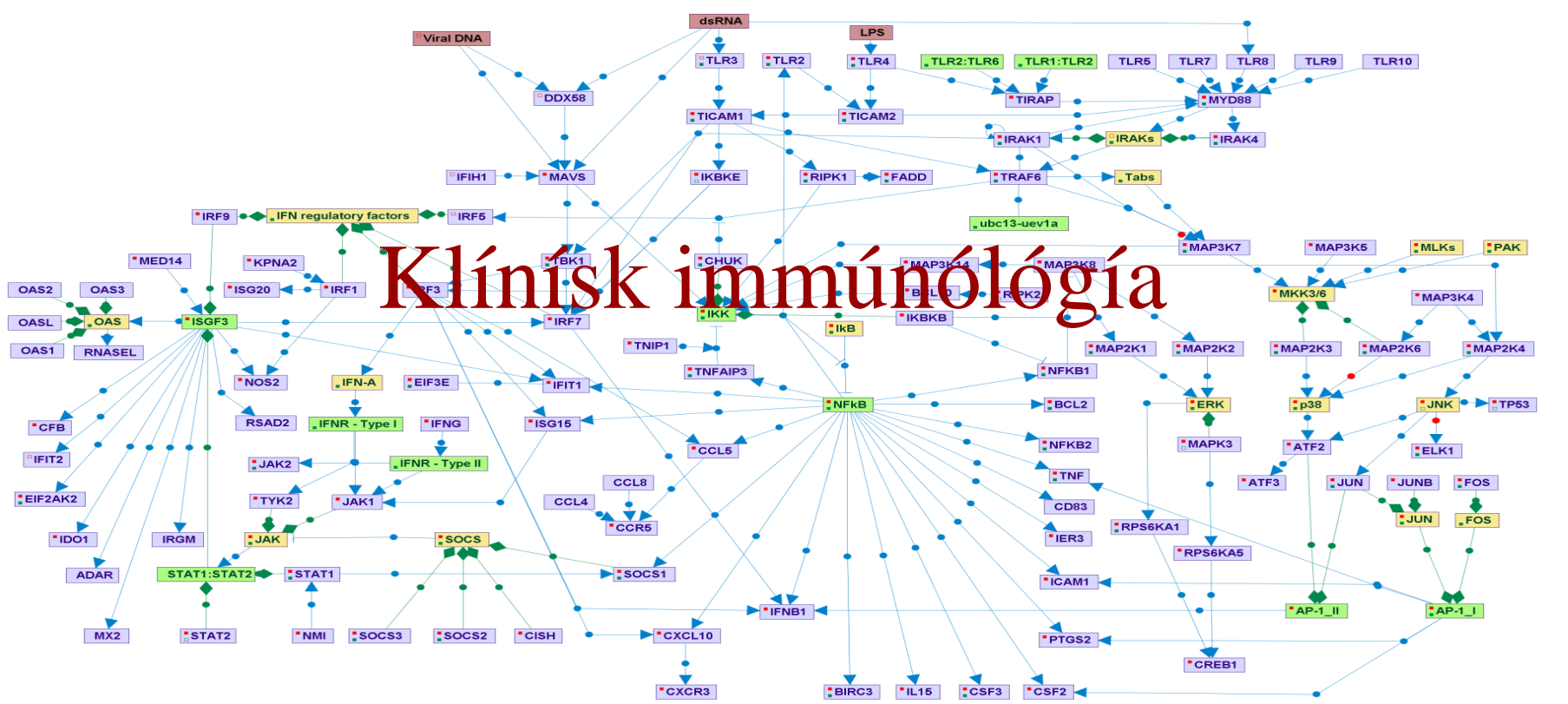


# Sjálf og non-sjálf





# Klinisk immunológia

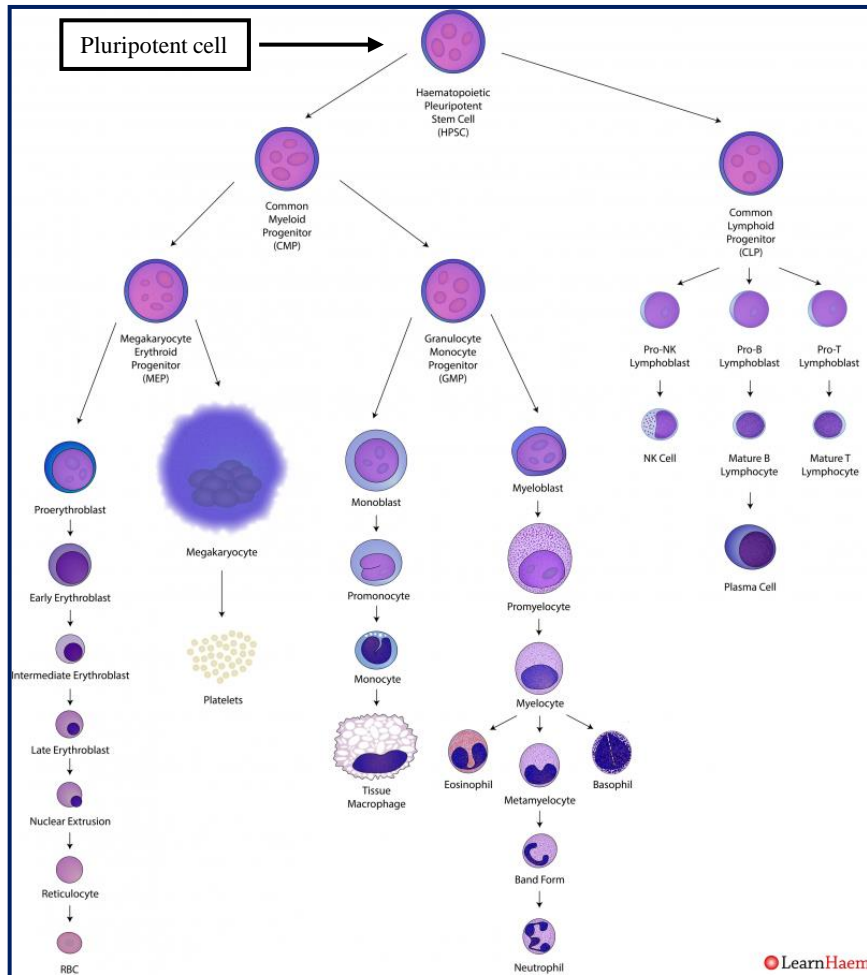


# Frumur ónæmiskerfisins

Granulocyta – monocyta lína  
Monocyta/macrophagar  
Granulocyta  
Eosinophilar  
Basophilar  
Neutrophilar

Lymphocyta lína  
B-frumur  
T-frumur  
NK-frumur  
... og undirflokkar

Auk þess ...  
Kompliment  
Frumuboðefni  
..... o.m.fl



# The immune system

Innate immunity  
(non-specific)

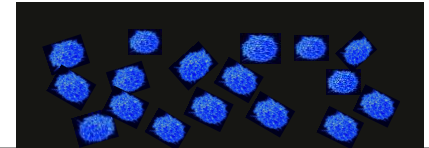
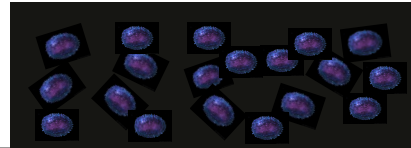
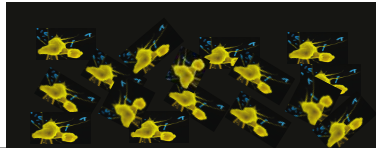
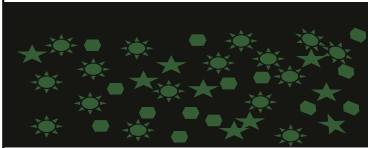
Adaptive immunity  
(specific)

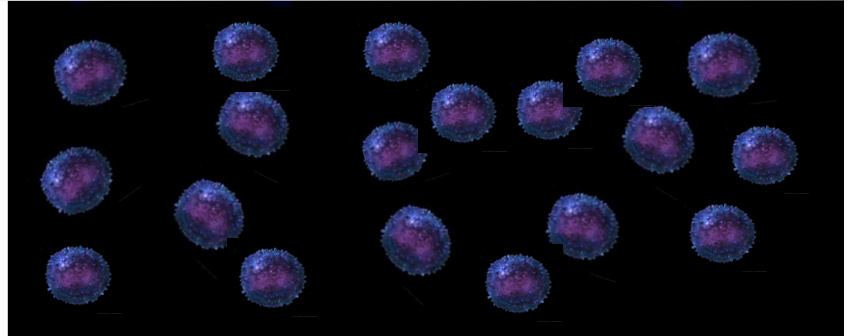
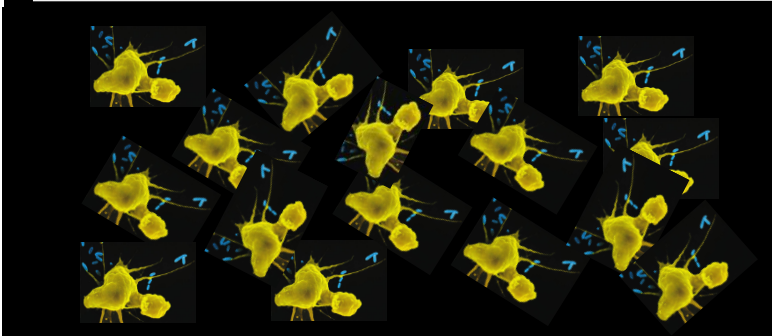
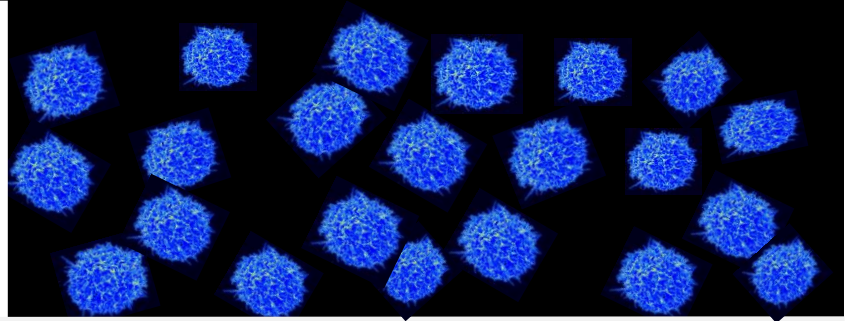
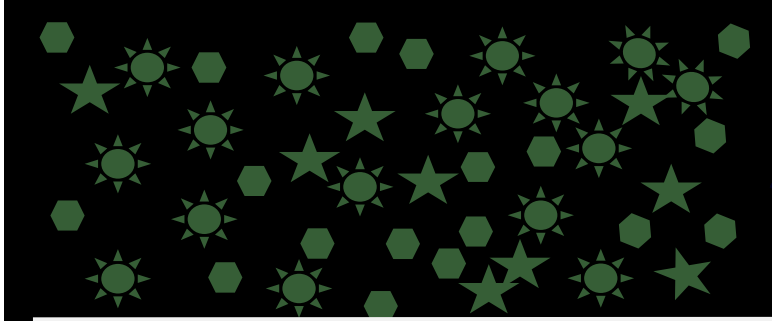
Soluble factors

Phagocytes

Humoral immunity  
B-cells

Cellular immunity  
T-cells





Soluble factors

Phagocytes

Humoral immunity  
B-cells

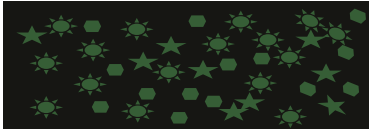
Cellular immunity  
T-cells



# Ónæmisgallar / Immune defects

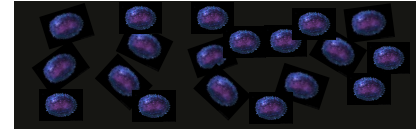
Neutrophil defects

Macrophage function

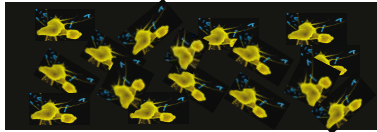


Humoral defects

B-cell defects

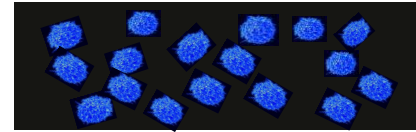


Complement defects



Cellular defects

T-cells defects



# Ónæmisgallar / Immune defects

## Neutrophil defects

- Number or function
- Skin infections
- Mucous membranes infections
- Granulomas
- Umbilical cord



## Humoral defects

- B-cell defects
- Number and function
- Not in first months of life
- Recurrent infections (RTI)
- Bacterial infections (esp. capsulated)



## Complement defects

- Recurrent bacterial infections
- Inf with capsulated bacteria  
(meningococcus, pneumococcus)
- Autoimmune disorders



## Cellular defects

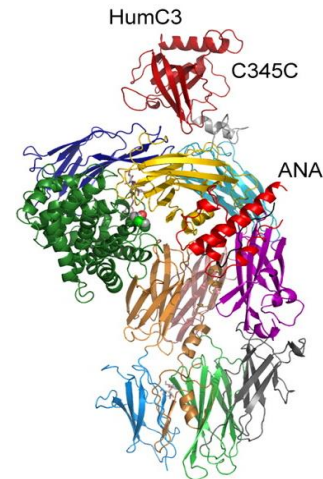
- Early in life
- Recurrent infections,  
viral, fungal and parasitic
- Malignancies



# Allt er ónæmisfræði

Helstu þættir ónæmiskerfisins

(Um frumurnar og fleira!)

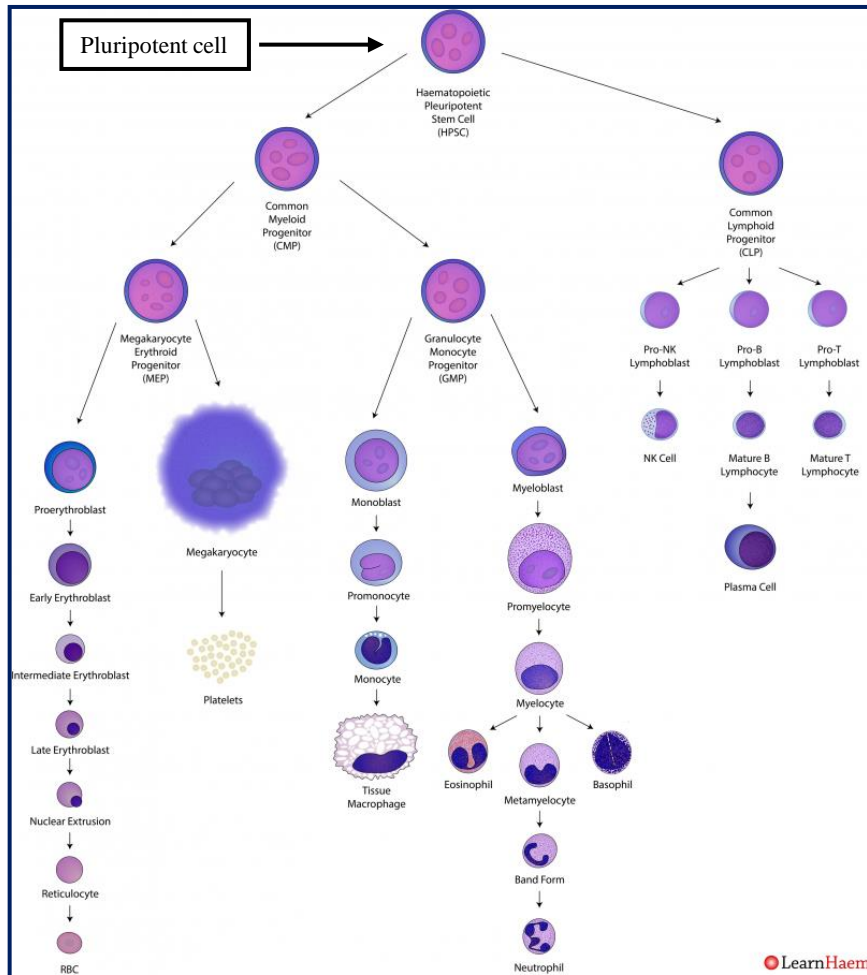


# Frumur ónæmiskerfisins

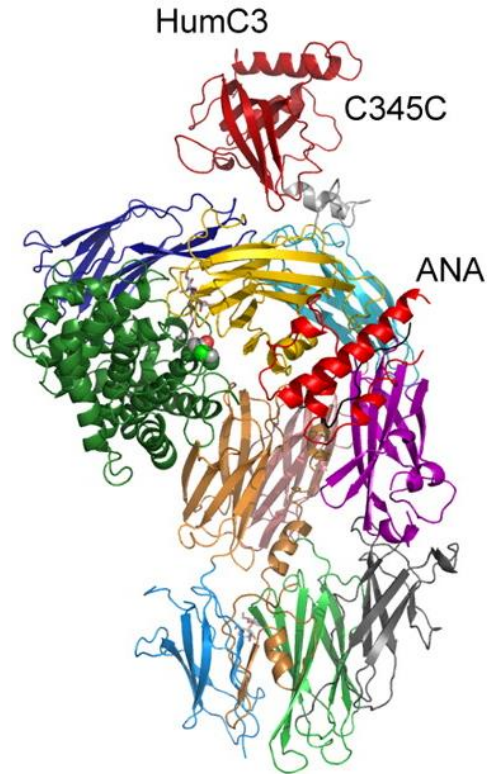
Granulocyta – monocyta lína  
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Eosinophilar  
Basophilar  
Neutrophilar

