Microbiome Center

Candida in health and disease

Scientific and practical insights

Roy Montijn, Koosje Janssen, Dennis Zeilstra, Wim de Jong
15 January 2026

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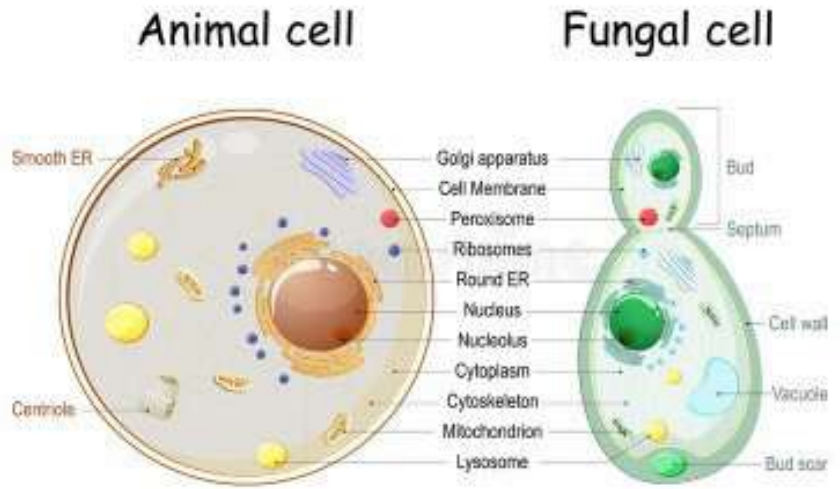
1. Theory (Roy Montijn)
   - Background fungal infections
   - Yeasts and fungi in the gut microbiome ecosystem
   - How fungi and yeast are involved in diseases, pathogenic mechanisms
   - Fungal and yeast in neurodegenerative diseases
   - Treatment via prebiotics/probiotics: ecosystem approach
2. Practice (Koosje Janssen)
   - Case report showing ecosystem behavior
3. Updates from Microbiome Center (Dennis Zeilstra)

The Role Candida in Health and Disease

Roy Montijn

15 January 2026

Fungal Infections



- studies have estimated that globally, fungal infections kill more than **1.5 million people per year** (similar to tuberculosis and about three-times more than malaria)[1]

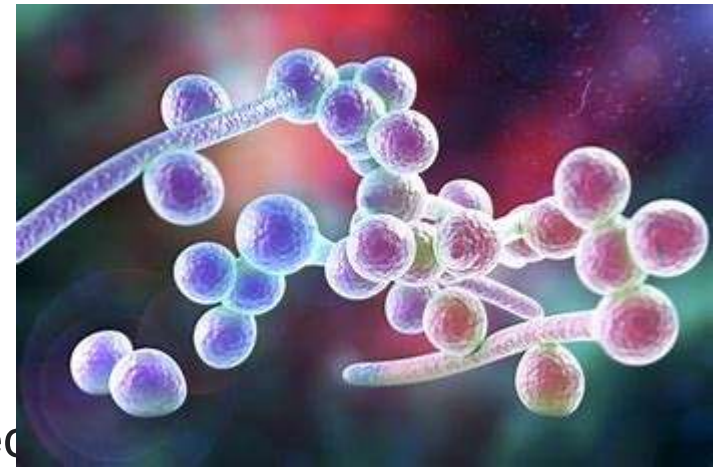
- the 3 most common classes of antifungal agents are toxic:
  - Polyenes (e.g., amphotericin B) and Azoles (e.g., fluconazole), **target the synthesis of the cell membrane, a structure shared by both mammalian and fungal cells**, and thus these drugs have inherent toxicity
  - Echinocandins (e.g., micafungin) show Cardiac toxicity

- Growing numbers of resistant pathogenic fungi

- New emerging multi-resistent pathogens are on the rise (e.g. *Candida auris*)

[1] Bongomin F, et al. Global and multi-national prevalence of fungal diseases-estimate precision. *J Fungi (Basel)* 2017

Acute fungal infections



Most common fungal diseases

• Athlete's foot (*Trichophyton*), Dandruff (*Malassezia*), Fungal nail infec

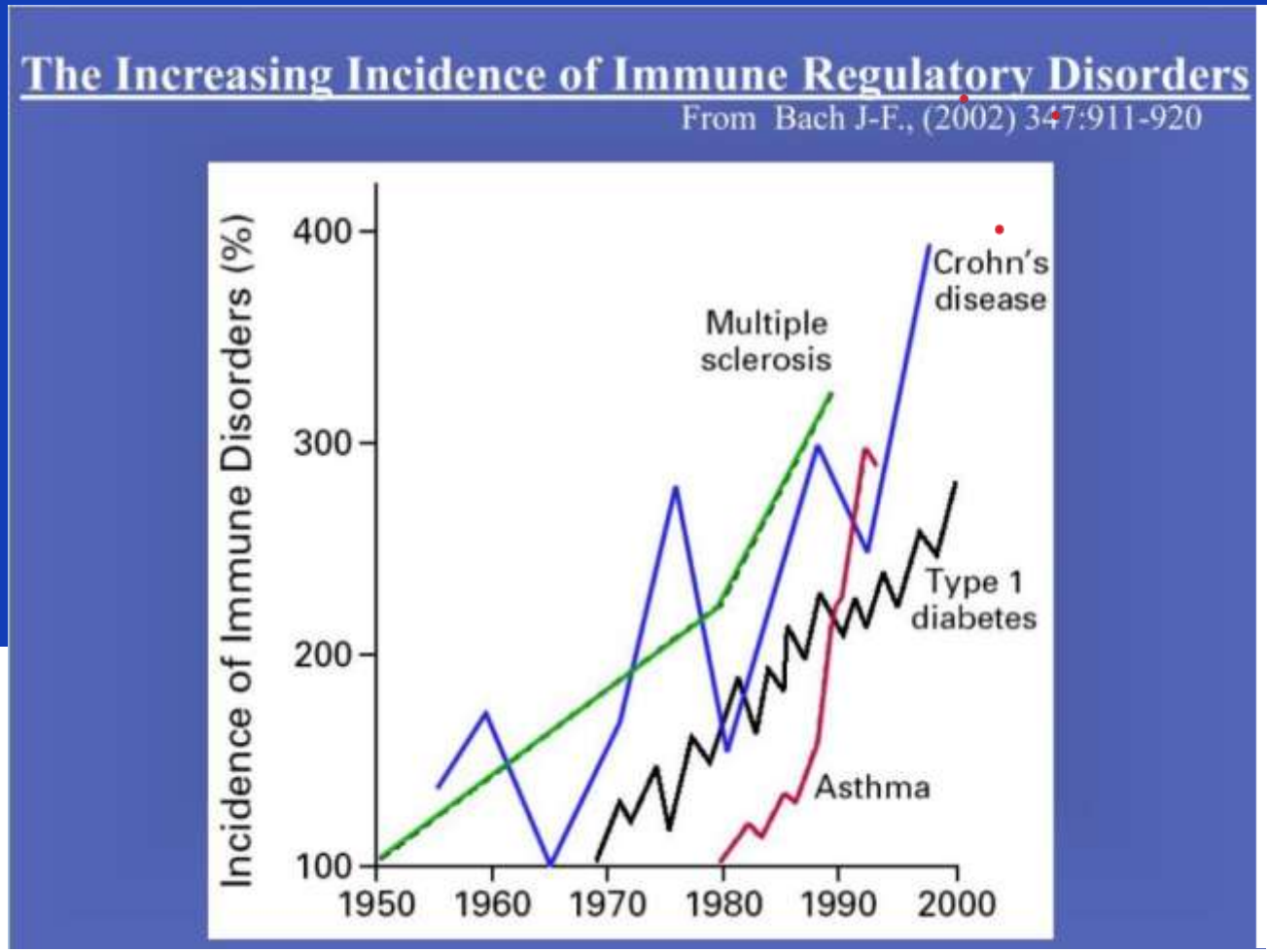
• Vaginal *Candida* infection. “Jock itch” (*Malassezia*), Ringworm (*Trichophyton, Microsporum*, *Epidermophyton et cetera) Candida* infections of the mouth, throat, and esophagus

