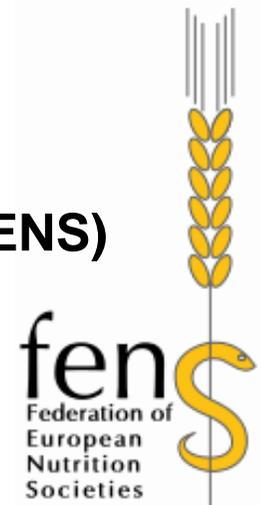


Nutrition to support immune health

Philip C. Calder
Professor of Nutritional Immunology
Faculty of Medicine
University of Southampton
Southampton, UK

AND

President of the Federation of European Nutrition Societies (FENS)



IUNS World Food Day Event, November 2021

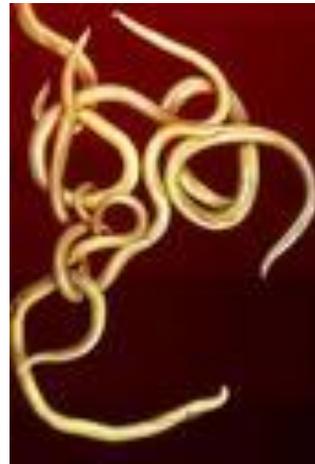
The immune system

... is a cell and tissue system that protects the individual from harmful organisms (= pathogens)