Lymphocyta lína  
B-frumur  
T-frumur  
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Auk þess ...  
Kompliment  
Frumuboðefni  
..... o.m.fl

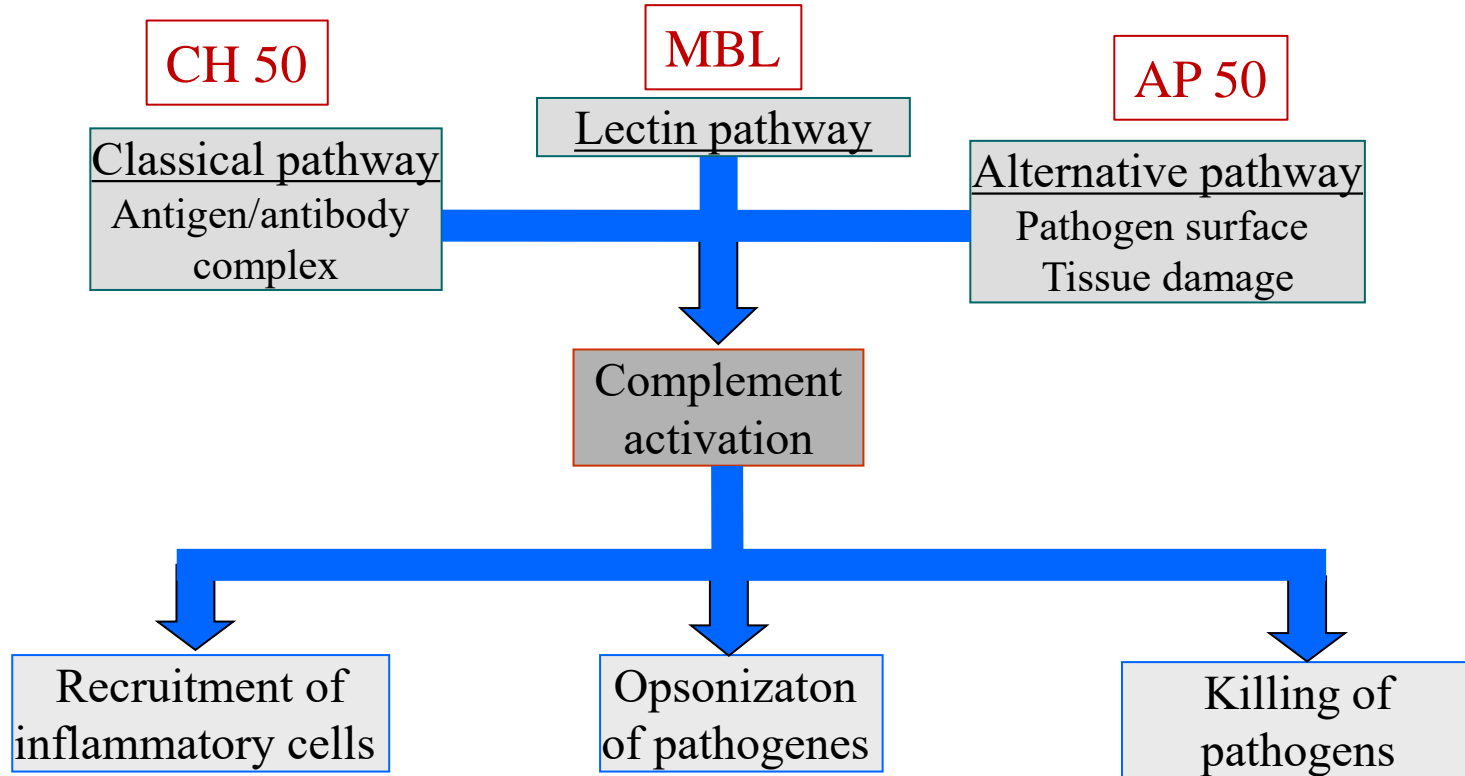


# Complement





# Kompliment kerfið / magnakerfið



# Kompliment kerfið / magnakerfið

## Complement defects

Recurrent bacterial infections

Inf with capsulated bacteria  
(meningococcus, pneumococcus)

Autoimmune disorders

SLE

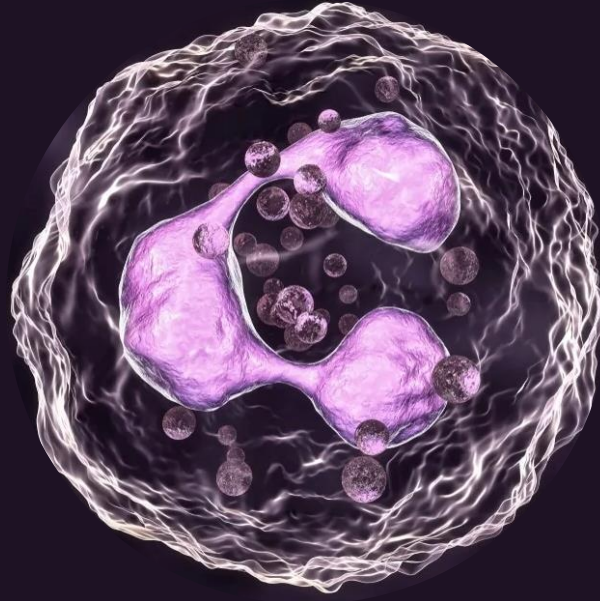
Glomerulonephritis

HUS

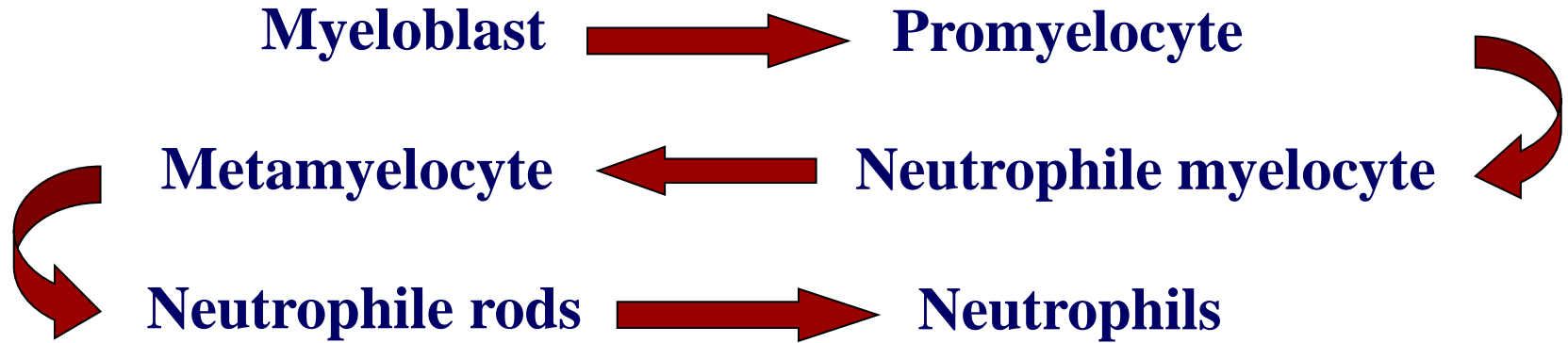
Angio-oedema



# Neutrophilar (og aðrir granulocytar)



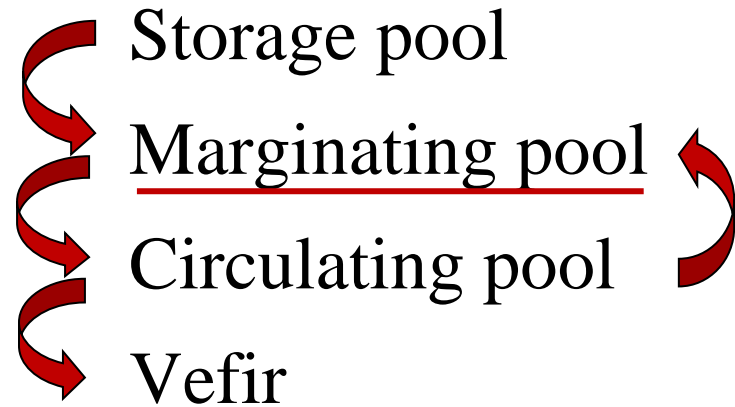
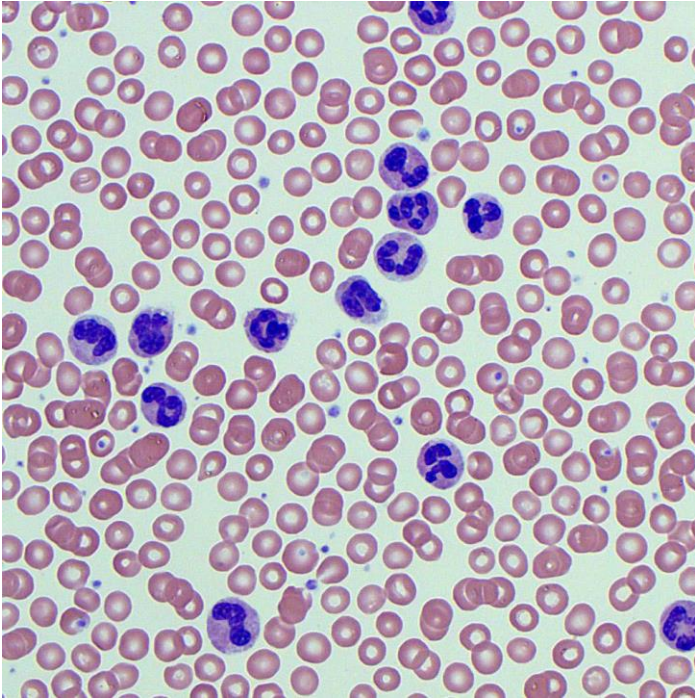
# Neutrophilar - þroski



Process 9-11 days, can be 24 h in newborns

G-CSF, GM-CSF, IL-3, IL-6, SCF

# Neutrophilar - fjöldi





# Neutrophil defects

Neutrophil numbers

Neutrophil function

- Recurrent resp inf
- +/- fever
- Skin infections
- Mucous membranes infections
- GE infections / disorders
- Sepsis
- Granulomas , +/- abscesses
- Unusual pathogens
- Umbilical cord !

# Granulocyta gallar

## √ Neutropenia

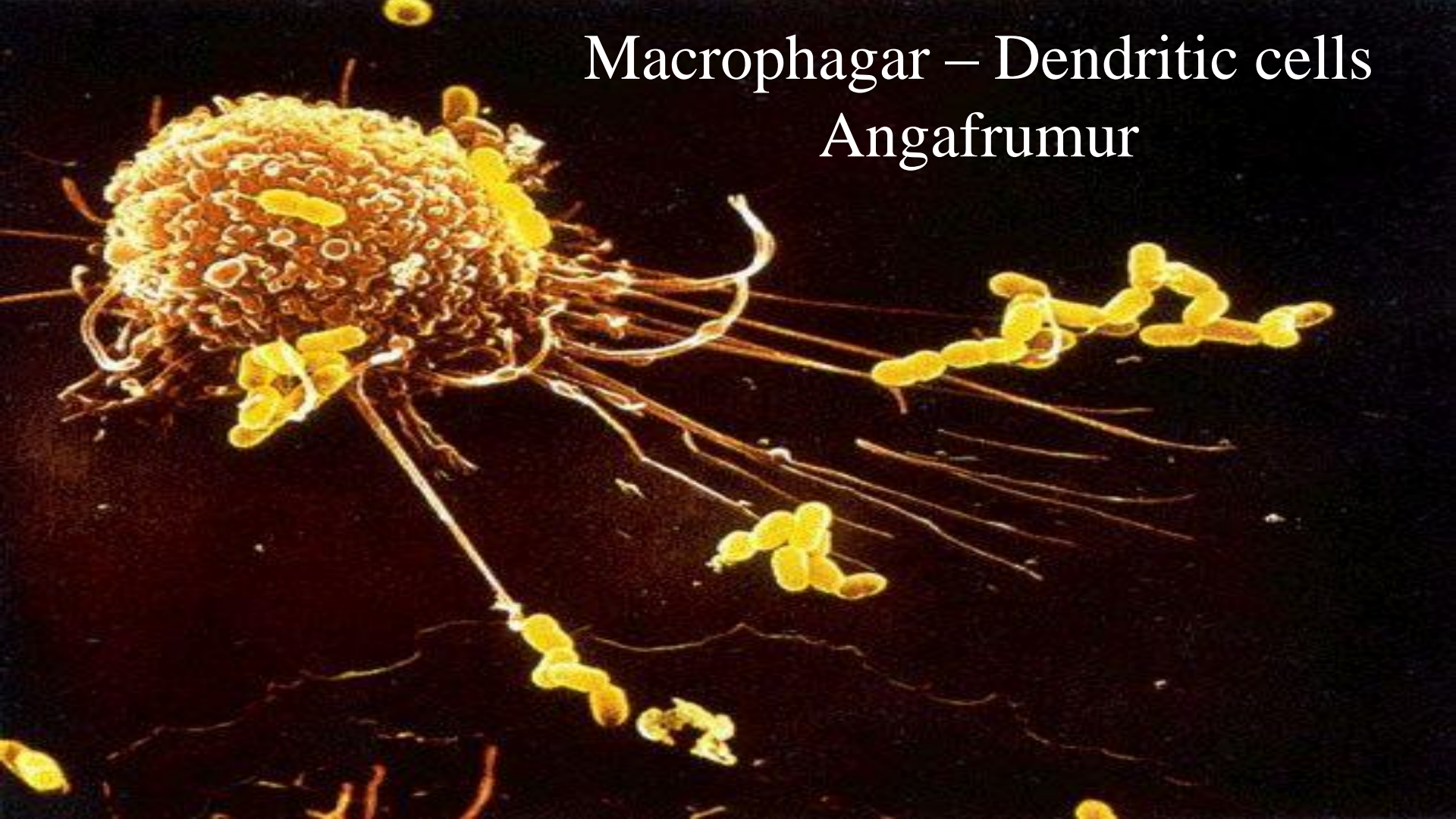
**Neutrophils < 1500 = neutropenia**

**Neutrophils < 1000 = moderately severe neutropenia**

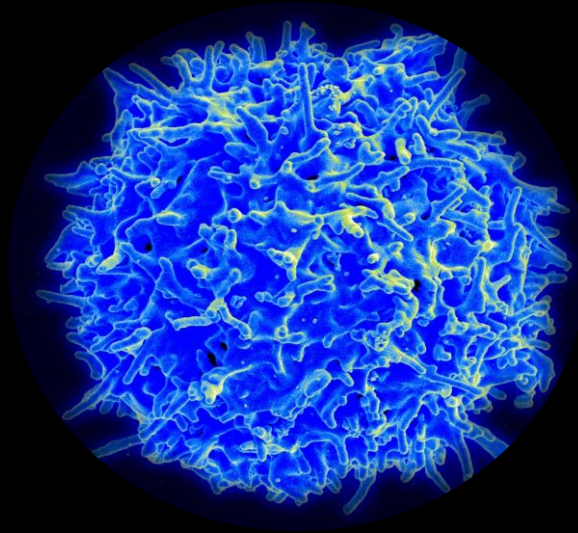
**Neutrophils < 500 = severe neutropenia**