Fungal diseases that affect people with weakened immune systems

• Invasive Candiasis caused by *C. albicans* or *C. auris*, *Cryptococcus neoformans,* Mucormycosis, Talaromycosis, *Pneumocystis* pneumonia

What about Chronic Fungal Infection?

History of Chronic Diseases



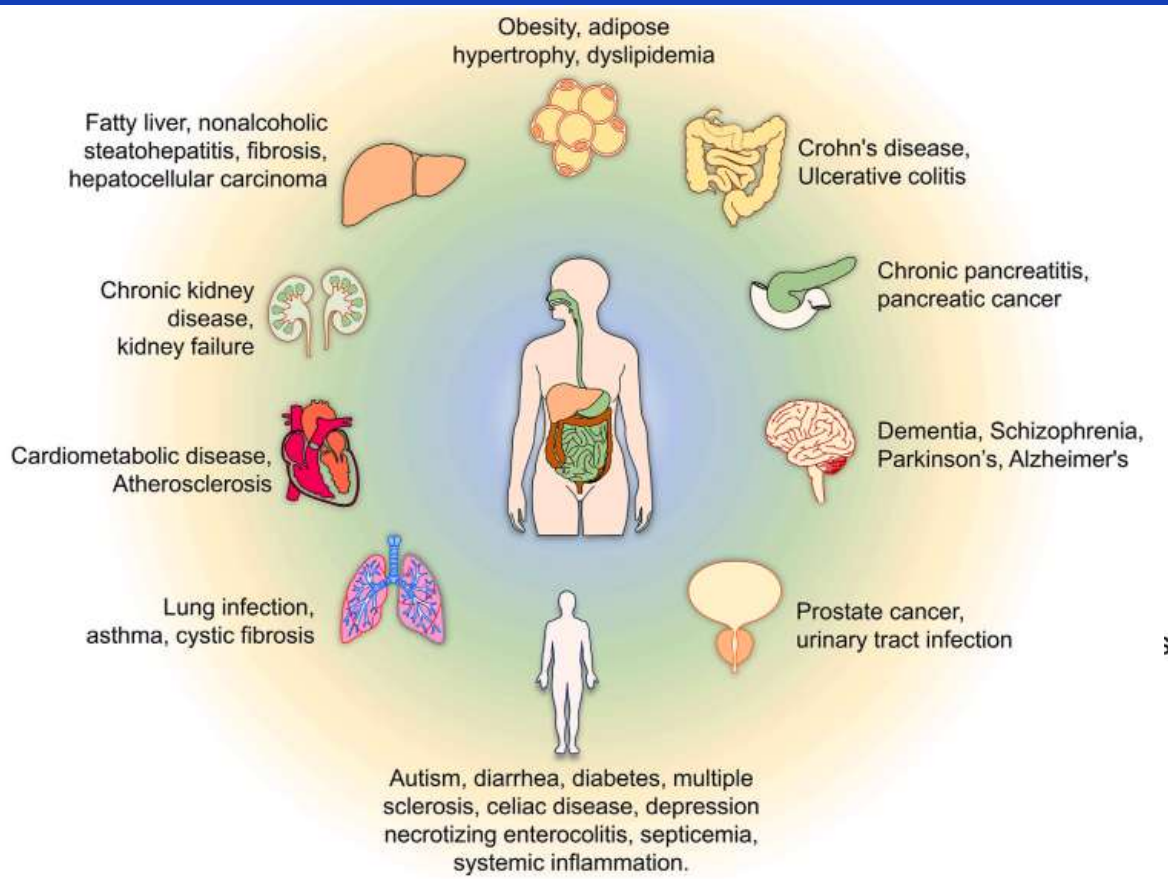
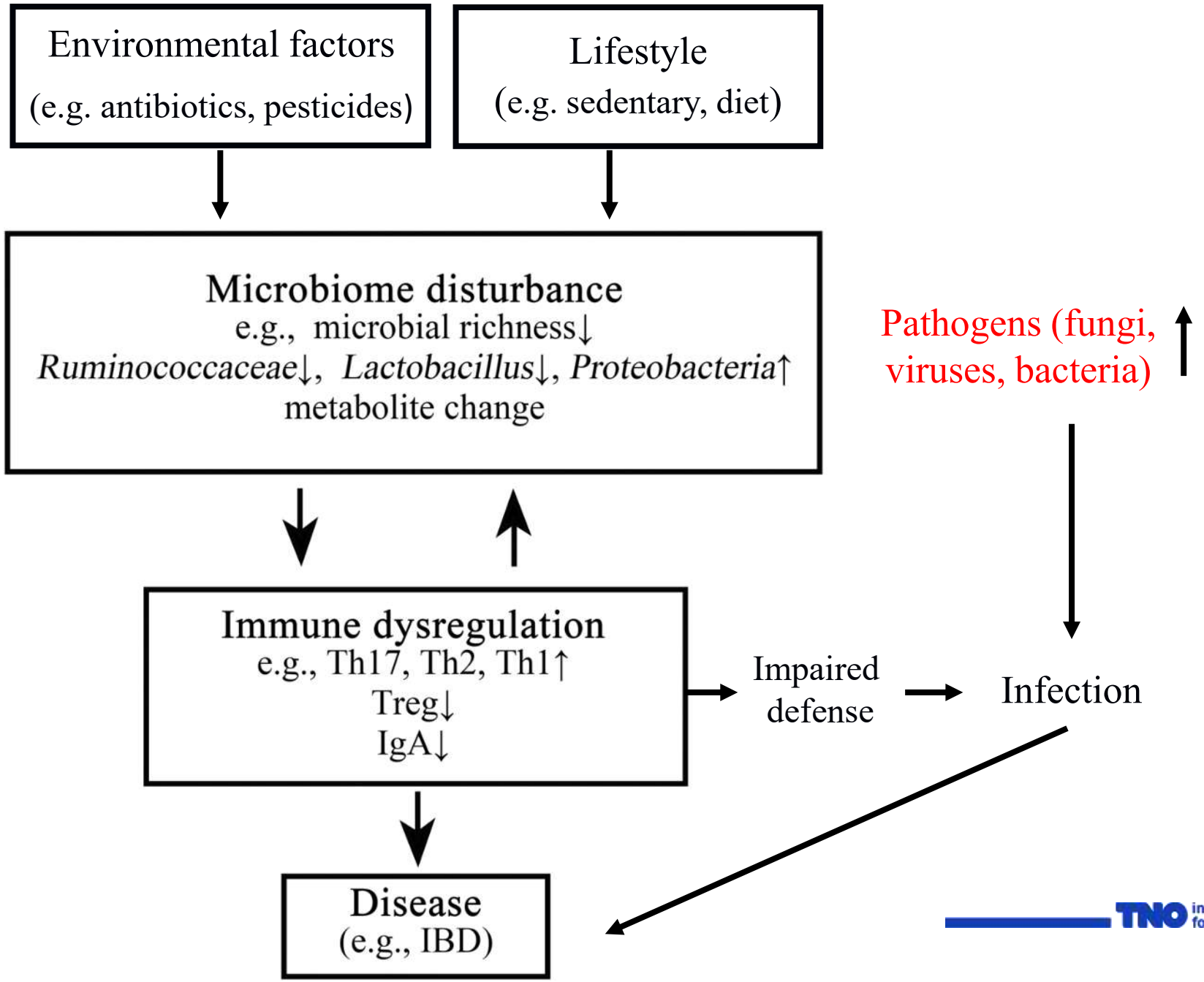