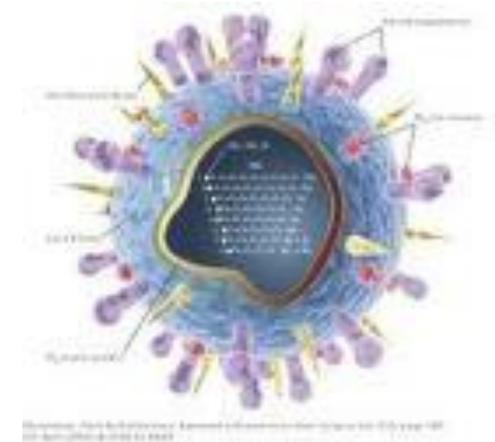
Bacteria



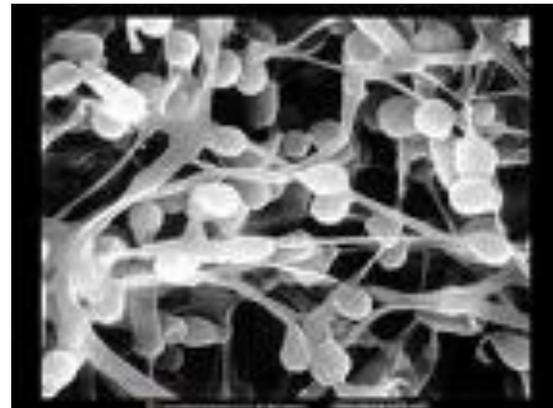
Parasitic worms



Viruses



Fungi

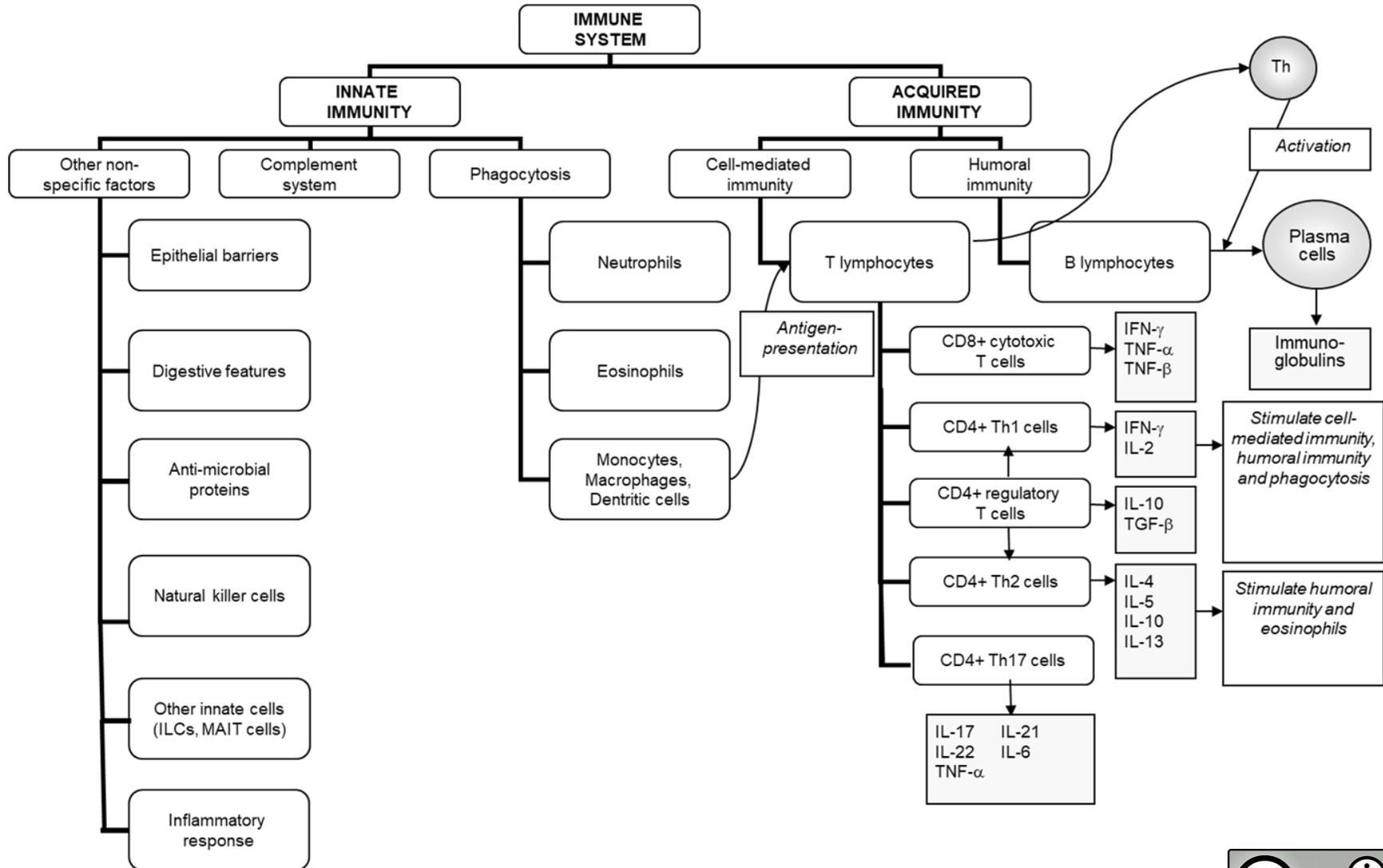


**A well functioning immune system
is key to providing robust defence
against pathogens**

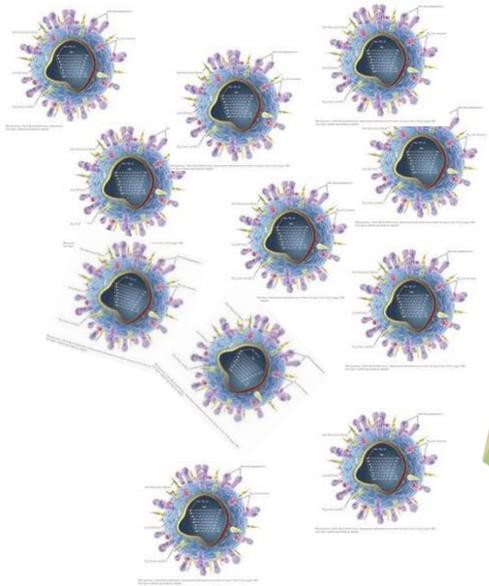
The four general functional features of the immune system

- **Exclusion barrier**
 - Skin, mucosal linings, acid pH of stomach, proteins in secretions ...
- **Identification/recognition**
 - Generic via pattern recognition receptors; specific via “antigen receptors”
- **Elimination**
 - Phagocytosis and digestion; Direct destruction; Killing virally-infected cells
- **Memory**

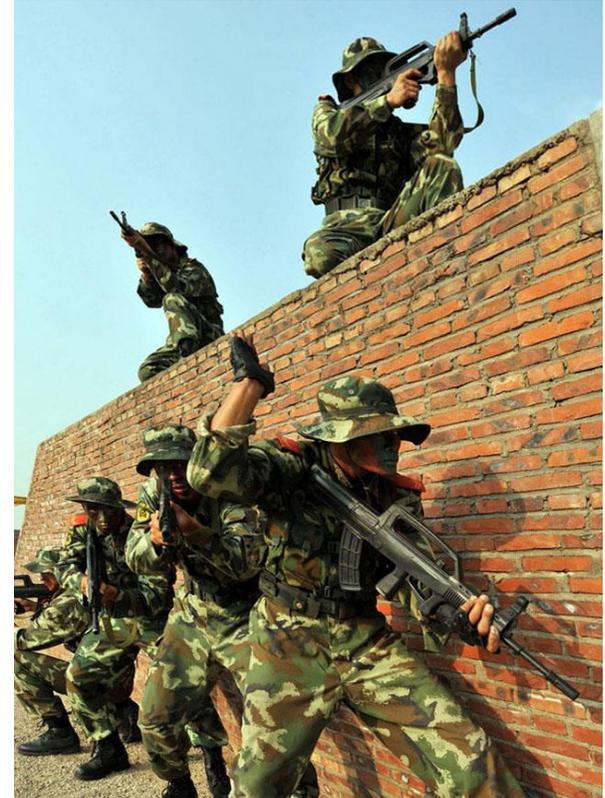
The immune system involves many cell types – each has their own role