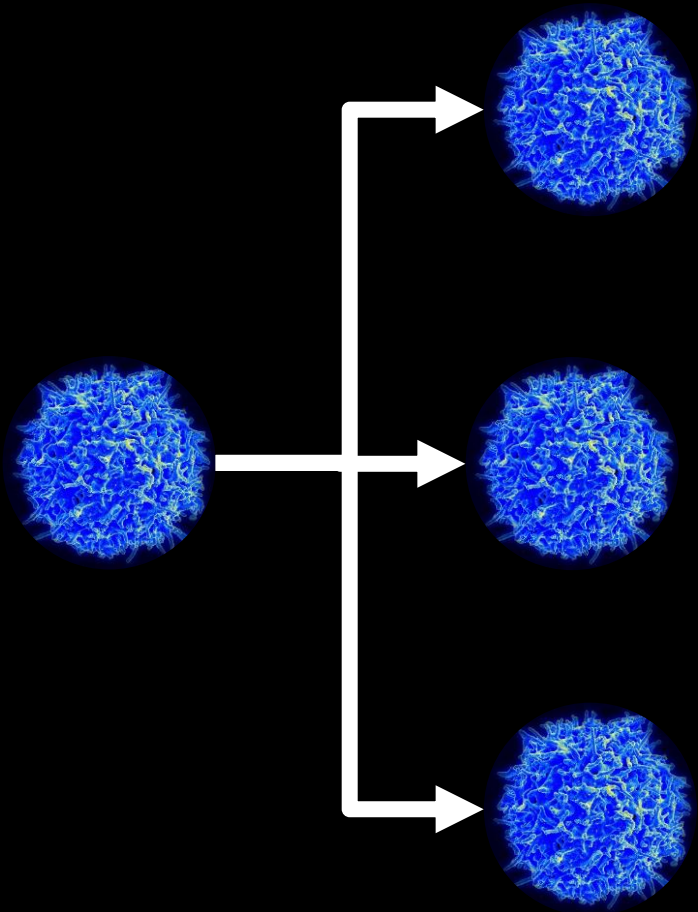
## √ Dysfunction of granulocytes

# Macrophage – Dendritic cells Angafrumur



# T-frumur





Drápsfrumur

Minnisfrumur

Hjálparfrumur



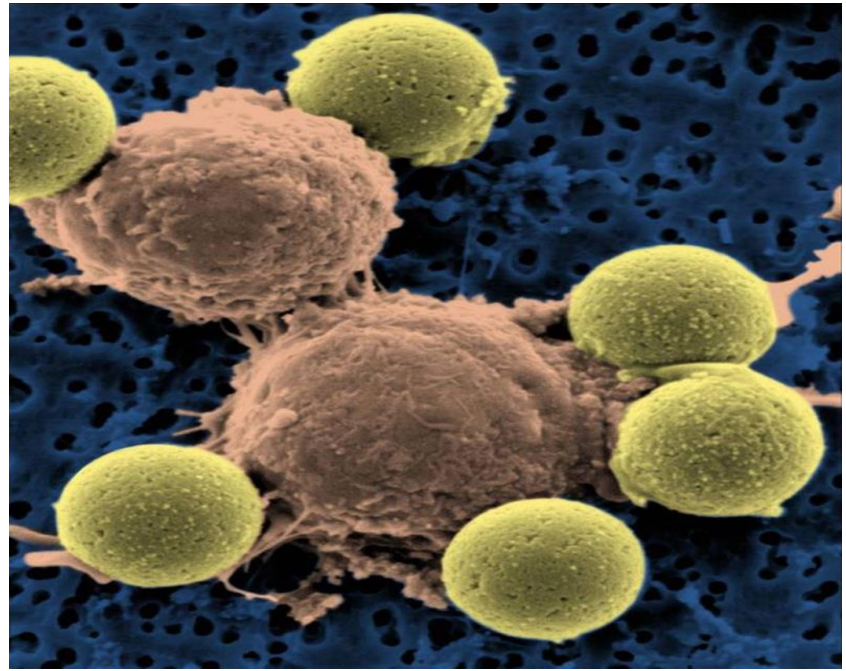
# T-cells



- Helper (CD4+), several subsets
- Cytotoxic (CD8+, CTL), several subsets
- Memory (CD4+ eða CD8+)
- Regulatory (T<sub>reg</sub>)
- NK (NKT fr)

.....

.....

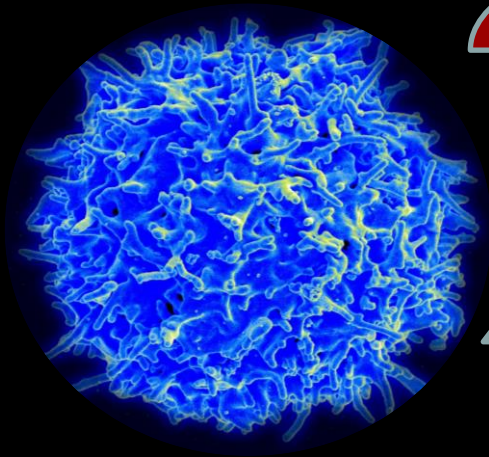


# T cell disorders

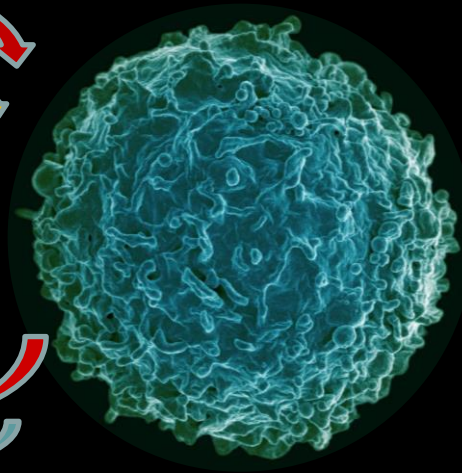
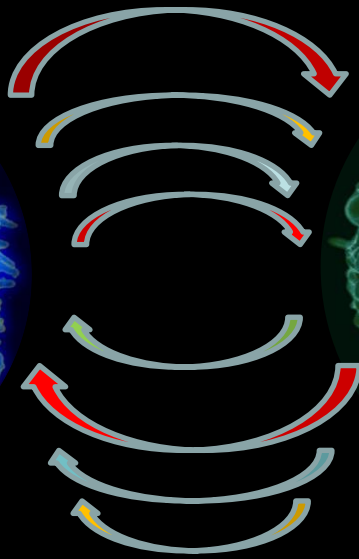
## Cellular defects

(with B- cell involvement)

- ✓ Early in life
- ✓ Failure to thrive
- ✓ Recurrent infections,  
viral, fungal and parasitic
- ✓ Autoinflammatory  
reactions
- ✓ Malignancies
- ✓ etc



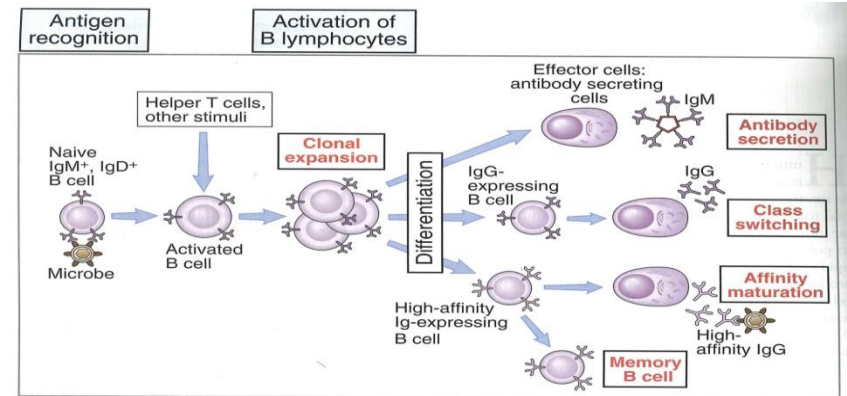
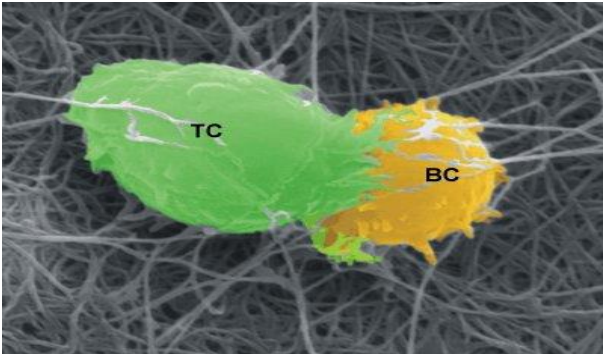
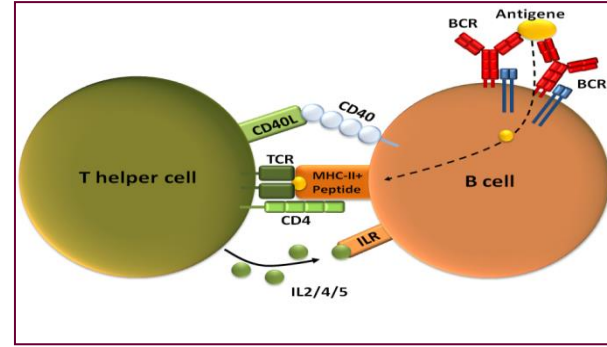
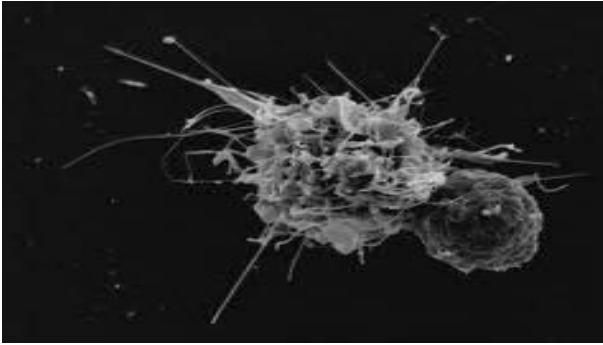
T-frumur



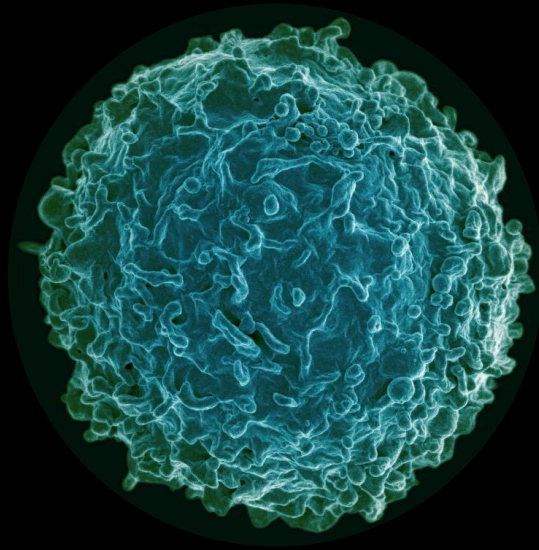
B-frumur

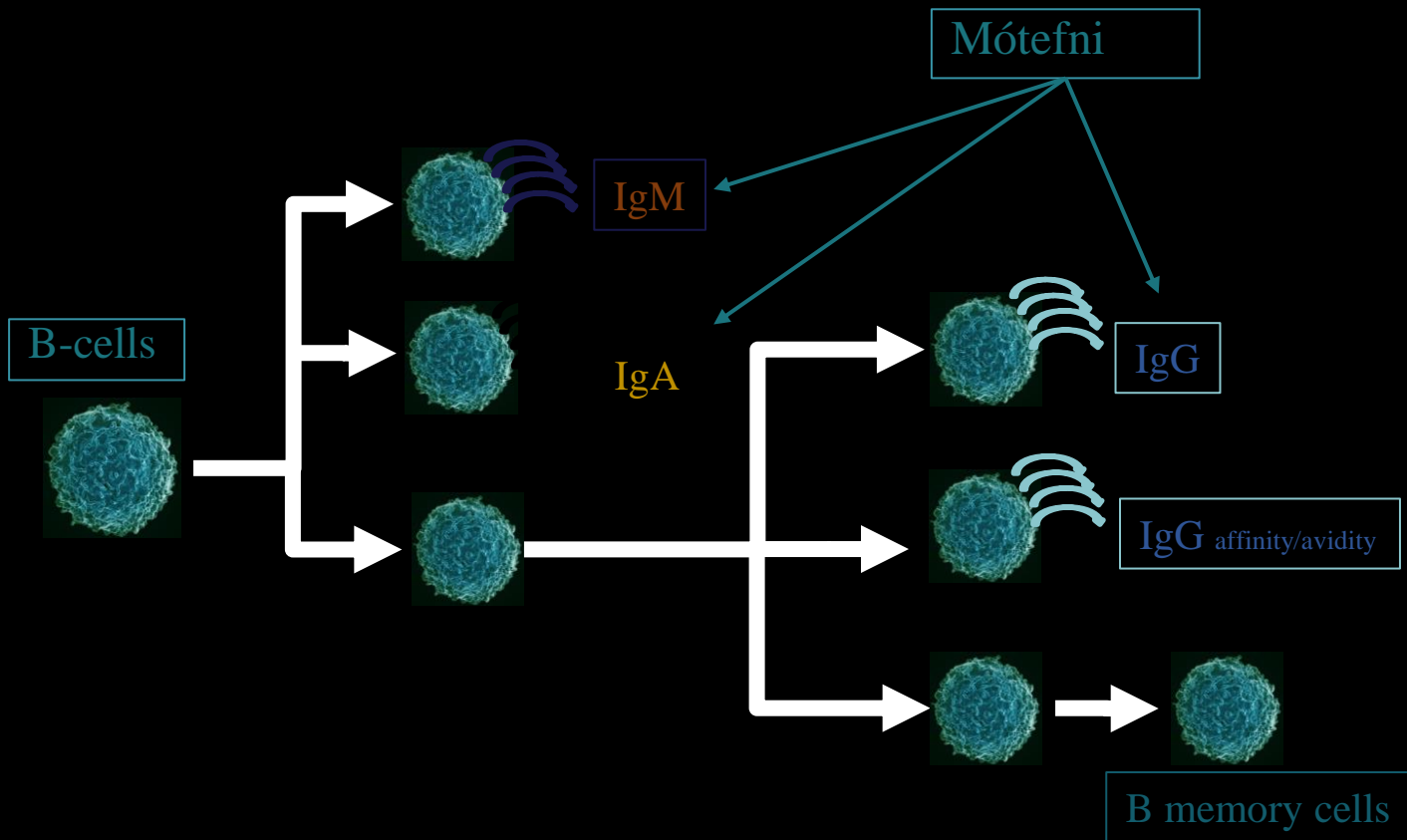
# Helper (CD4+), several subtypes

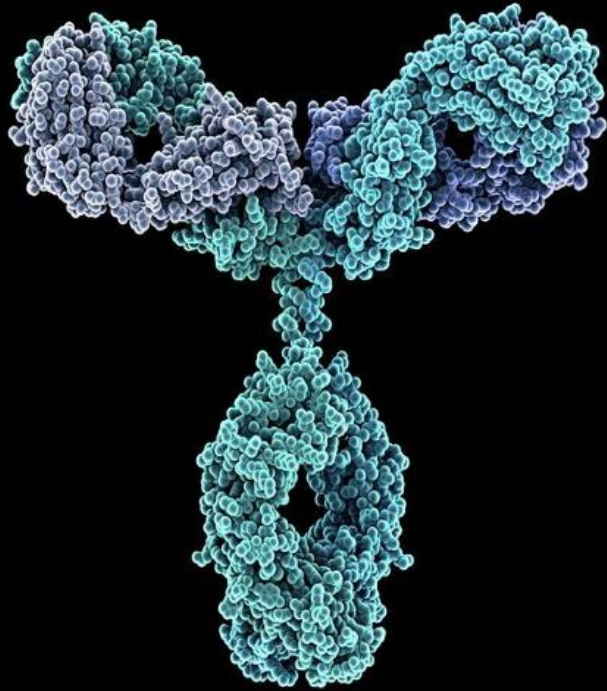
## Control/activating/cytokine production