Fig. 1. Human chronic diseases with direct or indirect intestinal etiology.

Bach JF. The effect of infections on susceptibility to autoimmune diseases and allergic conditions.*N Engl J Med*. 2002

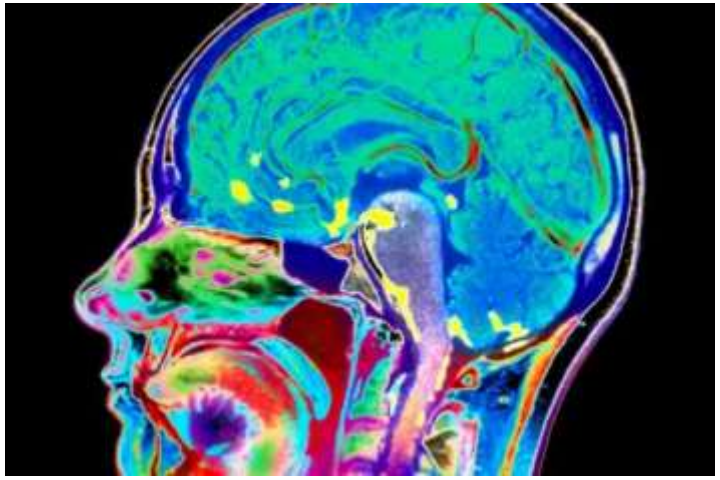
Microbiome dysbiosis

Dysbiosis and Chronic Diseases



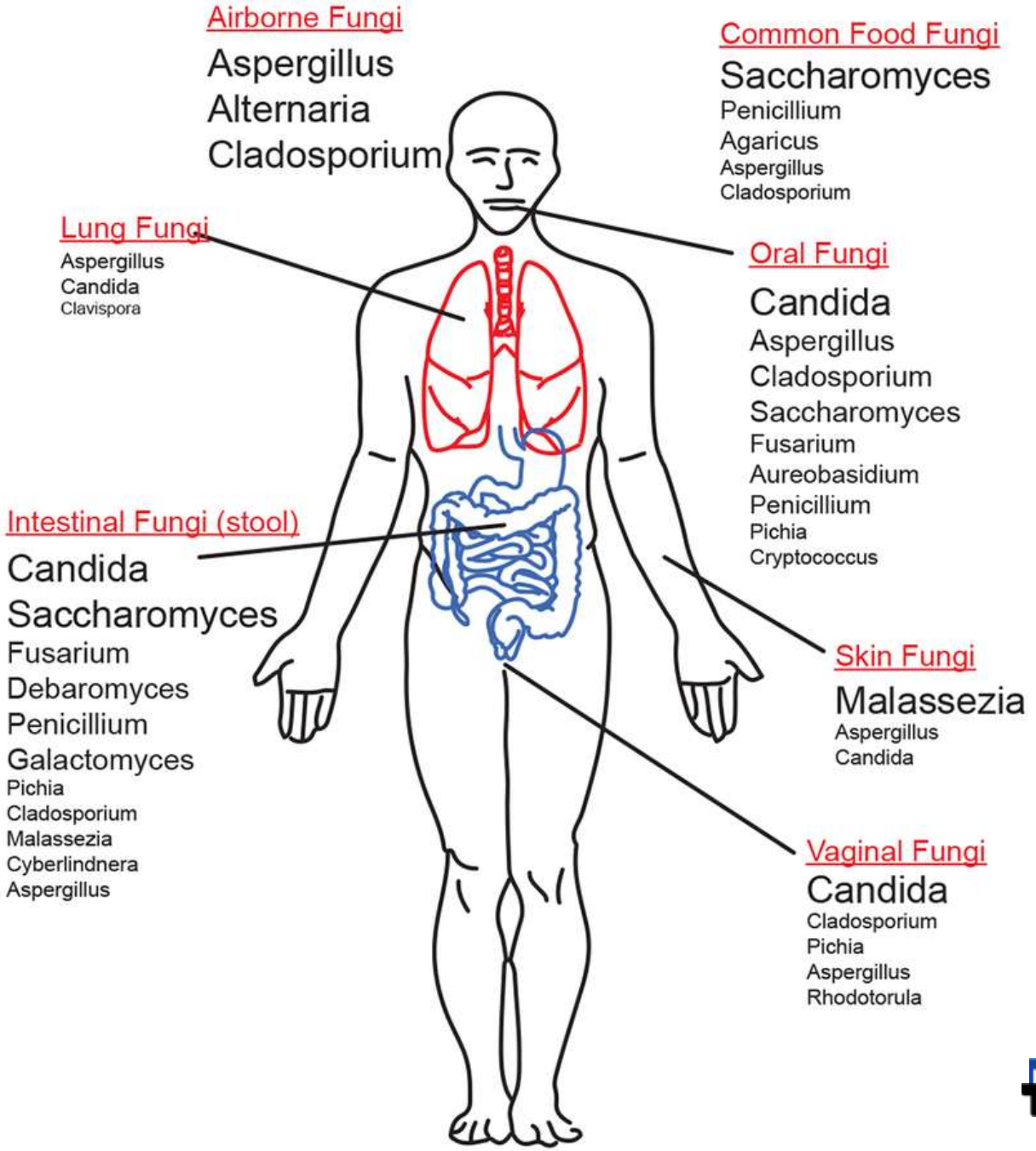
TNO innovation for life