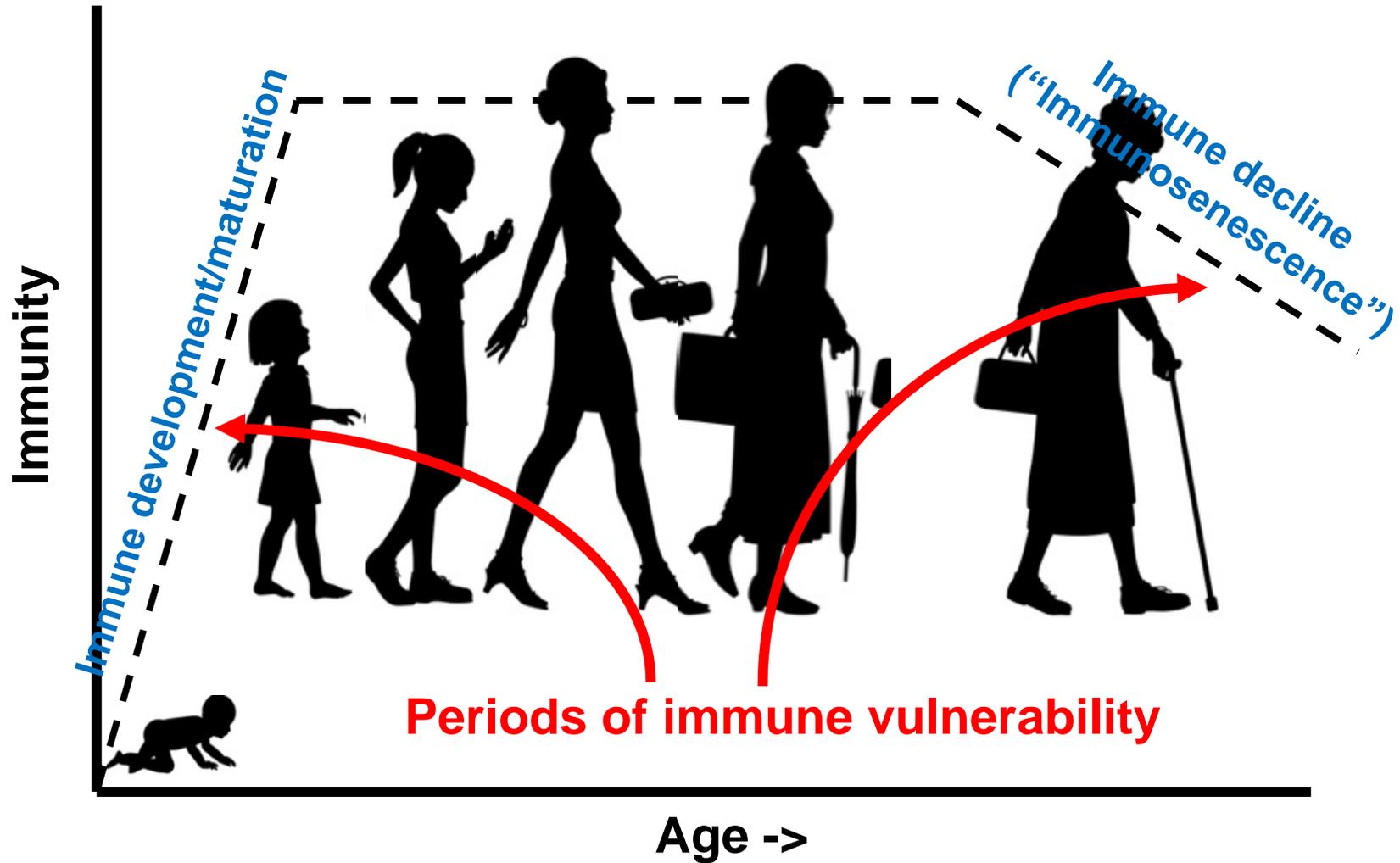
Barrier



Cellular components of innate and acquired immunity



Immune development, immune decline & “immune vulnerability”



Weak immunity

= Poor defence against harmful organisms

= Infection

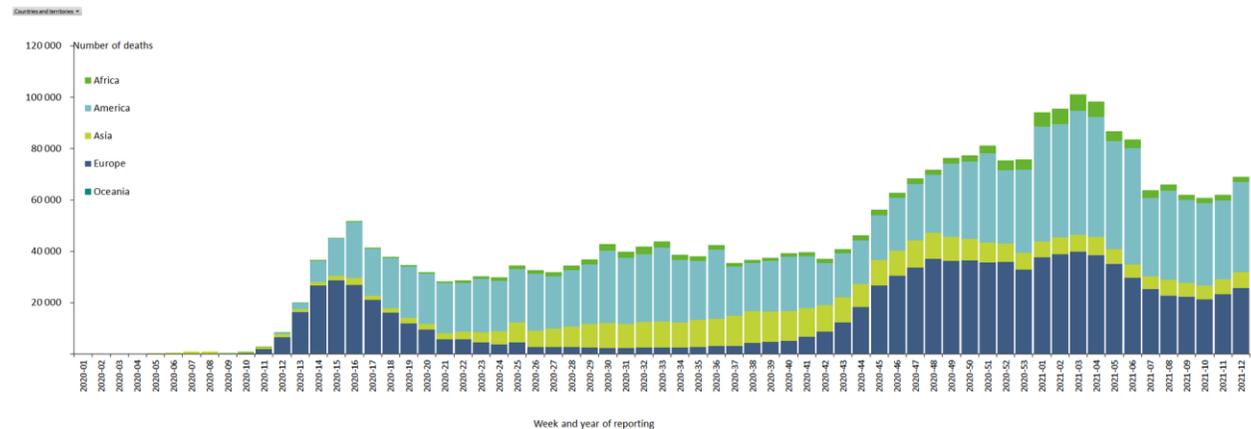
In 2020 weak immune systems were exposed as a major public health challenge!

SOMEONE IN THIS HOUSE HAS A WEAK IMMUNE SYSTEM

People with weak immune systems are more likely to catch Coronavirus (COVID-19) and more likely to suffer serious complications if they become ill. Because of this we are self-isolating and self-distancing.