# B-frumur







IgG

IgG1

IgG2

IgG3

IgG4

IgA

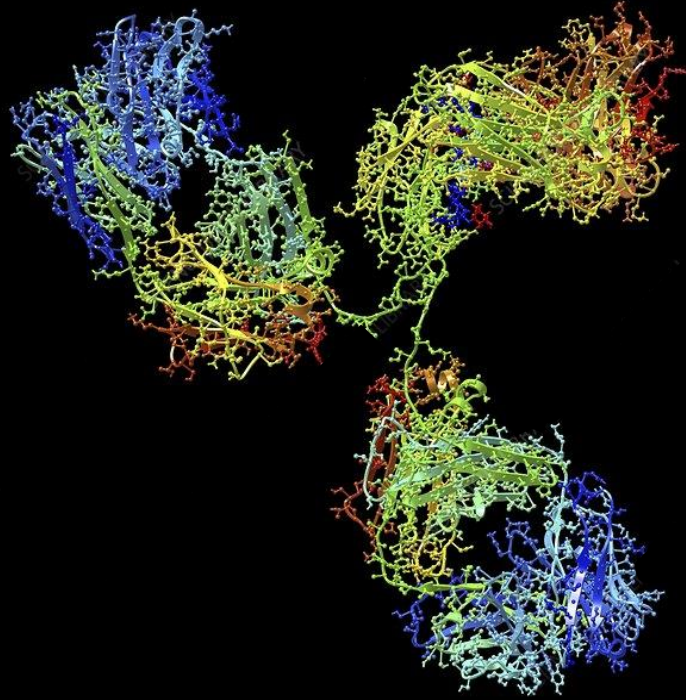
IgM

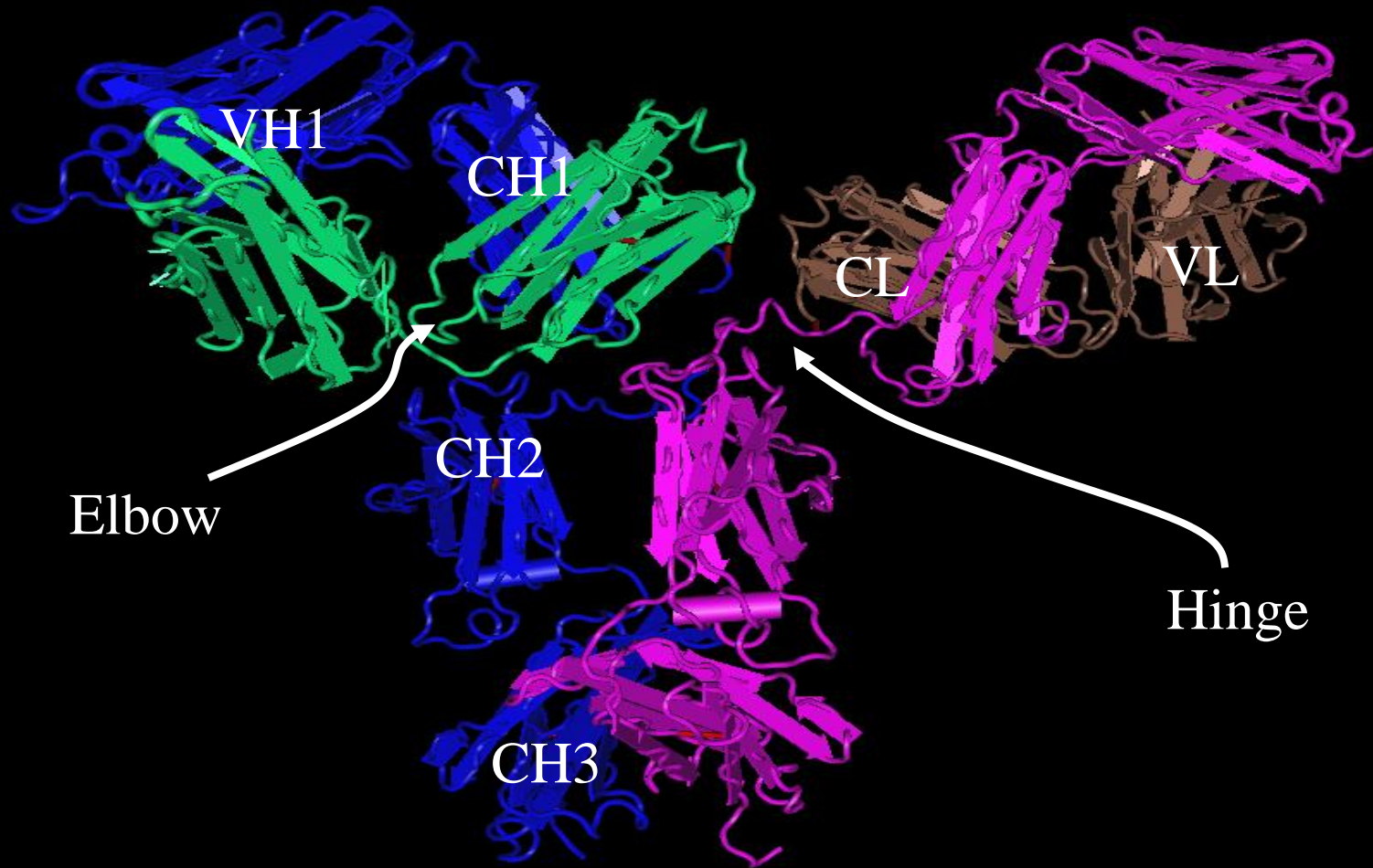
**IgE**

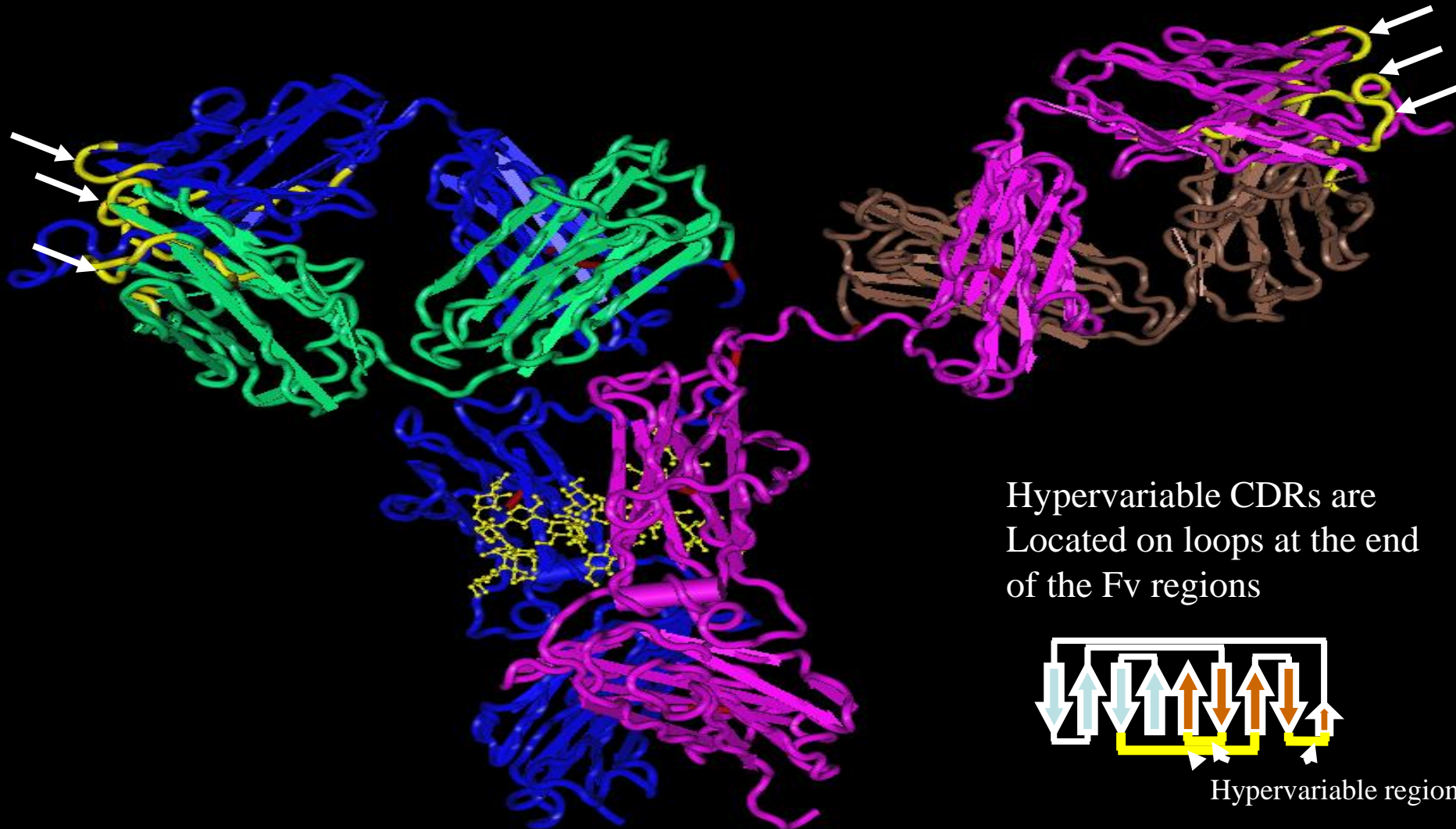
**IgD**



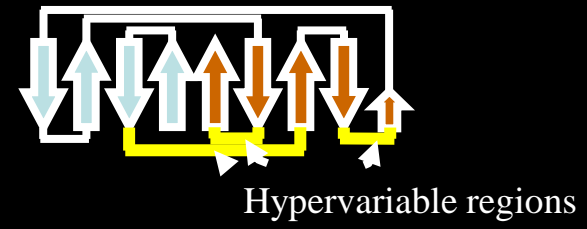
# Immunoglobulins







Hypervariable CDRs are  
Located on loops at the end  
of the Fv regions



# B-cell immune defects

Agammaglobulinaemia

Hyogammaglobulinaemia

Transient hypogamma of infancy

IgA deficiency

S subclass deficiency (i.e. IgG2 def)

Hyper IgE Sx

Hyper IgM Sx

Heavy chain deletion

Kappa chain deficiency

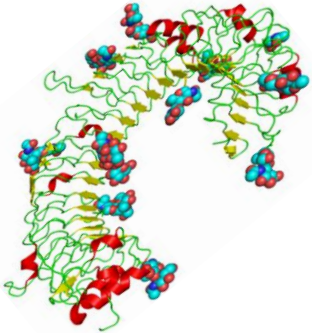
CVID

## Humoral defects

- B-cell defects
- Number and function
- Not in first months of life
- Recurrent infections (RTI)
- Bacterial infections (esp. capsulated)

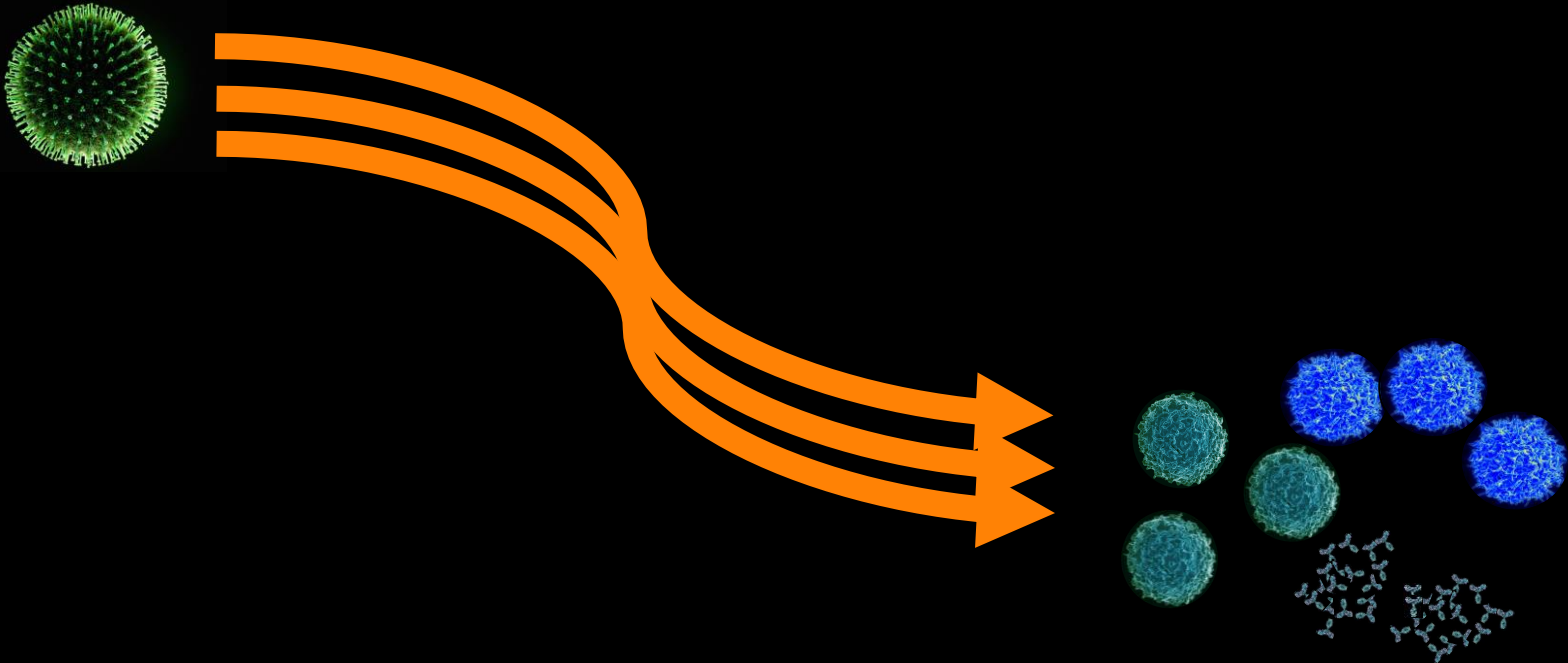
# Allt er ónæmisfræði

## Virkjun ónæmiskerfisins

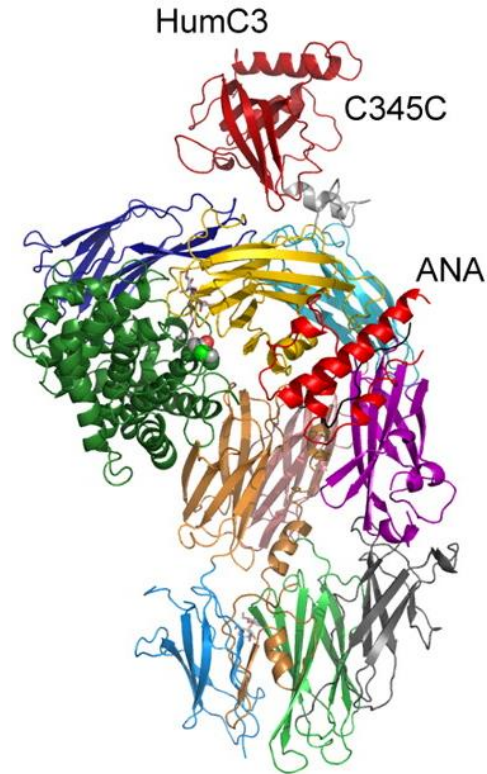


Hvernig þekkir ónæmiskerfið sýkla  
og bregst við!