Fungi are everywhere
ALSO IN YOUR BODY



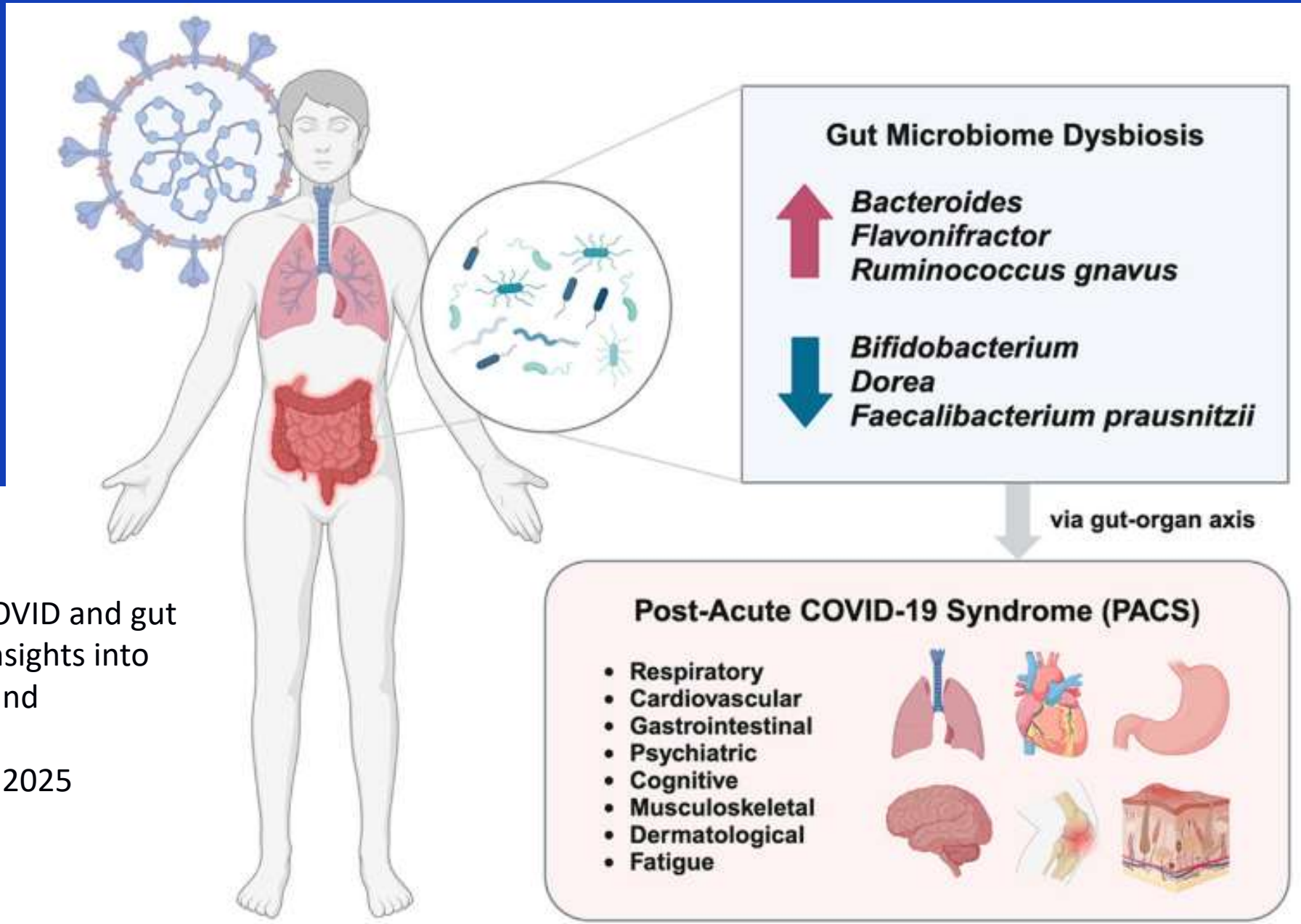
Fungal infection of the nervous system

SIMON FRASER/NEWCASTLE HOSPITALS NHS TRUST /
SCIENCE PHOTO LIBRARY / Getty Images



TNO innovation for life

Long-Covid and Dysbiosis



Lau RI, et al. COVID and gut microbiome: insights into pathogenesis and therapeutics.
Gut Microbes. 2025