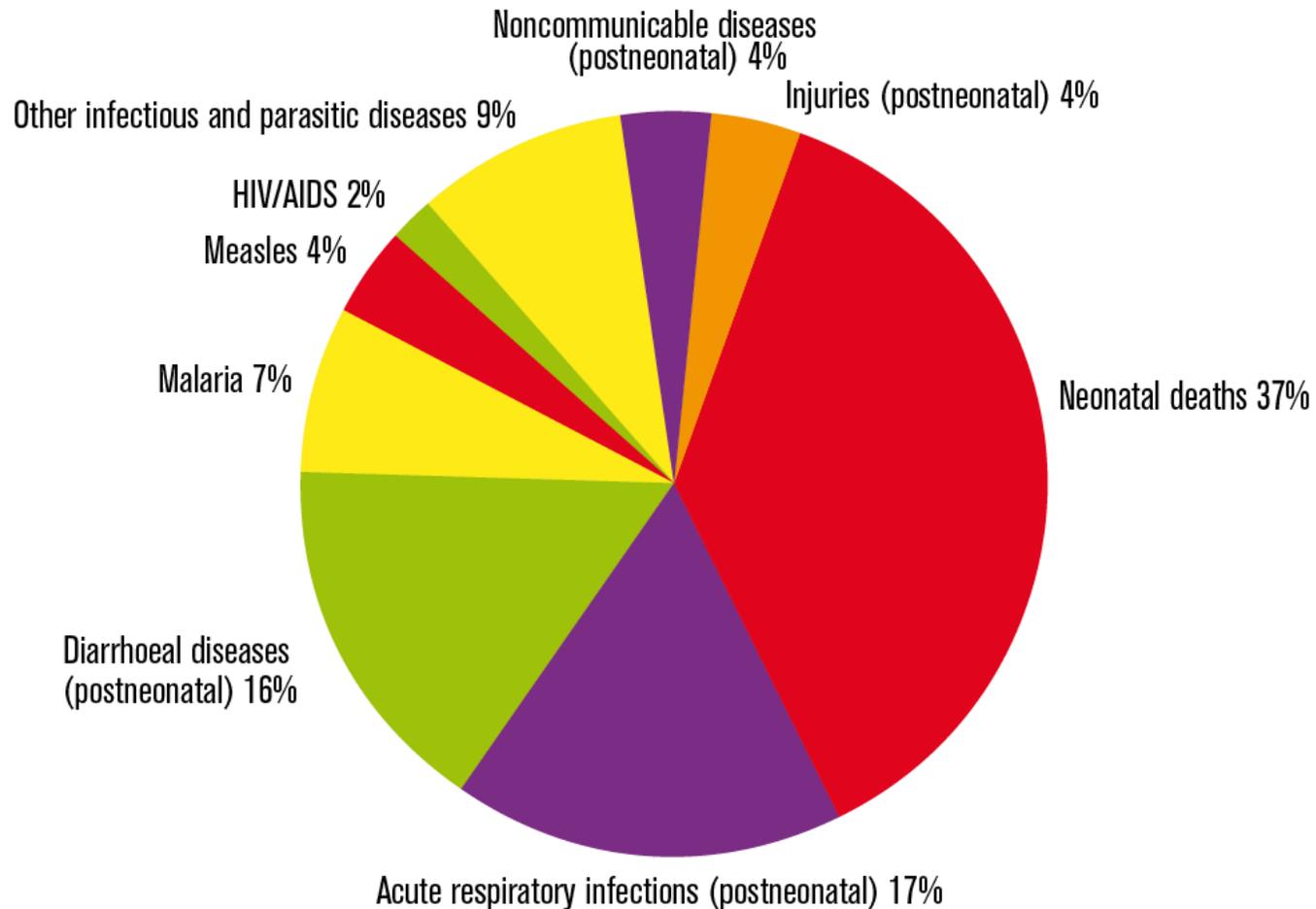


COVID-19 mortality by week and region



European Centre for Disease Prevention and Control

MAJOR CAUSES OF DEATH IN NEONATES AND CHILDREN UNDER FIVE IN THE WORLD

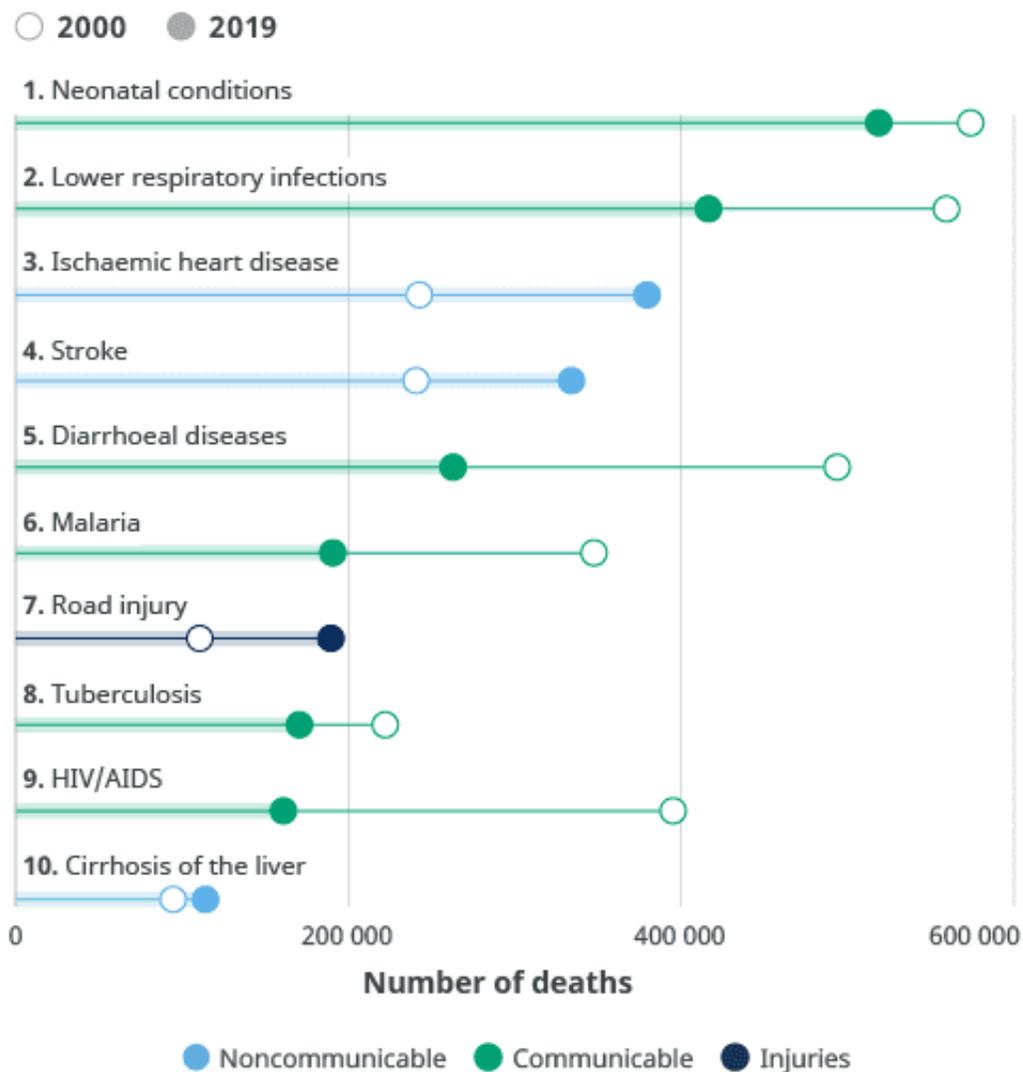


34% OF UNDER-FIVE DEATHS ARE FROM DIARRHOEAL DISEASE AND ACUTE RESPIRATORY INFECTIONS

Sources:

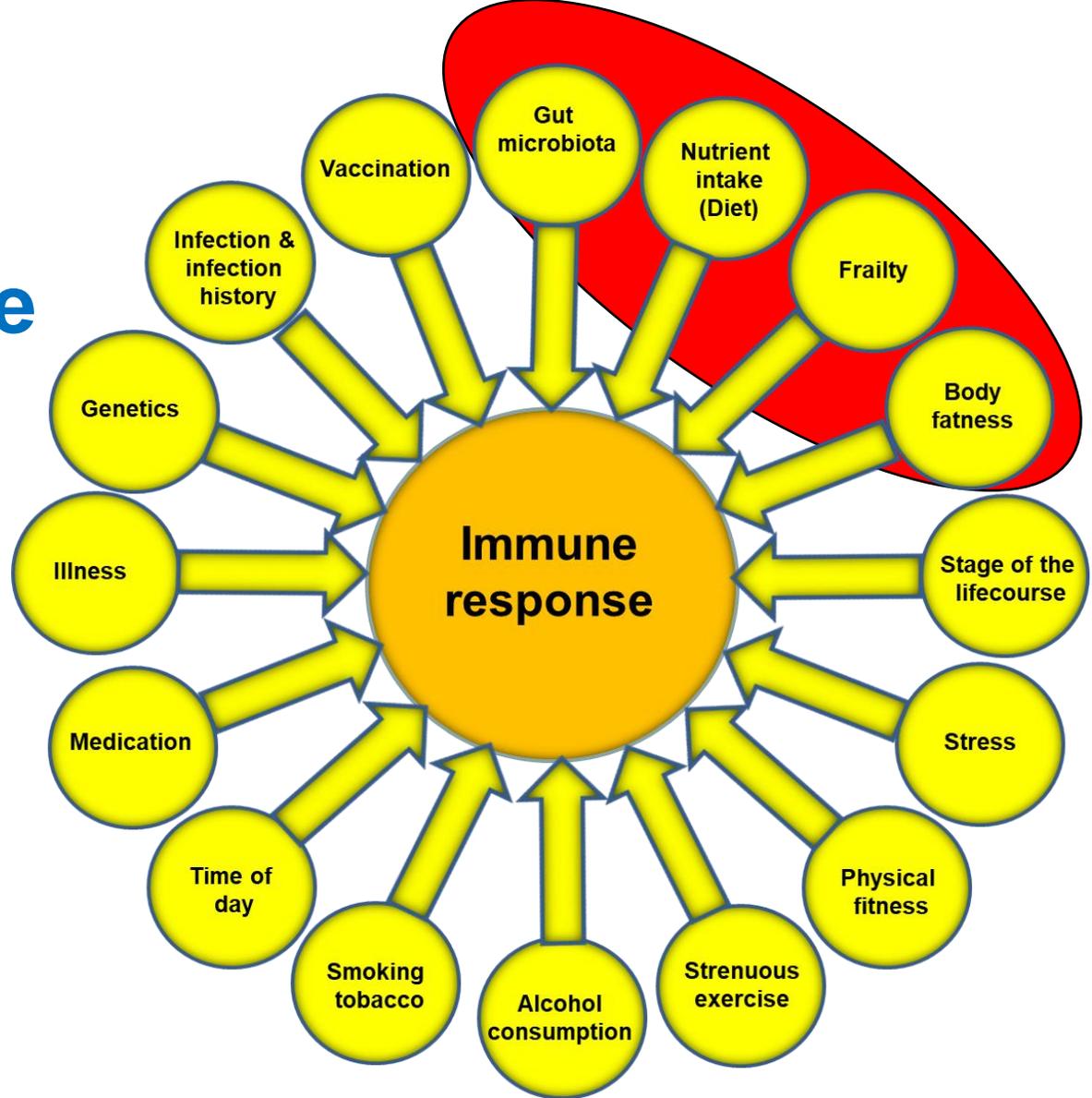
For estimates of causes of neonatal and under-five deaths: World Health Organization. The global burden of disease: 2004 update. For estimates of undernutrition: Black R et al. Maternal and child undernutrition: global and regional exposures and health consequences. Lancet 2008; 371:243-60. Sources: (1) WHO. The Global Burden of Disease: 2004 update (2008); (2) For undernutrition: Black et al. Lancet, 2008

Leading causes of death in low-income countries



Source: WHO Global Health Estimates. Note: World Bank 2020 income classification.