Sýklar → ónæmissvar

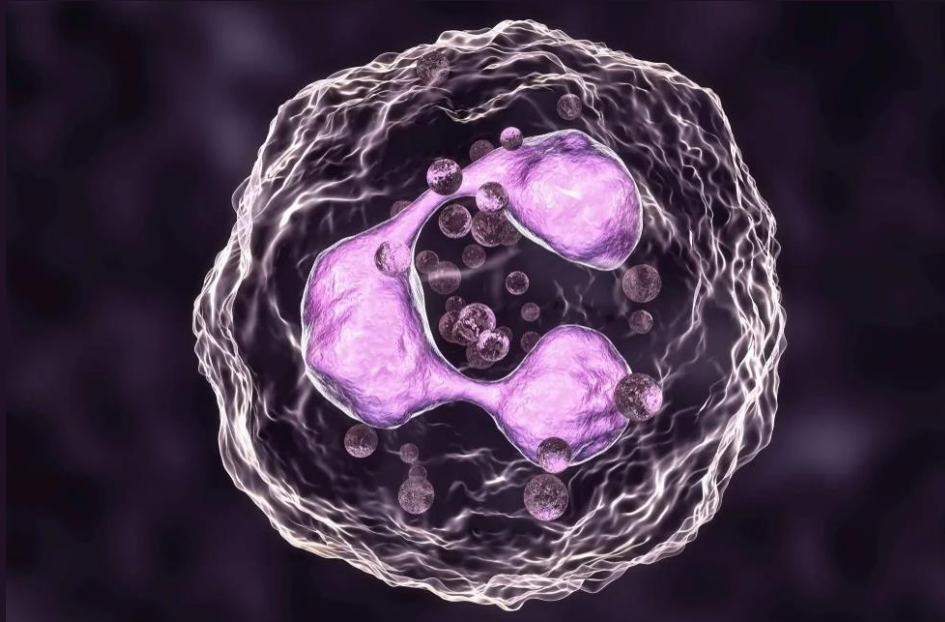


# Complement

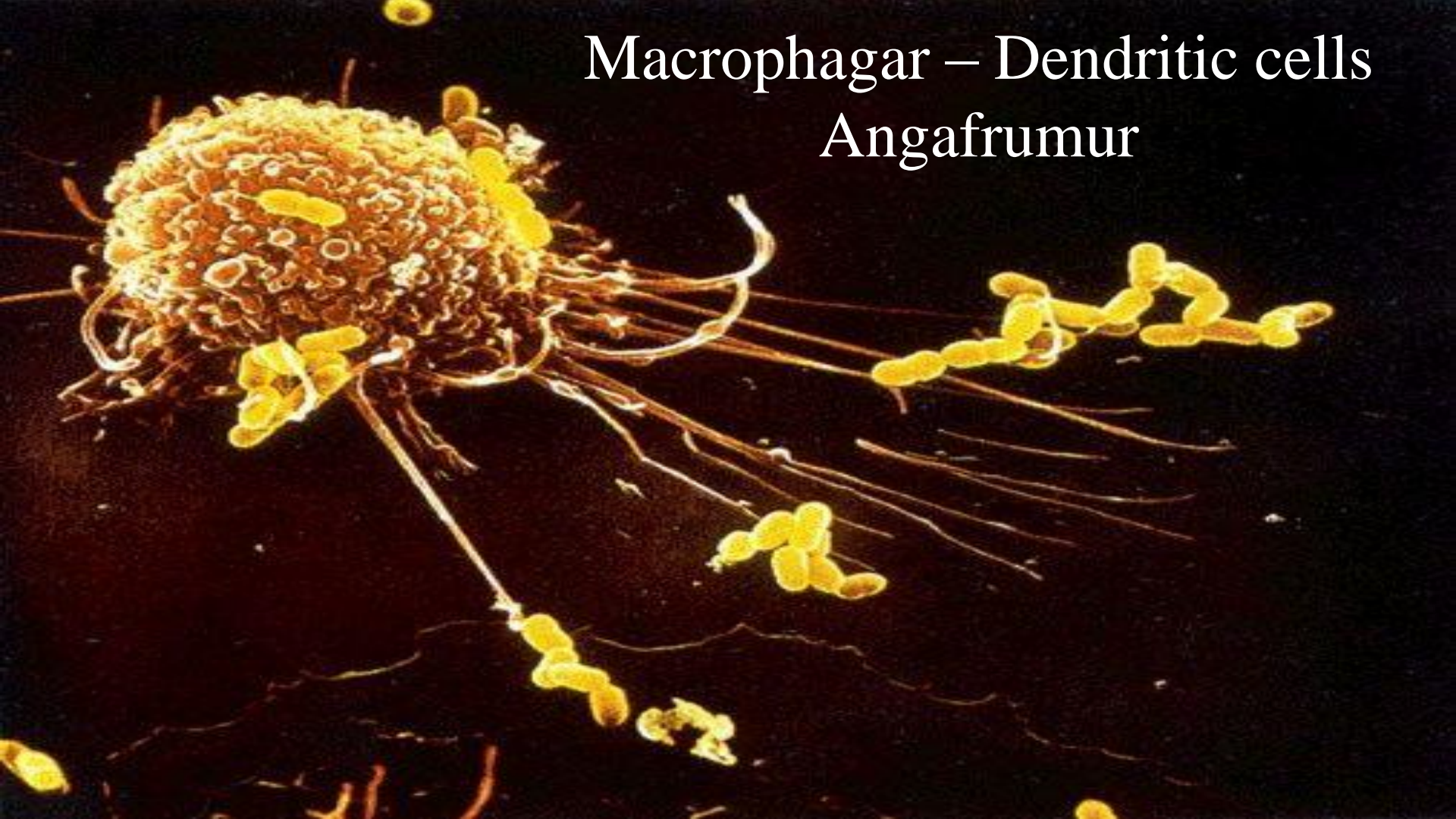




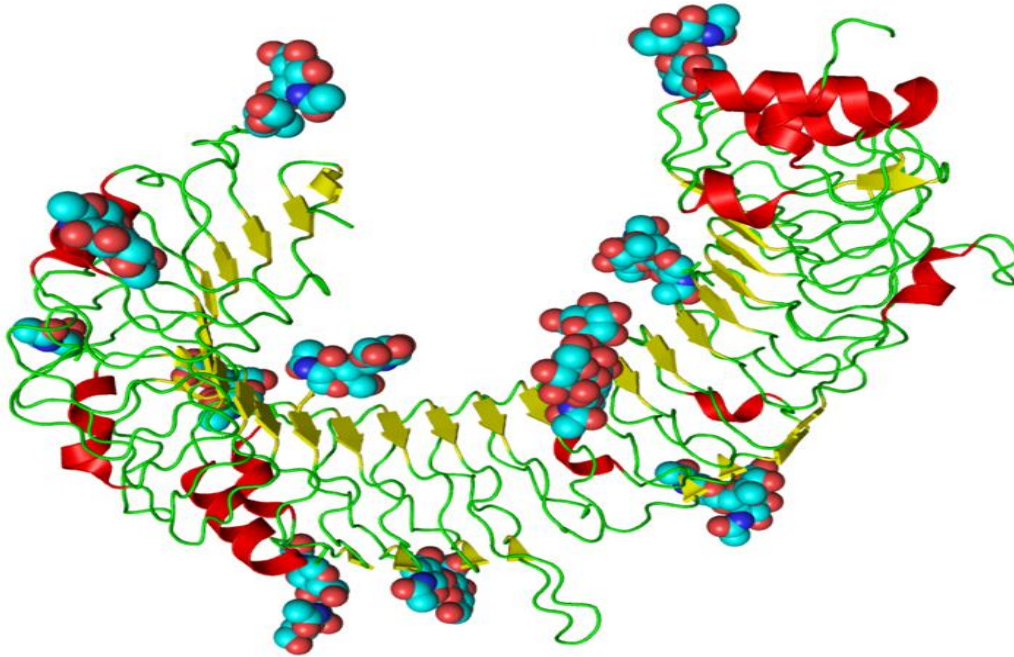
# Neutrophilar (og aðrir granulocytar)



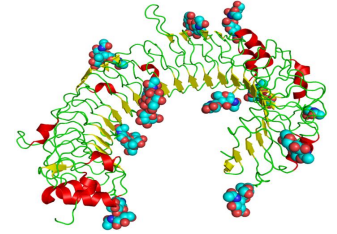
# Macrophage – Dendritic cells Angafrumur



# Hinir glæsilegu TLR! (Toll like receptors)



# Hinir glæsilegu TLR! (Toll like receptors)



TLR1

TLR2

TLR3

TLR4

TLR5

TLR6

TLR7

TLR8

TLR9

TLR10

(TLR 11, 12 og 13 ekki í mönnum)

Cell membrane

Intracellular vesicles

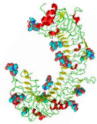
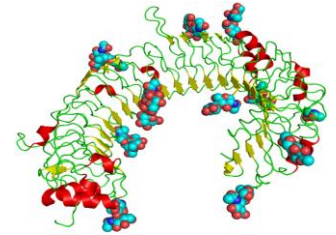
Eru á macrophögum/dendritic cells,  
Einnig NK, T & B, epi & endothleial fr  
o.fl

Greina mismunandi sýkla og flokka  
af bakteríum, veirum og sveppum

PAMP: Pathogen associated molecular pattern  
PRR(P): Pattern recognising receptors (proteins)



# Hinir glæsilegu TLR! (Toll like receptors)



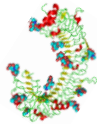
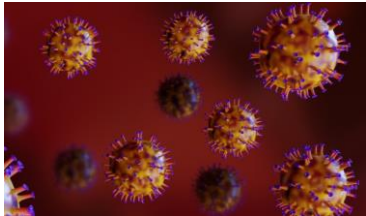
MØ



T-frumur



Ræsing sérhæfða  
ónæmissvarsins



Stöðvar prótein  
framleiðslu



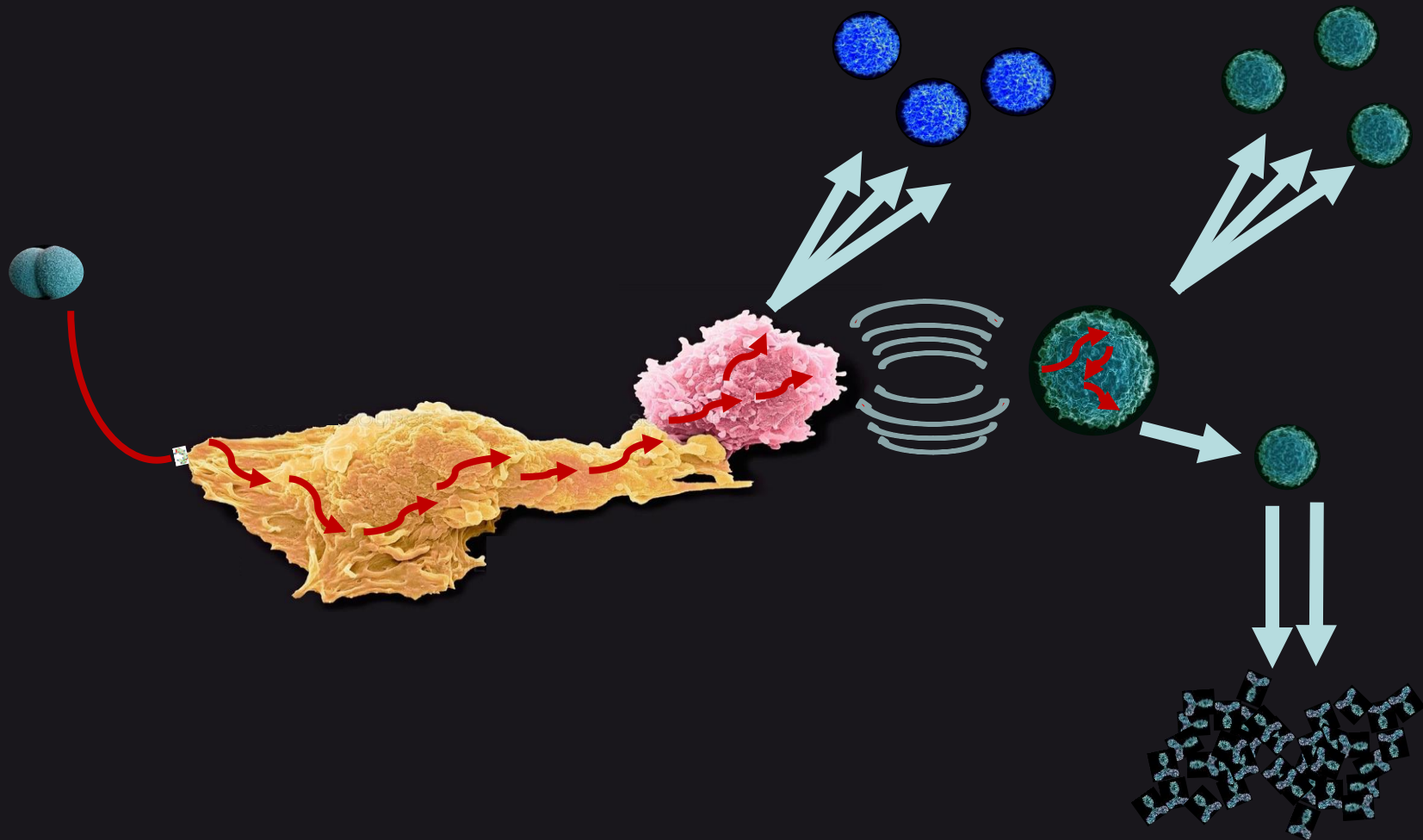
Apoptosis



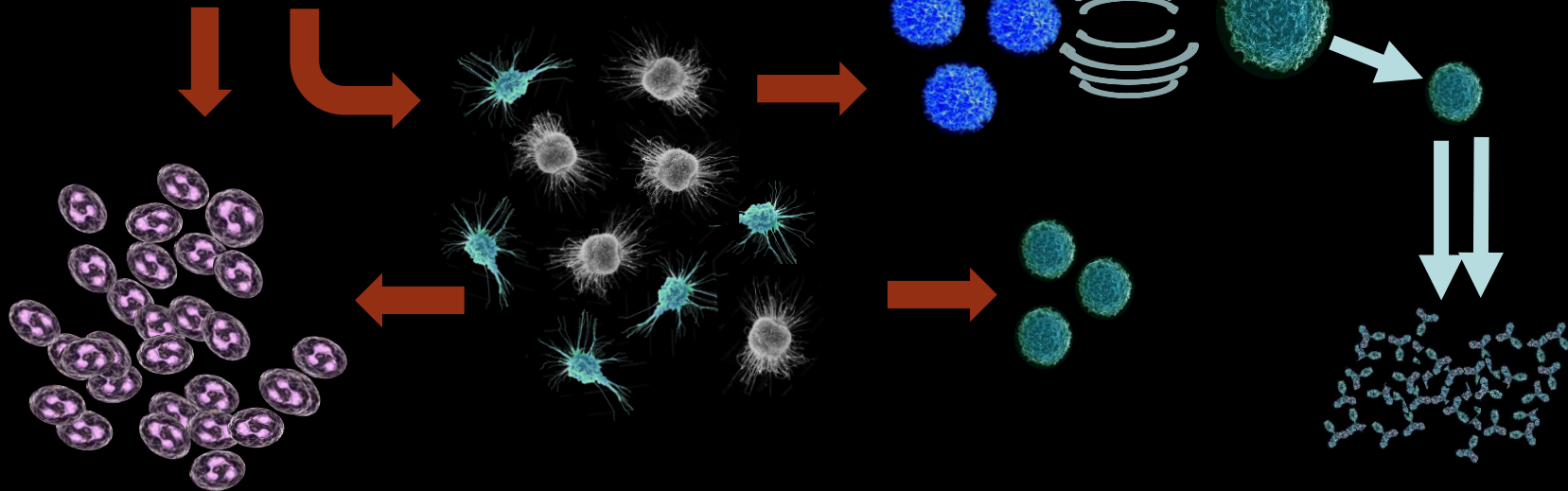
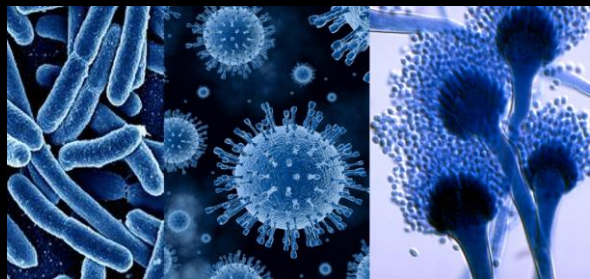
Örvar framleiðslu  
antiviral cytokina



Veirudráp



# Ræsing ónæmikerfisins



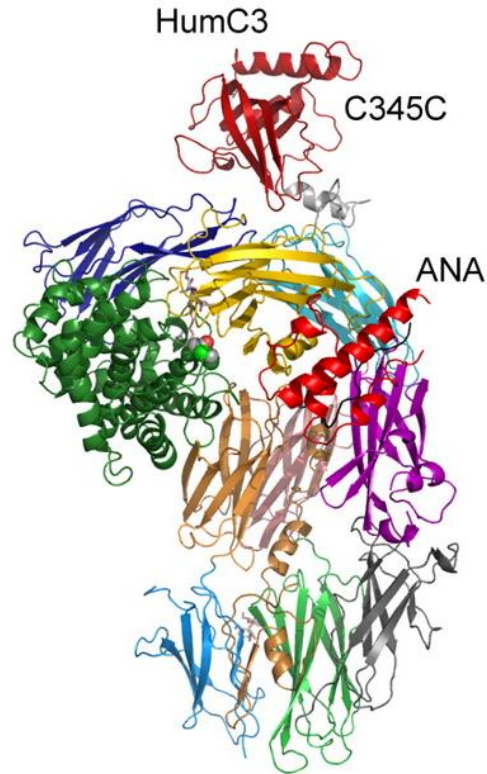


# Allt er ónæmisfræði

Ýmsir sjúkdómar í ónæmiskerfinu

... en þeir eru miklu fleiri!