TNO innovation for life

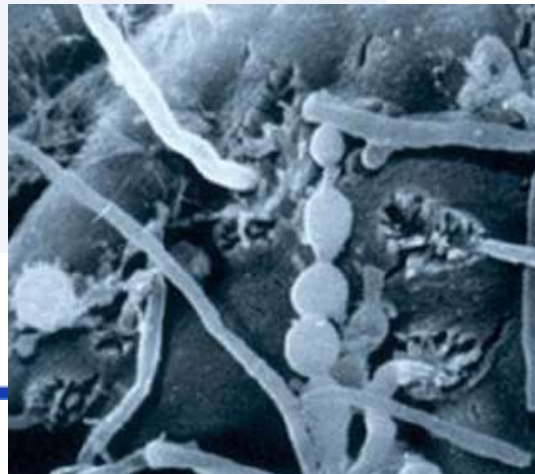
Intestinal *Candida albicans levels* are high in Long-Covid

Candida makes a lasting impression in COVID-19 Lagree K & Chen P. Nat Immunol. 2023 Nov

Severe COVID-19 is marked by excessive inflammation that can persist after infection. The commensal yeast *Candida albicans* is now implicated in the acute and chronic immunopathology of COVID-19

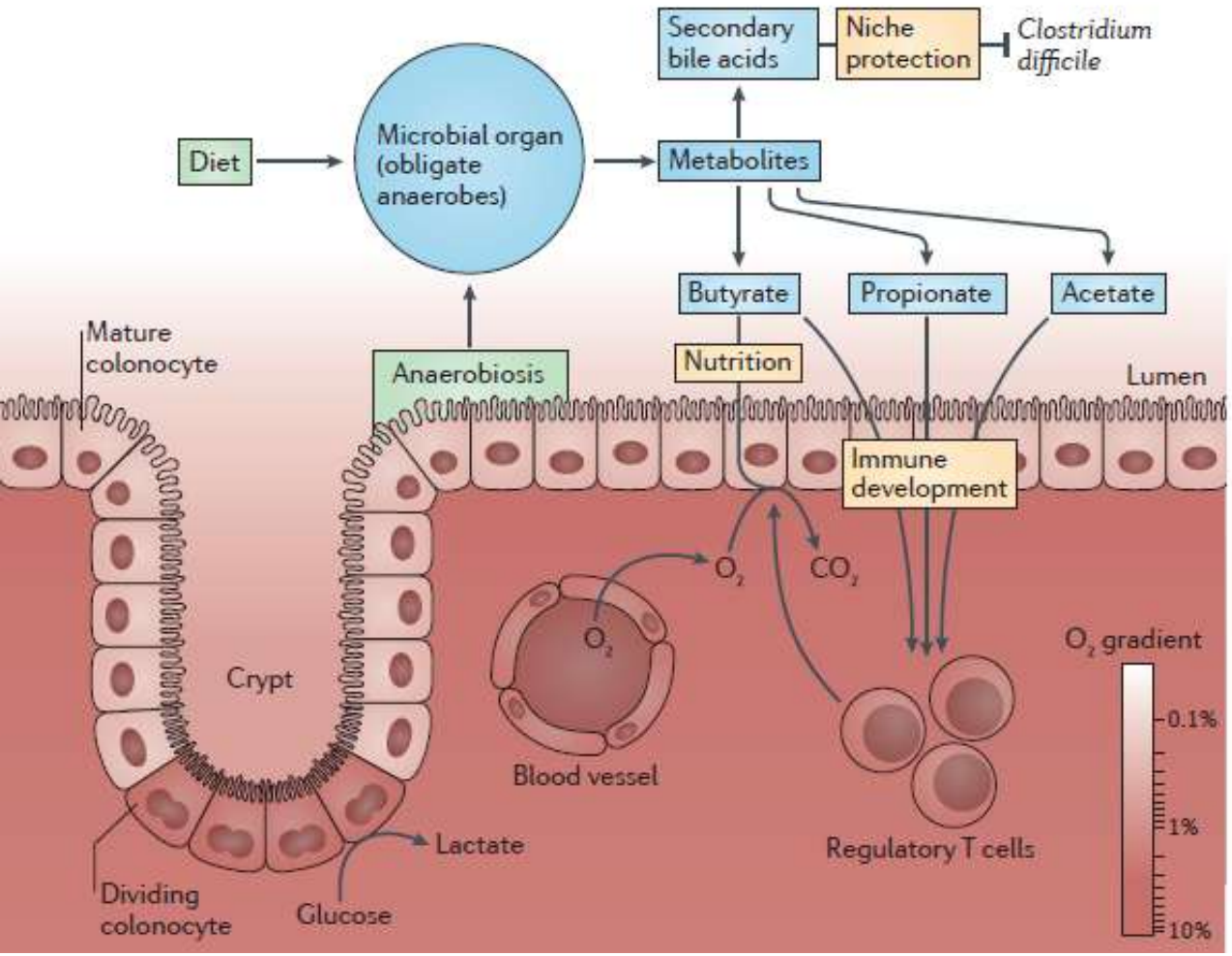
Fungal microbiota sustains lasting immune activation of neutrophils and their progenitors in severe COVID-19. Kusakabe T, **et al.** Nat Immunol. 2023 Nov

Gut fungal pathobionts contribute to immune activation during inflammatory diseases, offering potential **mycobiota-immune therapeutic strategies** for sCOVID-19 with prolonged symptoms.