Many factors affect the immune response



Calder (2021) Eur. J. Clin. Nutr. 75, 1309-1318

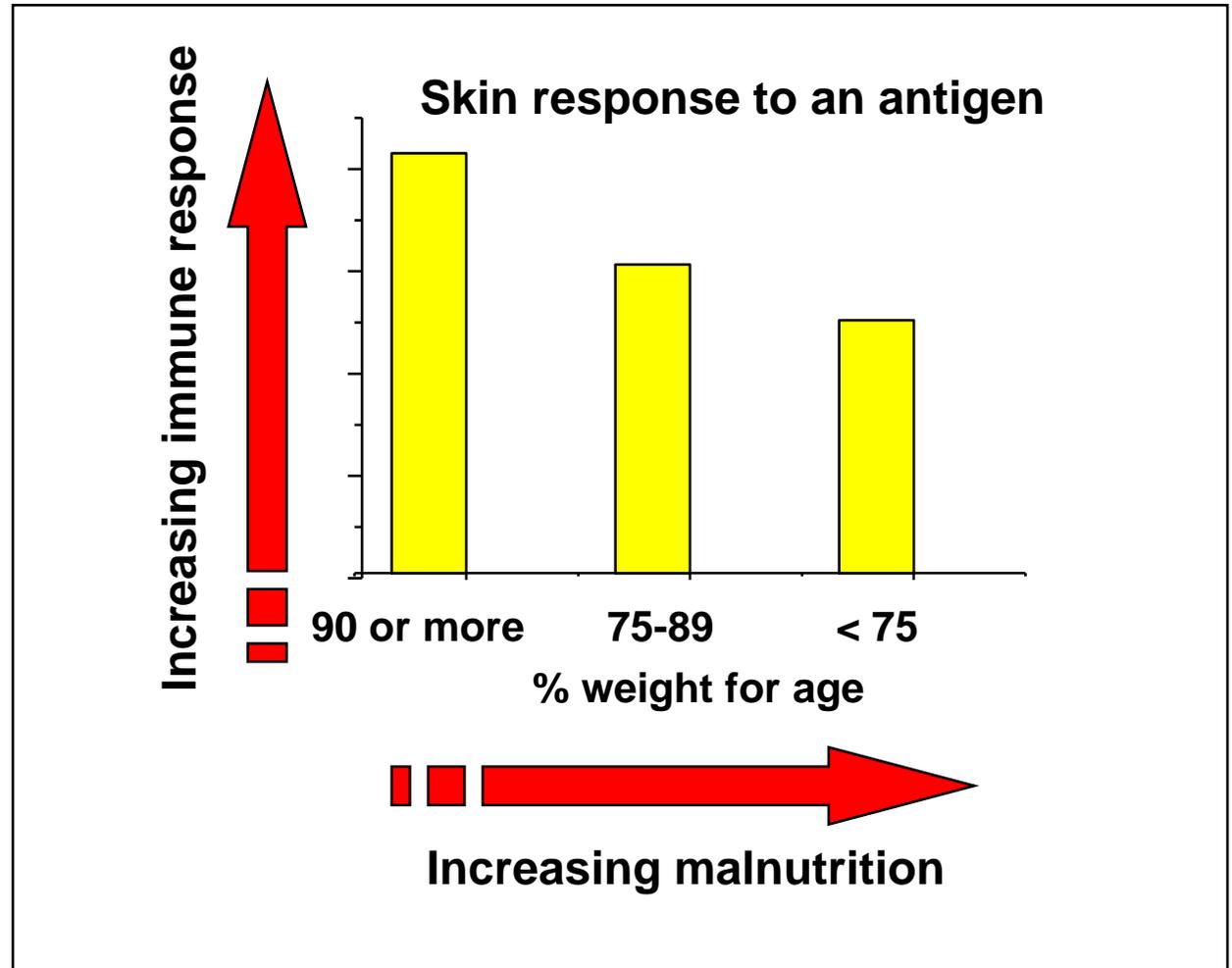


How nutrients can support the immune system

- **Fuels** for energy generation
- **Building blocks** (e.g. amino acids for immunoglobulins, cytokines, new receptors, acute phase proteins)
- **Regulators** of molecular and cellular responses (e.g. zinc, vitamin A)
- **Substrates** for the synthesis of chemicals involved in the immune response (e.g. arginine and nitric oxide)
- **Specific anti-infection roles** (e.g. Zn)
- **Protection** of the host from oxidative and inflammatory stress (e.g. vitamin C, vitamin E, cysteine, Zn, Cu, Se, many phytochemicals)
- **Creating a diverse microbiota** (e.g. fibre, prebiotics, phytochemicals,)

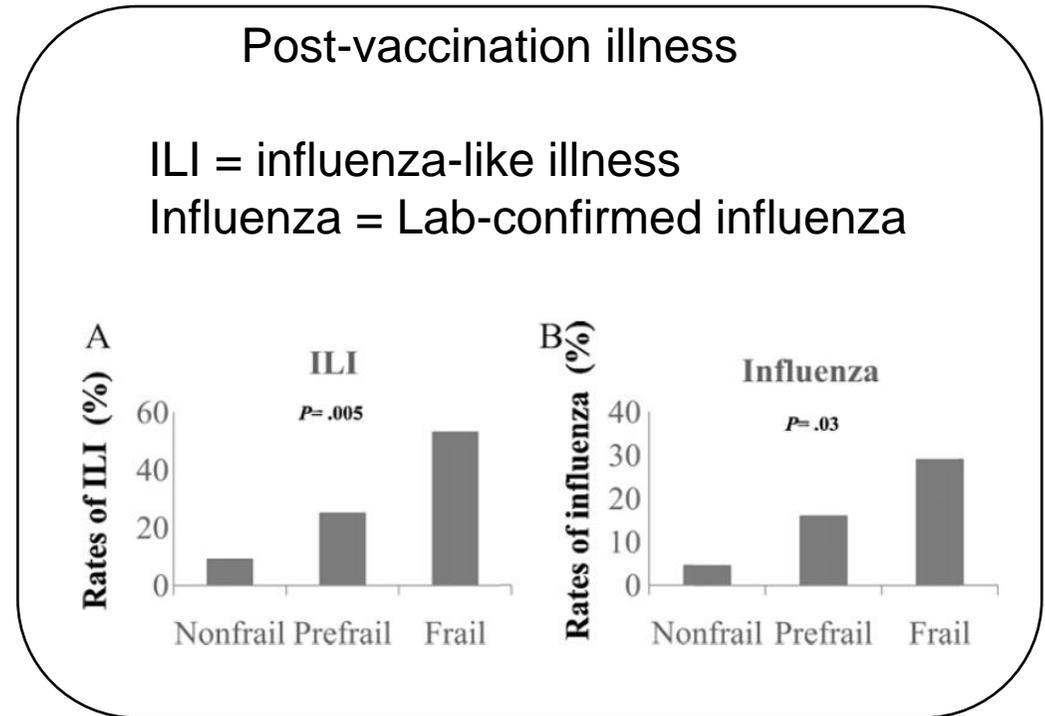
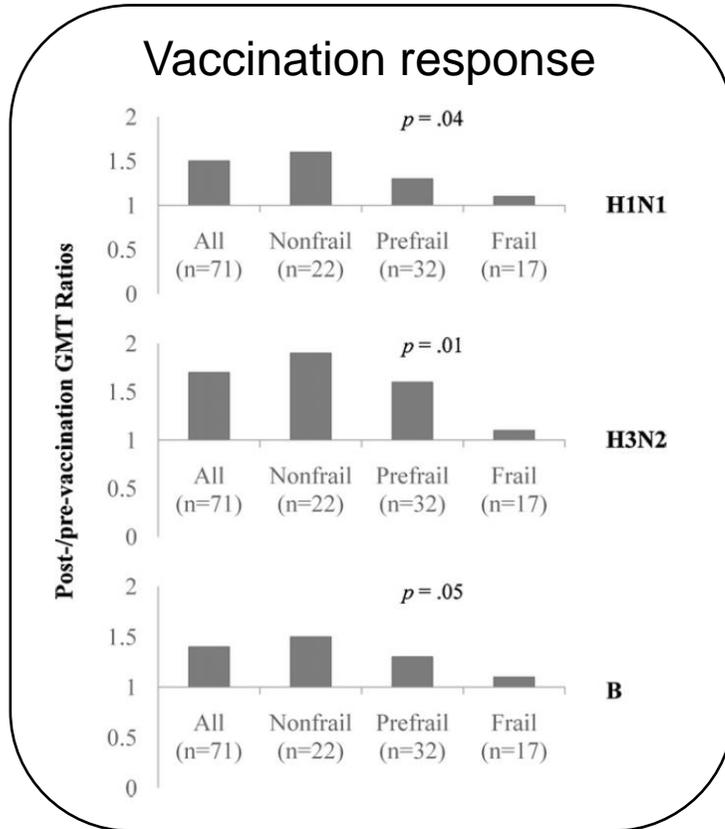
Undernutrition