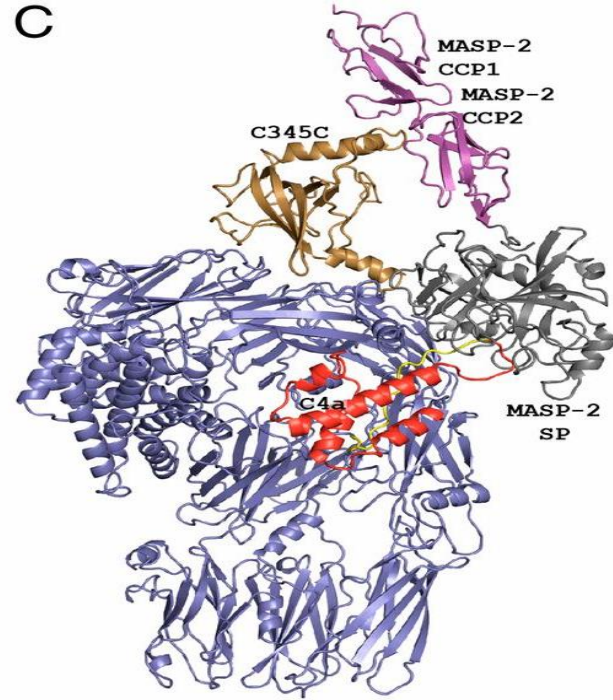
# Complement



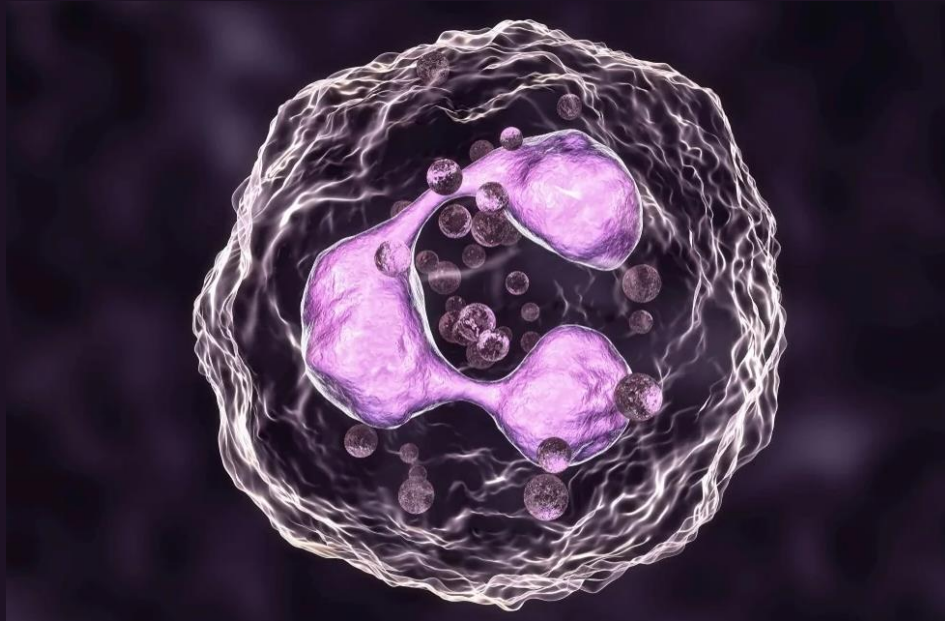
# Complement defects

## Complement defects

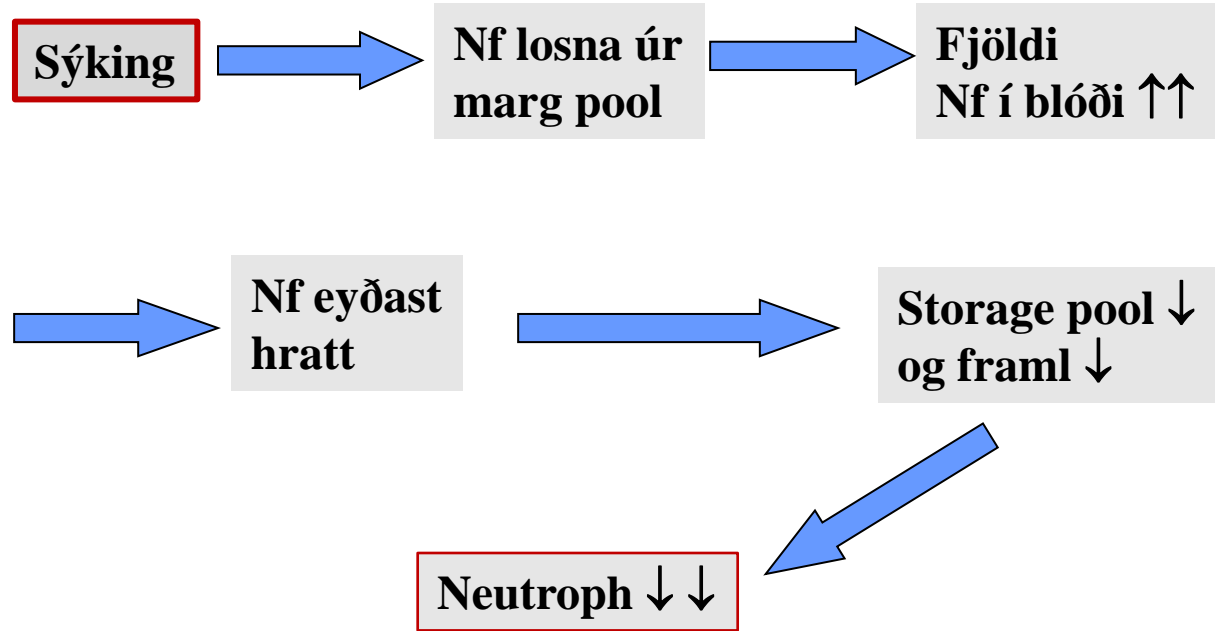
- V** Recurrent bacterial infections
- V** Inf with capsulated bacteria (meningococcus, pneumococcus)
- V** Autoimmune disorders
  - SLE
  - Glomerulonephritis
  - HUS
  - Angio-oedema



# Neutrophilar (og aðrir granulocytar)



# Neutrophilar í (neonatal) sepsis



# Granulocyta gallar

## √ Neutropenia

**Neutrophils < 1500 = neutropenia**

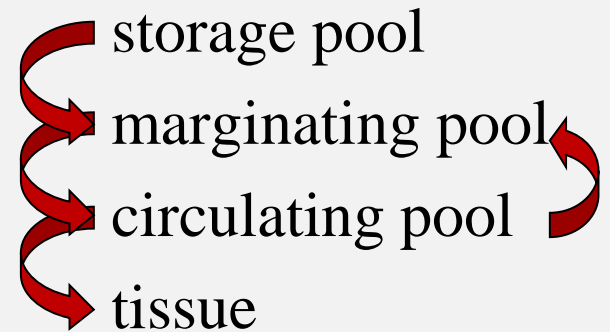
**Neutrophils < 1000 = moderately severe neutropenia**

**Neutrophils < 500 = severe neutropenia**

## √ Dysfunction of granulocytes

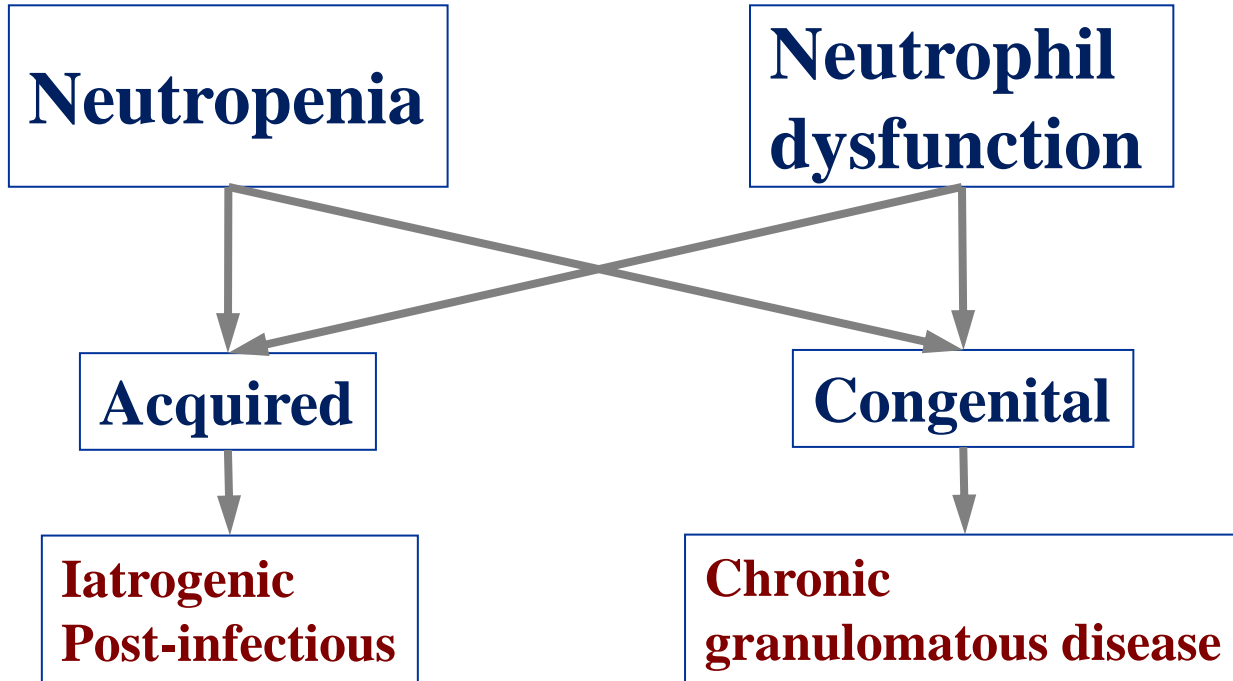


# Neutrophils





# Granulocyte disorders



# Neutrophil defects

Neutrophil numbers

Neutrophil function

- Recurrent resp inf
- +/- fever
- Skin infections
- Mucous membranes infections
- GE infections / disorders
- Sepsis
- Granulomas , +/- abscesses
- Unusual pathogens
- Umbilical cord !



# Áunnar neutropeniur

✓ Aplastic anaemia

**Pancytopenia**

**(drugs, toxins, infections, etc.)**

✓ Postinfectious neutropenia

Autoimmune neutropenia

✓ Iatrogen

**(drugs, irradiation)**

✓ Chronic diseases

**Autoimmune dis**

**Infections**

**Drugs**

**Malignant dis**

**Hypersplenismus**

**etc**

# Neutrophile gallar

- ✓ Lazy leukocyte sx
- ✓ Leukocyte adhesion defects
- ✓ Hyperimmunoglobulin E sx
- ✓ Chronic granulomatous disease
- ✓ Glucosa-6-phosphatase def
- ✓ Myelokathexis
- ✓ Def ic killing



# Neutropenia and neutrophil dysfunction

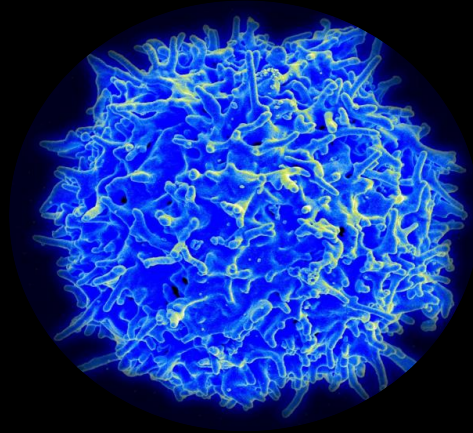
- ✓ Aplastic anaemia  
**Pancytopenia (drugs, toxins, infections, etc.)**

- ✓ Postinfectious neutropenia  
Autoimmune / benign

- ✓ Iatrogen  
**(drugs, irradiation)**

- ✓ Chronic granulomatous disease

# Ónæmisgallar T-frumur



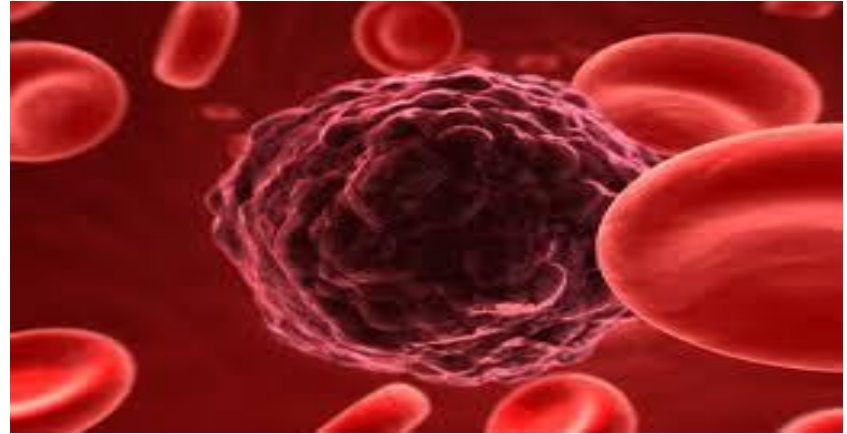


# T cell disorders

## Cellular defects

(with B- cell involvement)

- ✓ Early in life
- ✓ Failure to thrive
- ✓ Recurrent infections,  
viral, fungal and parasitic
- ✓ Autoinflammatory  
reactions
- ✓ Malignancies  
etc



SCID

WAS

TCR def

Omenn sx

HIV

DiGeorge

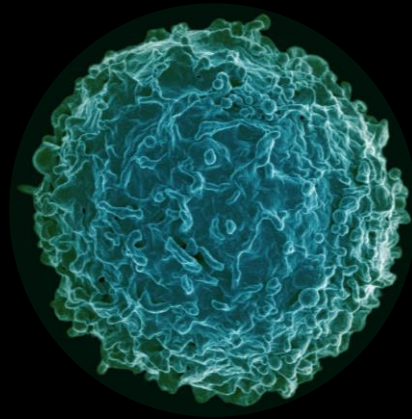
AT

CVID

# Meðfæddir T (og B) ónæmisgallar

- Frumubundnir og blandaðir gallar
  - CVID (common variable immunodeficiency) með yfirgnæfandi mótefna / frumubundnum göllum
  - SCID (severe combined immunodef) T-B- / T- B+
  - ADA SCID (adenosine deaminase deficiency)
  - PNP-SCID (purine nucleoside phosphorylase def)
  - MHC class I / class II skortur

# Ónæmisgallar B-frumur



# B - frumugallar

Agammaglobulinaemia

Hyogammaglobulinaemia

Transient hypogamma of infancy

Antibody deficiency

IgA deficiency

Suclass deficiency

HyprerIgE Sx

Hyper IgM Sx

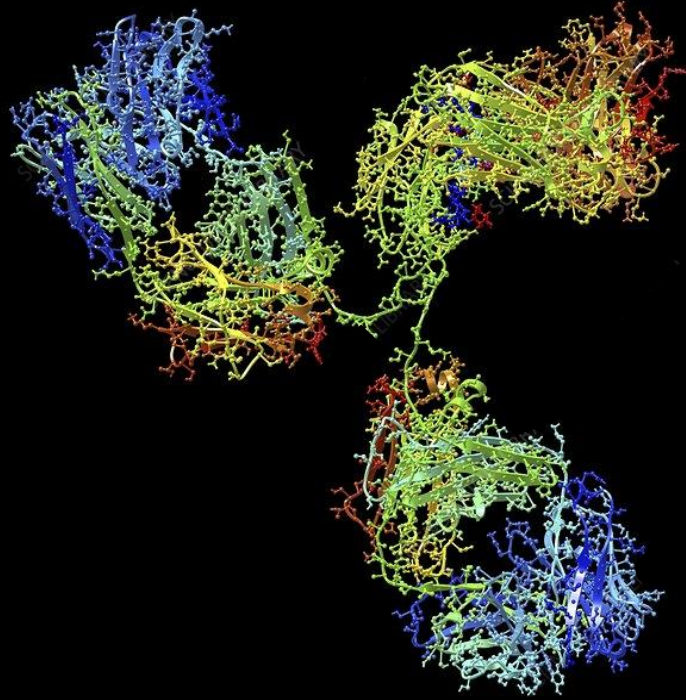
Heavy chain deletion

CVID

## Humoral defects

- B-cell defects
- Number and function
- Not in first months of life
- Recurrent infections (RTI)
- Bacterial infections (esp. capsulated)

# Immunoglobulins



A photograph of a clear blue sky with scattered, wispy white clouds. The clouds are most prominent in the upper half of the frame, with a few smaller ones scattered throughout. The overall tone is bright and airy.