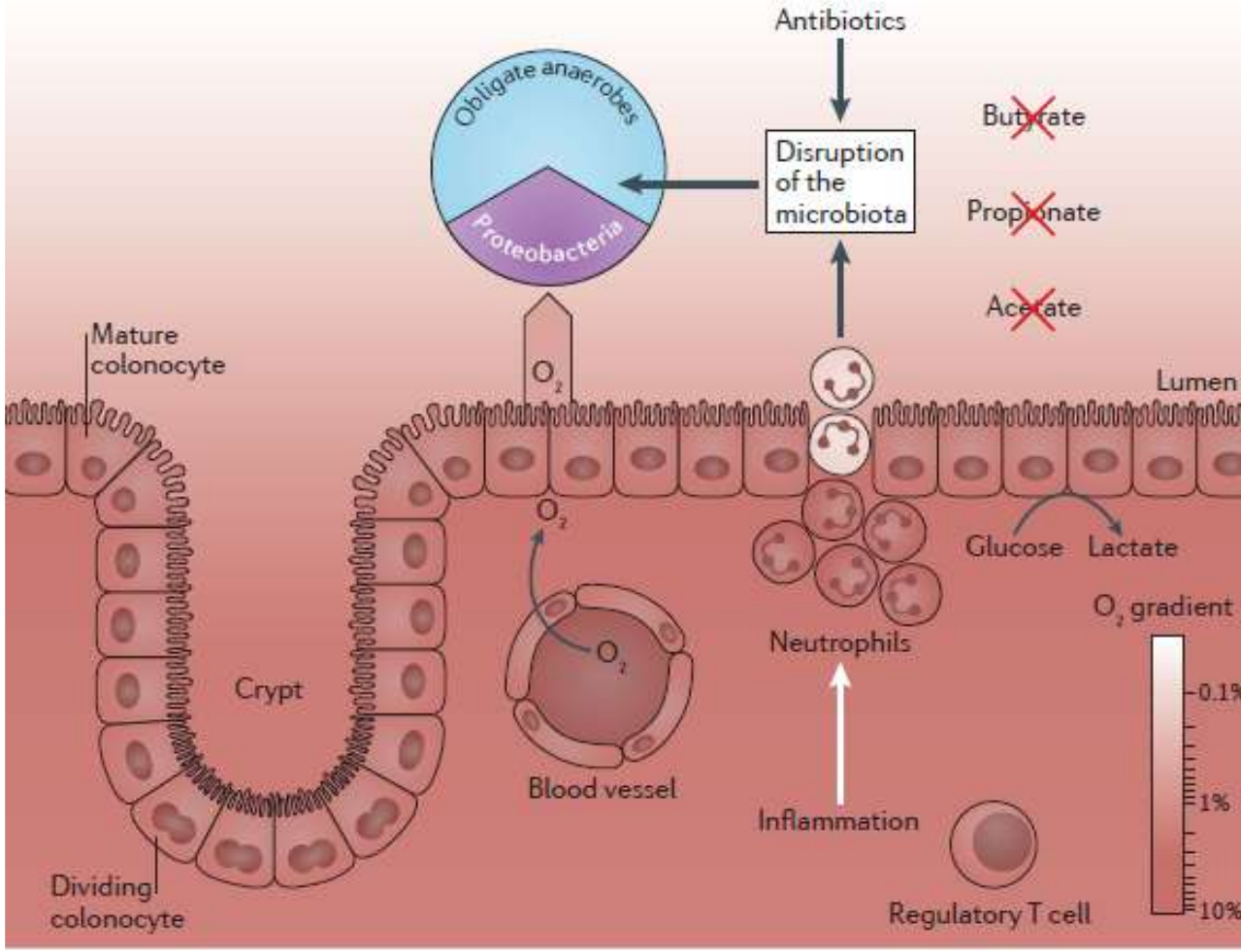
HOMEOSTASIS

Low oxygen level



DYSBIOSIS

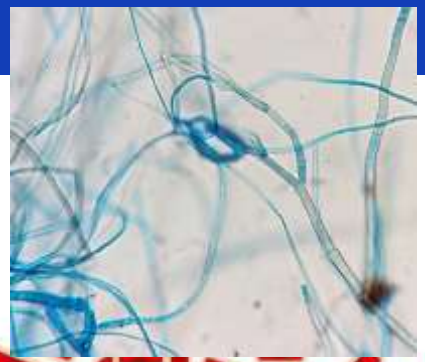
High oxygen level

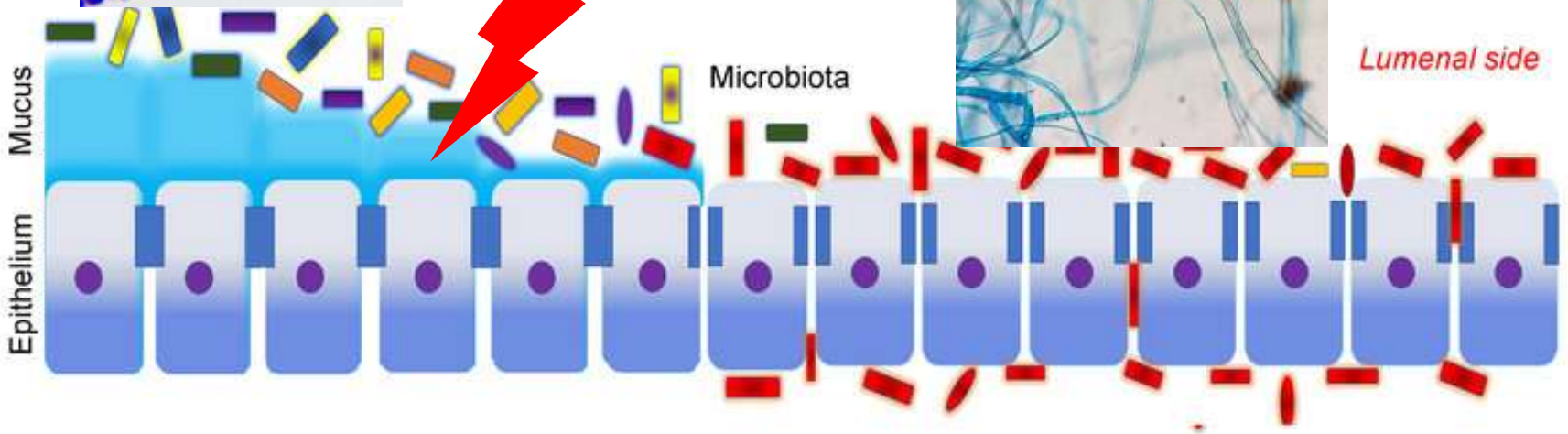


Nat Rev Microbiol 16: 103-110, 2018

Loss of anaerobiosis and mucus in dysbiosis and invasion of *Candida* albicans

UPF
Emulgators,
NSAID's





-Normal microbiota
- Intact mucus and TJs

-Dysbiosis
- Loss of mucus and TJs
-Bacterial adherence
- Activation of inflammatory pathways *(NFkB, STAT3)*