- Weakens immunity
- Predisposes to infection



Rivera et al. (1986) Nutr. Res. 6, 1161-1170

Frailty reduces response to influenza vaccination among older people



Reprinted from Vaccine, Vol 29, X Yao et al., Frailty is associated with impairment of vaccine-induced antibody response and increase in post-vaccination influenza infection in community-dwelling older adults, pp 5015-5021, Copyright (2011), with permission from Elsevier

Overnutrition



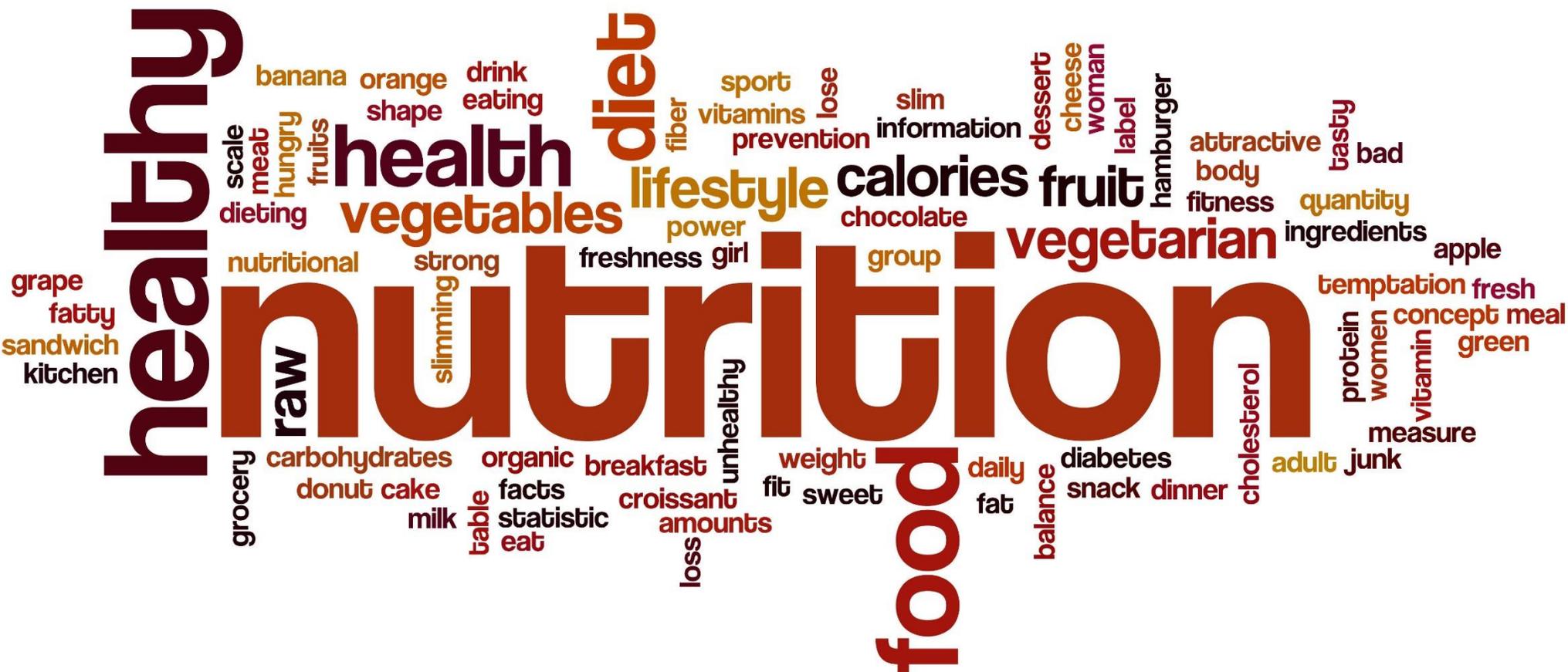
- **Obesity impairs the activity of helper T cells, cytotoxic T cells, B cells and NK cells**
- **Obesity reduces antibody responses**
- **Obesity reduces IFN- γ production**

- **People with obesity are more susceptible to many infections**
- **People with obesity do not respond so well to some vaccinations**

- **2009 H1N1 influenza pandemic: people with obesity showed delayed and weakened anti-viral responses to infection and poor recovery from disease**

- **People with obesity have a prolonged period of influenza virus shedding and show emergence of virulent minor strains**