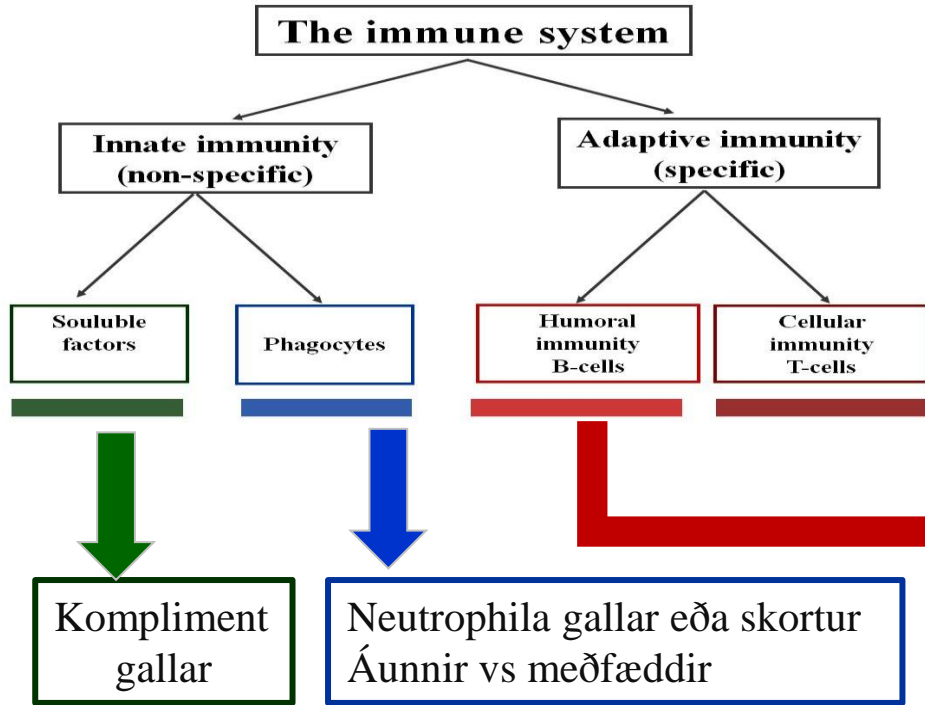
Secondary immunodeficiencies



# Secondary immunodeficiencies

- Congenital diseases and metabolic disorders  
(trisomy 21, malnutrition, nephrotic sx, protein losing enteropathy, etc )
- Immunosuppression
- Infections
  - Congenital (CMV, parvo, rubella)
  - Acquired (HIV, EBV, sepsis)
- Haematological diseases and malignancies
- Surgery, trauma, burn injuries, splenectomy
- Others (SLE, toxins, medications, liver failure etc)

# Ónæmisgallar - yfirlit



CVID

Antibody/ cellular defects

SCID (severe combined immunodef)

T-B- / T- B+

O.s.frv.

Transient hypogammaglobulinaemi of  
infancy

“Antibody deficiency”

IgA skortur

IgG undirflokkaskortur

.... O.s.frv.

# Allt er ónæmisfræði

Rannsóknir á ónæmiskerfinu  
Helstu meðferðarmöguleikar

Rannsóknir á ónæmiskerfinu



# Helstu blóðrannsóknir

Status og diff!

Kompliment

Immúnóglóbúlín

Deilitalning eitelfrumna

Neutrophil function



Rtg thorax (thymus)

Beinmergur

HLA – flokkun

Lymphocyte stimulation tests

Cytokine production

TLR

O.fl!

# Helstu blóðrannsóknir

Status og diff!



Kompliment

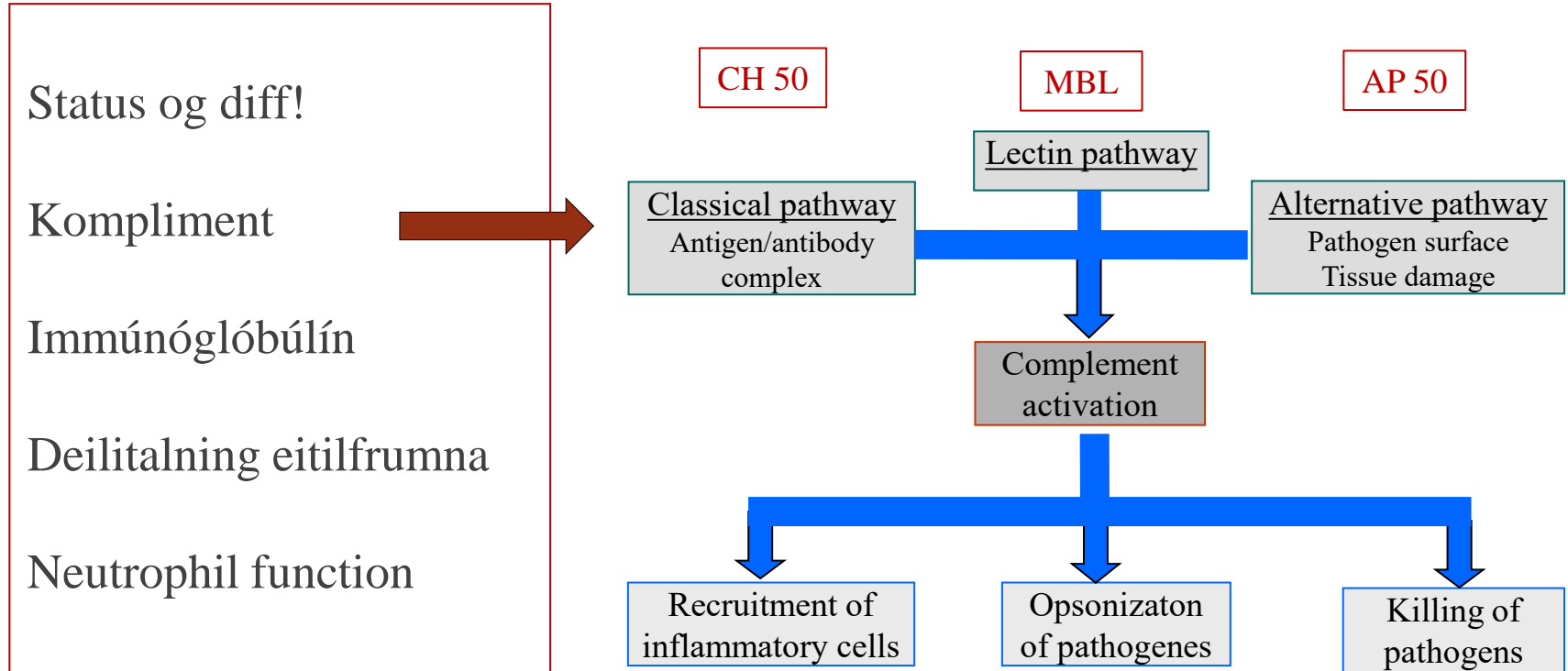
Immúnóglóbúlín

Deilitalning eitelfrumna

Neutrophil function

Blóðhagur			
B-Hvít blóðkorn	x10E9/L	7,6	2,2 L
B-Rauð blóðkorn	x10E12/L	4,49	3,99 L
B-Hemóglóbín	g/L	114	100 L
B-Hematókrít	L/L	0,34	0,31
B-MCV	fL	75	77
B-MCH	pg	25,4	25,1
B-MCHC	g/L	339	326
B-RDW		15,9 H	16,6 H
B-Blóðflögur	x10E9/L	328	263
B-MPV	fL	10,4	10,6
B-Neutrófilar	x10E9/L	0,0 L	0,3 L
B-Lymfócytar	x10E9/L	6,6	0,7 L
B-Mónócytar	x10E9/L	0,6	1,1
B-Eósínófilar	x10E9/L	0,2	0,0
B-Basófilar	x10E9/L	0,1	0,1
B-Forstig Granulocyta	%	0,1	0,0

# Helstu blóðrannsóknir





# Helstu blóðrannsóknir

Status og diff!

Kompliment

Immúnóglóbúlín

Deilitalning eitilfrumna

Neutrophil function



Ónæmisfræðideild / Department of Immunology		Viðmið / Norm	Eining /
Mótefnamælingar:			
<input type="checkbox"/> IgM	Ⓢ ↓ 0,40 (Ónæmisfræði)	0,55-3,15	g/l
<input type="checkbox"/> IgA	Ⓢ ↑ 2,65 (Ónæmisfræði)	0,58-2,56	g/l
<input type="checkbox"/> IgG	Ⓢ 10,80 (Ónæmisfræði)	6,40-15,20	g/l
<input type="checkbox"/> IgE	Ⓢ 4,70 (Ónæmisfræði)	<148	kU/l
IgG undirflokkar: 0			
<input type="checkbox"/> IgG1	Ⓢ 6,59 (Ónæmisfræði)	3,48-12,14	g/l
<input type="checkbox"/> IgG2	Ⓢ 3,20 (Ónæmisfræði)	1,18-6,62	g/l
<input type="checkbox"/> IgG3	Ⓢ 0,162 (Ónæmisfræði)	0,130-1,580	g/l
<input type="checkbox"/> IgG4	Ⓢ 0,072 (Ónæmisfræði) [1]	0,030-2,540	g/l

Aldursstöðluð  
viðmiðunarmörk

# Helstu blóðrannsóknir

## Sérhæfð mótefni

Status og diff!

Kompliment

Immúnóglóbúlín

Deilitalning eítílfrumna

Neutrophil function



Sértæk mótefni gegn bakteríum:		
<input type="checkbox"/> Upplýsingar um bólusetningu	ℓ	
<input type="checkbox"/> Pneumokokkar hjúpperð 4	ℓ	1,86 (Ónæmisfræði)
<input type="checkbox"/> Pneumokokkar hjúpperð 6B	ℓ	1,71 (Ónæmisfræði)
<input type="checkbox"/> Pneumokokkar hjúpperð 7F	ℓ	0,41 (Ónæmisfræði)
<input type="checkbox"/> Pneumokokkar hjúpperð 19F	ℓ	0,82 (Ónæmisfræði) [3]
<input type="checkbox"/> Pneumokokkar hjúpperð 8	ℓ	2,24 (Ónæmisfræði)
<input type="checkbox"/> Pneumokokkar hjúpperð 12F	ℓ	0,06 (Ónæmisfræði)
<input type="checkbox"/> Tetanus toxoid	ℓ	1,33 (Ónæmisfræði) [3]

<input type="checkbox"/> Varicella zoster veira IgM / Varicella zoster virus IgM	gℓ	Neikvæð (< 0.8 Ratio) (Blóðsýni)
<input type="checkbox"/> Varicella zoster veira IgG / Varicella zoster virus IgG	gℓ	
<input type="checkbox"/> Varicella zoster veira IgG / Varicella zoster virus IgG	gℓ	Neikvæð (< 80 IU/1) (Blóðsýni)
<input type="checkbox"/> Cytomegaloveira IgM (ECLIA) / Cytomegalovirus IgM	gℓ	Neikvæð (Blóðsýni)
<input type="checkbox"/> Cytomegaloveira IgG (ECLIA) / Cytomegalovirus IgG	gℓ	Jákvæð (Blóðsýni)
<input type="checkbox"/> Epstein Barr VCA IgM (ELISA) / Epstein Barr virus VCA IgM	gℓ	Neikvæð (< 0.8 Ratio) (Blóðsýni)
<input type="checkbox"/> Epstein Barr VCA IgG (ELISA) / Epstein Barr virus VCA IgG	gℓ	Jákvæð (>= 1.1 Ratio) (Blóðsýni)

# Helstu blóðrannsóknir

Status og diff!

Kompliment

Immúnóglóbúlín

Deilitalning eitifrumna

Neutrophil function



FACS greining á hvítfrumum í blóði 7. september 2021

Hvítfrumur	Dagsetning: 7. sept.		Áður 8. júní		Viðmið Hlutfall %	10-16 ára Abs fj.x10 <sup>9</sup> /L
	Hlutfall %	2021 Abs fj.x10 <sup>9</sup> /L	Hlutfall %	2021 Abs fj.x10 <sup>9</sup> /L		
<b>Monocytar</b>	7,2		9,9			
<b>Granuloeytar</b>	39,3		36,1			
<b>Lymphocytar</b>	51,5	2,3	48,0	1,9		1.0-5.3
<i>B frumur CD19+</i>	17,5	0,4	17,1	0,3	8-24%	0.2-0.6
Memory IgDneg	2,49		0,99			
Naive B frumur	93,25		94,29			
<i>T frumur CD3+</i>	65,5	1,5	61,0	1,1	52-78%	0.8-3.5
CD4+ T fr.og CD3+	32,6	0,8	<b>24,6</b>	0,4	25-48%	0.4-2.1
Naive CCR7+ CD45RA+	72,48		68,08			
Eff. CCR7neg CD45RAneg	13,36		18,23			
Activ. HLA-DR+ CD38+	4,19		2,85			
CD8+T fr. og CD3+	28,6	0,7	28,0	0,5	9-35%	0.2-1.2
Naive CCR7+ CD45RA+	19,84		12,43			
Eff. CCR7neg CD45RAneg	40,61		48,74			
Activ. HLA-DR+ CD38+	15,66		1,01			
Hlutfall CD4+/ CD8+	= 1,15		<b>= 0,85</b>		0.9-3.4	
<i>NK frumur CD16+ og CD56+</i>	14,7	0,3	20,9	0,4	6-27%	0.07-1.2

*Eðlileg deilitalning og ekki merki um ræsingu. Niðurstöður frá 8. júní til samanburðar.*

# Helstu blóðrannsóknir

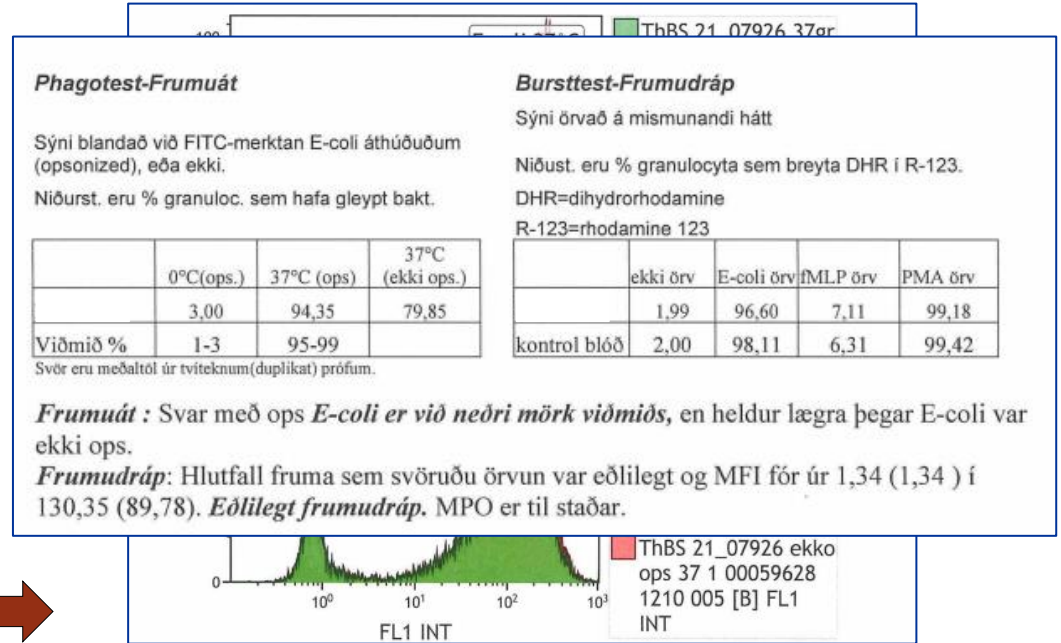
Status og diff!

Kompliment

Immúnóglóbúlín

Deilitalning eitifrumna

Neutrophil function



# Helstu blóðrannsóknir

Status og diff!