- Bacterial translocation
- DNA damage *(ROS, genotoxins, secondary bile)*

TNO innovation for life

Candida hyphal growth = pathogenicity

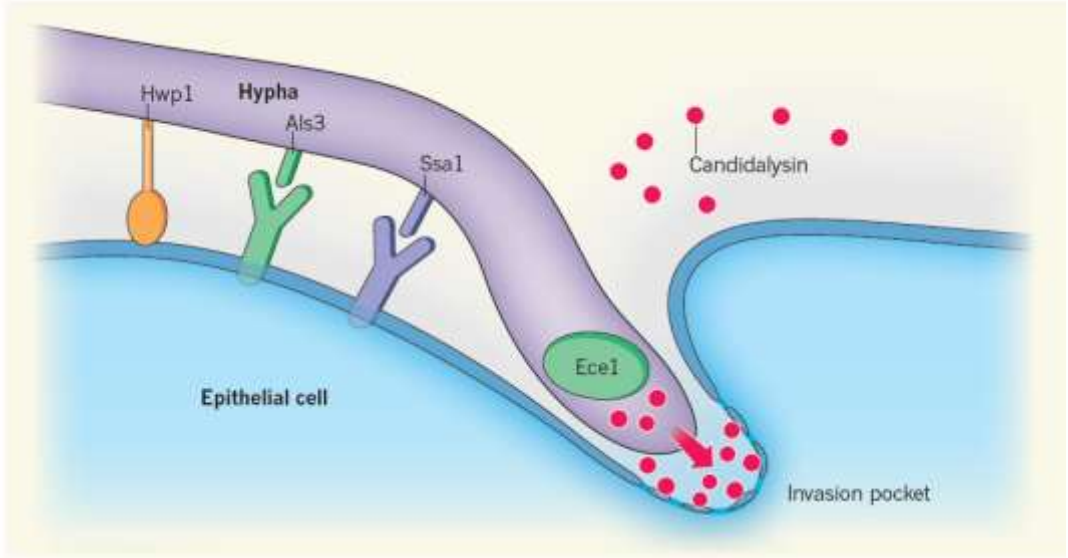
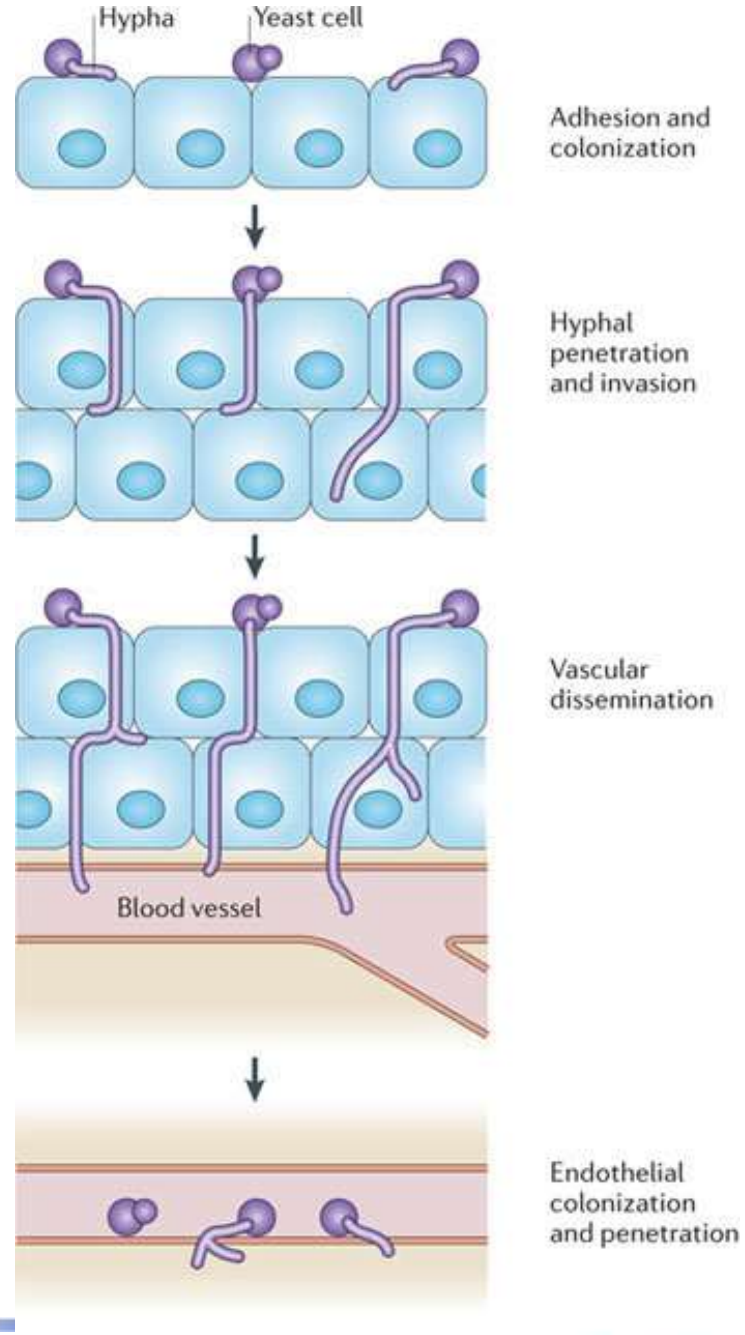
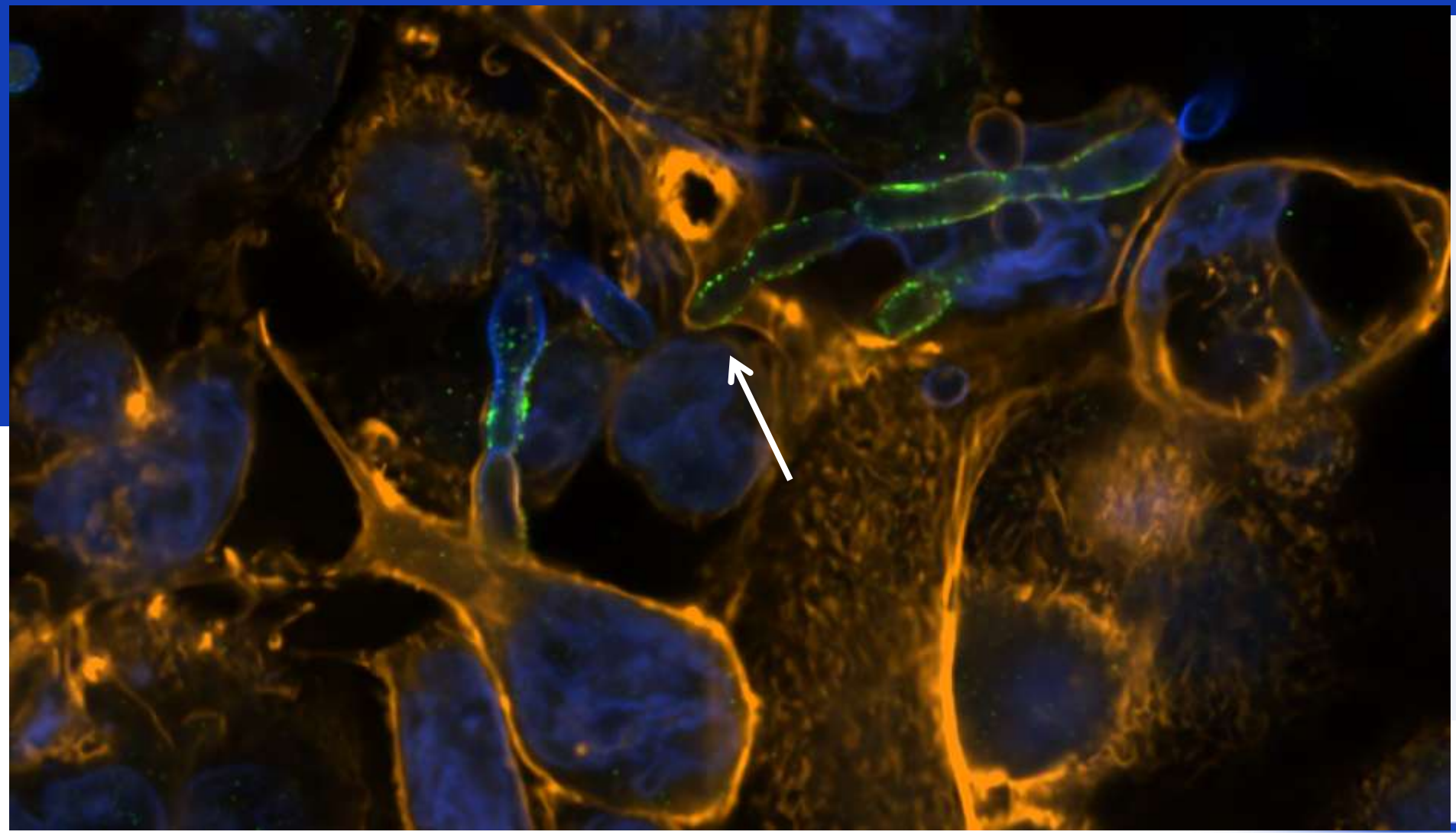