- **Vaccinated individuals with obesity have twice the risk of influenza than healthy weight people, indicating poorer protection from vaccination**



healthy

scale
meat
hungry
fruits
diets
nutritional
strong
slimming
raw
grocery

health
vegetables

diet

lifestyle

calories

fruit
vegetarian

grape
fatty
sandwich
kitchen

carbohydrates
donut
cake
milk
table
facts
statistic
eat

organic
breakfast
croissant
amounts
loss
unhealthy

weight
fit
sweet

food

daily
fat

balance
diabetes
snack
dinner

cholesterol

adult
junk

temptation
fresh
concept
meal
green

protein
women
vitamin

measure

banana
orange
shape
drink
eating

scale
meat
hungry
fruits

fiber
vitamins
prevention

sport
lose
information

slim
dessert
cheese
woman
label

hamburger

attractive
body
fitness

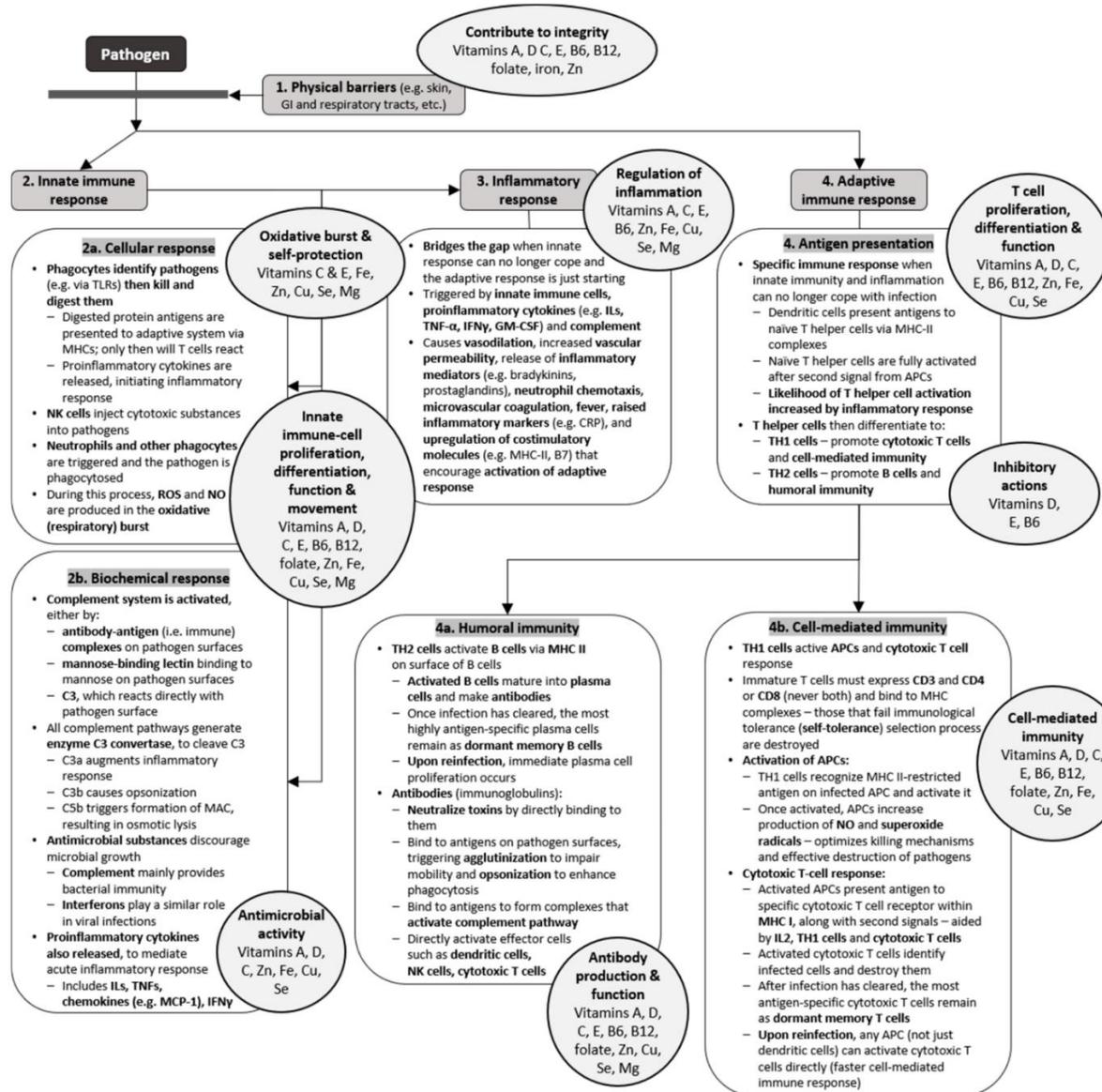
quantity
ingredients
apple

temptation
fresh
concept
meal
green

protein
women
vitamin

measure

Micronutrients are vital to the immune system



Key nutrients that are involved in immune system support

Fat-soluble vitamins: A, D, E, (K)

Water-soluble vitamins: B6, B9 (folate), B12, C,

Minerals: Zn, Cu, Se, Fe

Some amino acids: S-containing, glutamine, arginine, leucine, taurine, and some amino acid metabolites

Several fatty acids: Essential fatty acids, Omega-3 (EPA & DHA)

Optimal nutrient supply



Optimal nutrient status (& stores)



Optimal immune function

Optimal nutrient supply



Optimal nutrient status (& stores)



Optimal immune function



Good defence against pathogens

INADEQUATE nutrient supply



INADEQUATE nutrient status (& stores)



IMPAIRED immune function



IMPAIRED defence against pathogens

**-> more infections; more severe
infections; illness; death**

Summary

- **A well functioning immune system is required for effective defence against pathogenic organisms**
 - Impaired immunity predisposes to infections
 - Impaired immunity weakens vaccine responses
- **The immune system is weakened with obesity, frailty, malnutrition and micronutrient deficiencies**
 - Weakened immunity is an under-recognised result of these factors
- **Multiple nutrients (including a range of vitamins and minerals) play important roles in supporting the immune system and low intakes and status of these impair the immune response and make people more susceptible to infections – this situation can be prevented or reversed by repletion**
- **Nutritional approaches should be part of the approach to preventing infections, optimising vaccine responses and promoting recovery from infection**
 - supplements may be necessary to achieve the required intakes of some of the key nutrients

Thank you!