Kompliment

Immúnóglóbúlín

Deilitalning eitelfrumna

Neutrophil function



# Allt er ónæmisfræði

Meðferð við ónæmisgöllum og  
frávikum í ónæmiskerfinu

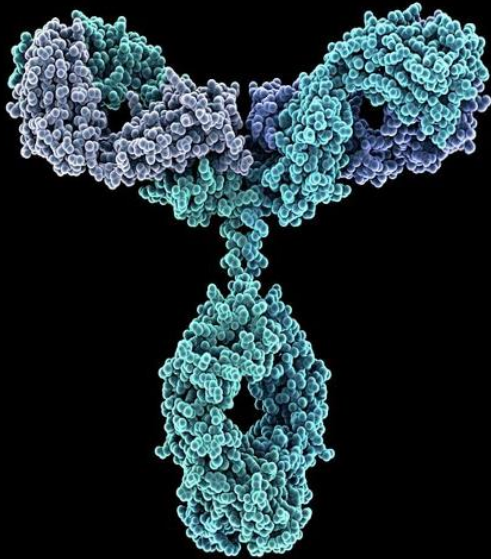
Nokkrir meðferðarmöguleikar



# Sýklalyf – en af skynsemi!



# Mótnagjafir / IVIG - ScIG



IgG

IgG1

IgG2

IgG3

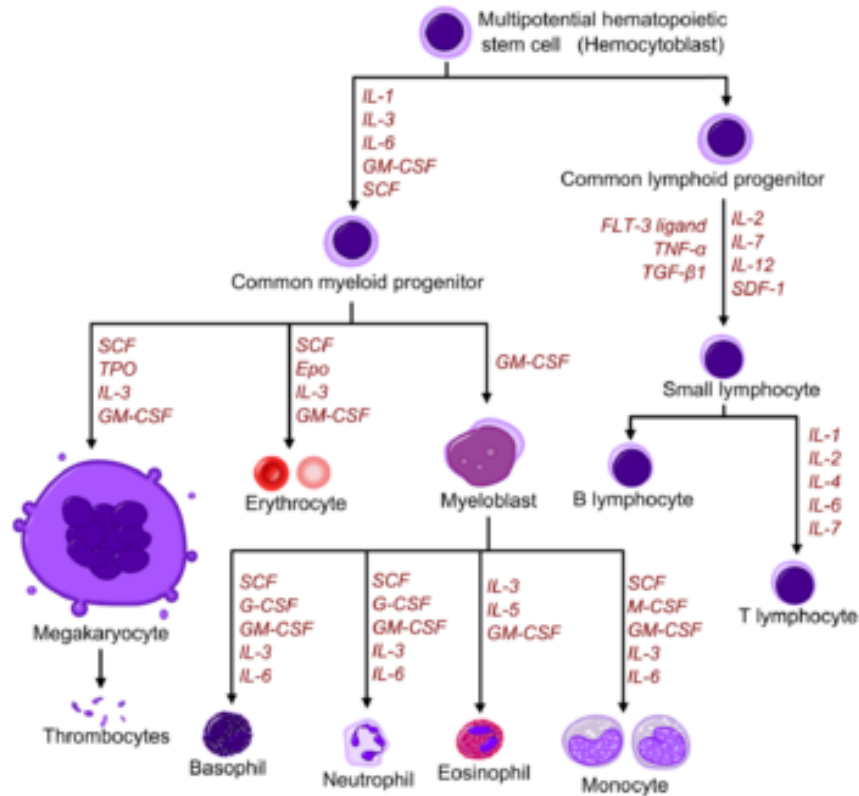
IgG4

Sérhæfð mótefni !

# Lífæknilyf



# Frumuboďefni

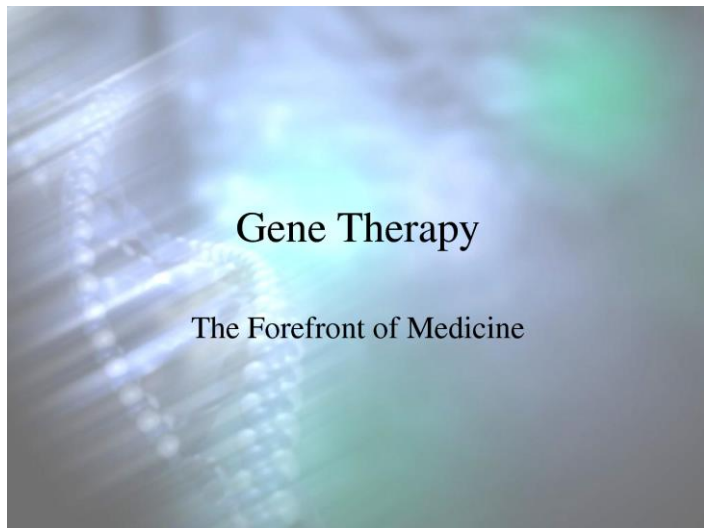


# Beinmergsskipti / stofnfrumumeðferð





# Genalækningar !



# Ábendingar

- I. Illkynja sjúkdómar í beinmerg
- II. Krónískir sjúkómar í beinmerg
- III. Meðfæddir ónæmisgallar
- IV. Blóðsjúkdómar
- V. Haemoglobinopathiur
- VI. Storage diseases
- VII. Sjálfnæmsisjúkdómar?
- VIII. „Rescue“ meðferð?



SCID – ýmsar tegundir  
T-frumugallar - ýmsar tegundir  
Chronic granulomatous disease  
Severe congenital neutropenia  
Hyper IgE sx, WAS, FEL  
o.s.frv.



# Aukaverkanir og áhætta

## Snemmkomnar aukaverkanir

Sýkingar

Höfnun

Graft vs host disease  
(og Graft vs tumor effect)

Hemorrhagic cystitis,

Mucositis

Veno-occlusive disease

Lymphoproliferative sx

## Síðkomnar aukaverkanir

Illkynja sjúkdómar

Áhrif á vöxt og þroska

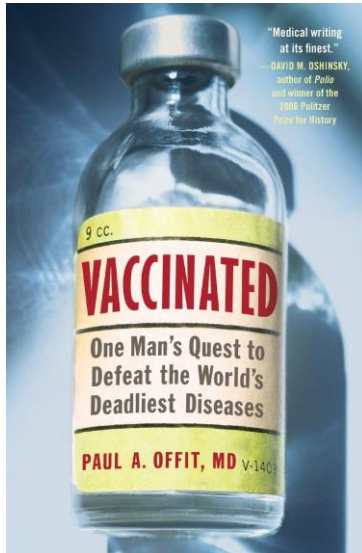
Graft vs host disease

Lymphoproliferative sx

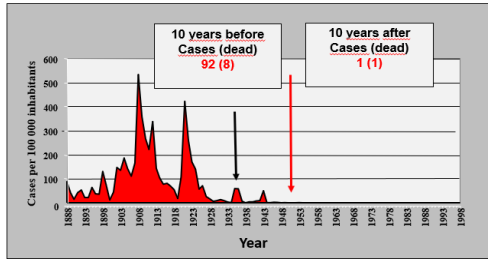
o.s.frv.

# Að ógleymdri fyrirbyggjandi meðferð...

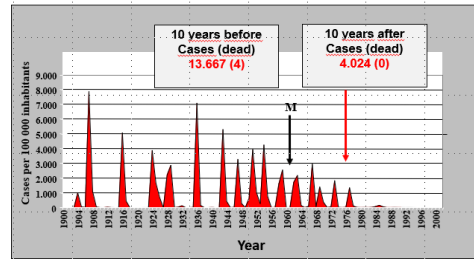
**Sem bjargað hefur fleiri mannlífum  
nokkur önnur heilbrigðismeðferð  
– að hreinu vatni undanskildu**



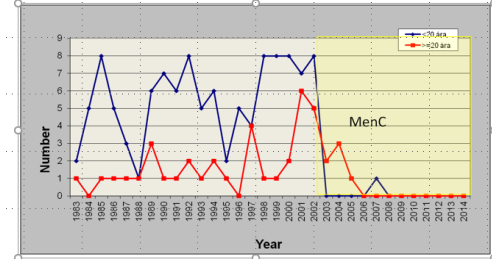
## Diphtheria in Iceland



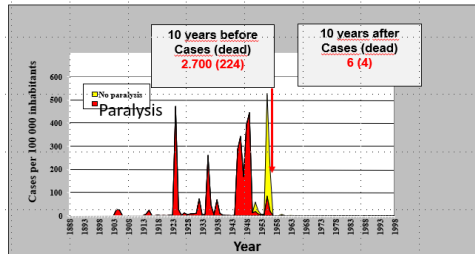
## Measles in Iceland



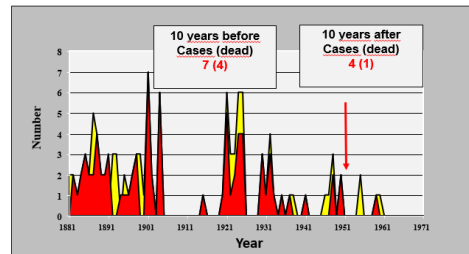
## Men C in Iceland



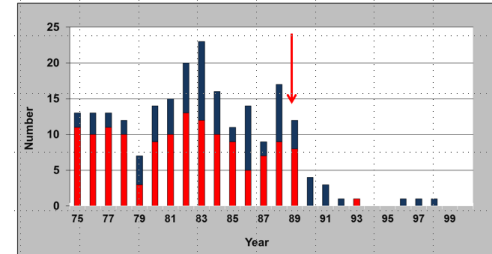
## Poliomyelitis in Iceland



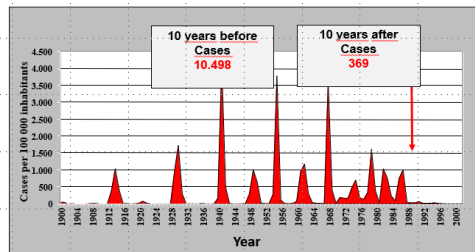
## Tetanus in Iceland



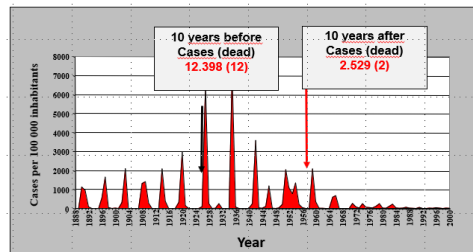
## Hib in Iceland



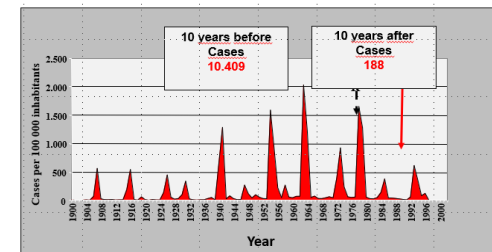
## Mumps in Iceland



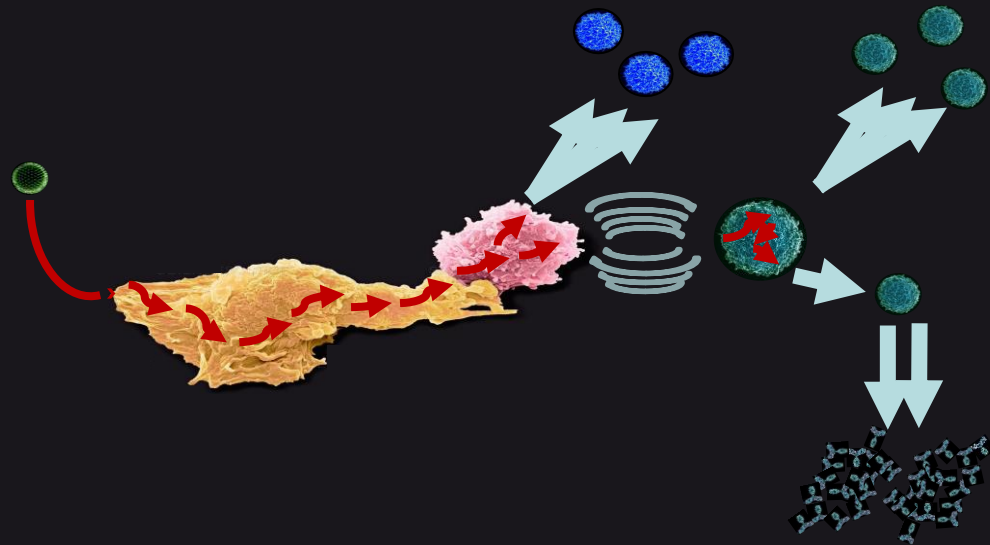
## Pertussis in Iceland



## Rubella in Iceland



Getum við notað þessa þekkingu til að þróa bóluefni ???





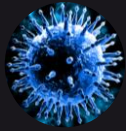
Dauðar veirur  
Veiklaðar veirur  
Veiruhluta

Dauðt dauðir sýklar (oftast veirur)  
Inflúensa, IV polio, Hepatitis A

Veiklaðir sýklar  
MMR, Hlaupabóla  
Rotaveira, Bólusótt, Yellow fever

Veiruhluta  
Toxin: Tetanus, Barnaveiki





Dauðar veirur  
Veiklaðar veirur  
Veiruhluta

Polysaccharide vaccine  
PPV (pneumococcal polysaccharide vaccine)  
(Hepatitis B, HPV)

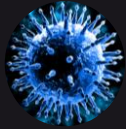


Dauðir sýklar  
Sýklahlutar  
Með trikkum!

Protein conjugated vaccine  
Haemmophilus influenzae, type b,  
PCV (pneumococcal conjugated vaccine)  
MenC

BCG (úr öðrum tegundum)  
Kúabóla





Dauðar veirur  
Veiklaðar veirur  
Veiruhluta



Dauðar bakteríur  
Bakteríuhluta  
Með trikkum!



Eitthvað annað?  
Beta?  
Vir kara?  
Ódýrara?  
Markvissara?  
.....?

RNA vaccine:

mRNA sem skráir fyrir próteini, pakkað inn í vector (veiru, lipid nanópartikkla).  
Dæmi: SARS CoV-2

DNA vaccine:

DNA úr veiru komið fyrir í manna eða dýrafrumum, DNA/mRNA-protein !  
Væntanlega afar langvinnt ónæmissvar.  
Dæmi: enn í tilraunum (hestar og West-Nile virus, monoclonal Ab?)

Recombinant vector:

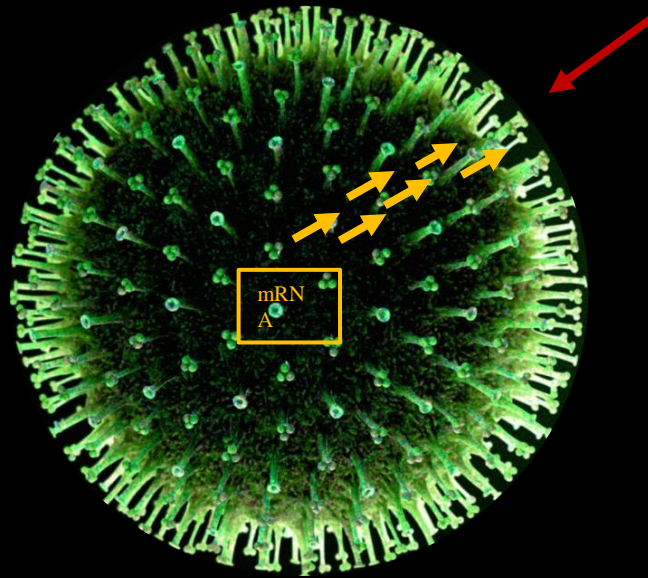
Samþætta eiginleika ákveðins sýkils við DNA úr öðrum.  
Dæmi: RSV-ZEBOV (Ebóla bóluefni!)

T-cell receptor peptide vaccines:

Breytir T-frumu samskiptum og frumuboðenfun.  
Bóluefni gegn sjúkdómum (atopic dermatitis o.fl). Dæmi: enn í tilraunum

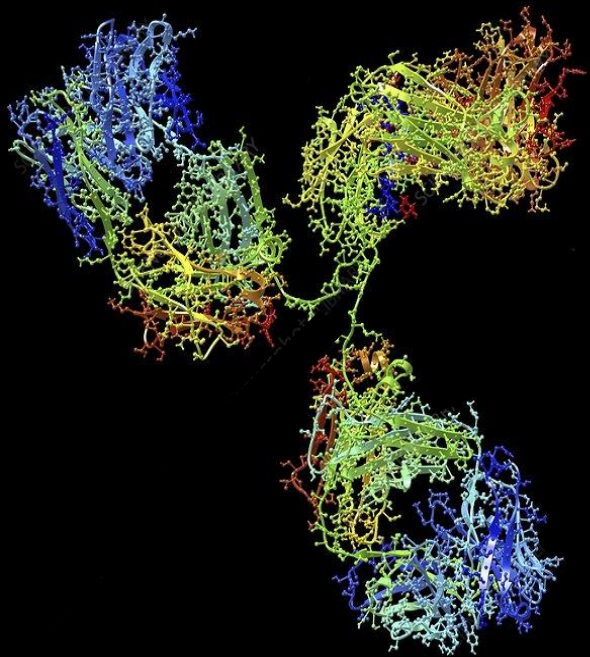
Dendritic cells (angafrumurnar):

Bóluefni gegn sjúkdómum  
(brain tumor, mal melanoma), ex-vivo mRNA (DNA?) programming





# Lokaniðurstaðan!



Allt

er ónæmisfræði !!!