Figure 1 | A toxic relationship. The pathogenic fungus *Candida albicans* infects its host by forming filamentous structures called hyphae. Proteins on the hyphal surface — the adhesin Hwp1, the invasin Als3 and its partner Ssa1 — make contact with the host cell directly or through receptor proteins to promote adhesion and engulfment of the hypha by the host. Moyes *et al.*[2] report that the protein Ece1 is secreted from the hypha as eight short peptides. One of these, Candidalysin, acts as a toxin that accumulates in the invasion pocket and attacks the host-cell membrane, leading to membrane permeabilization and the induction of host defences.

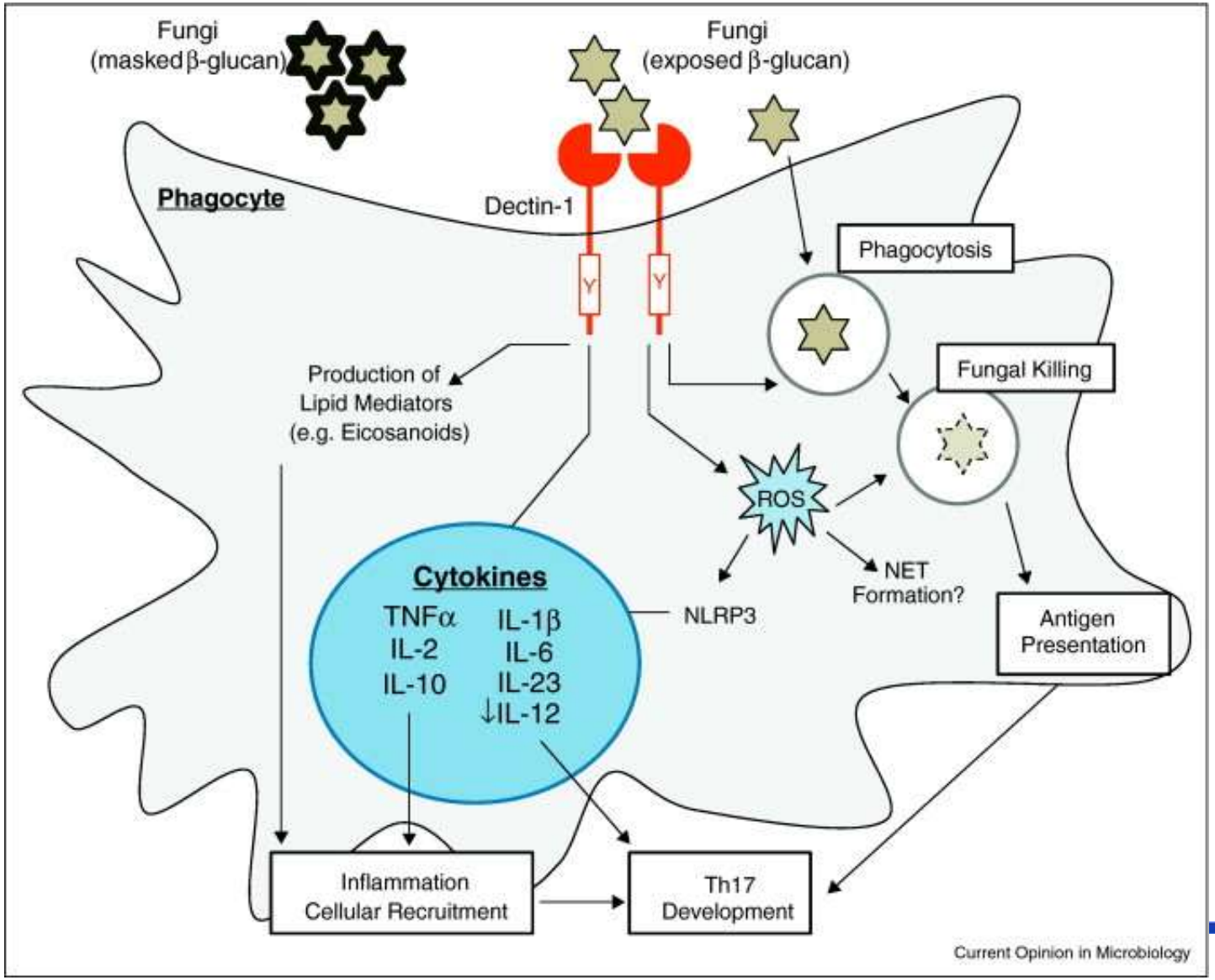


Dysbiosis: invasion of intestinal cells by *Candida*

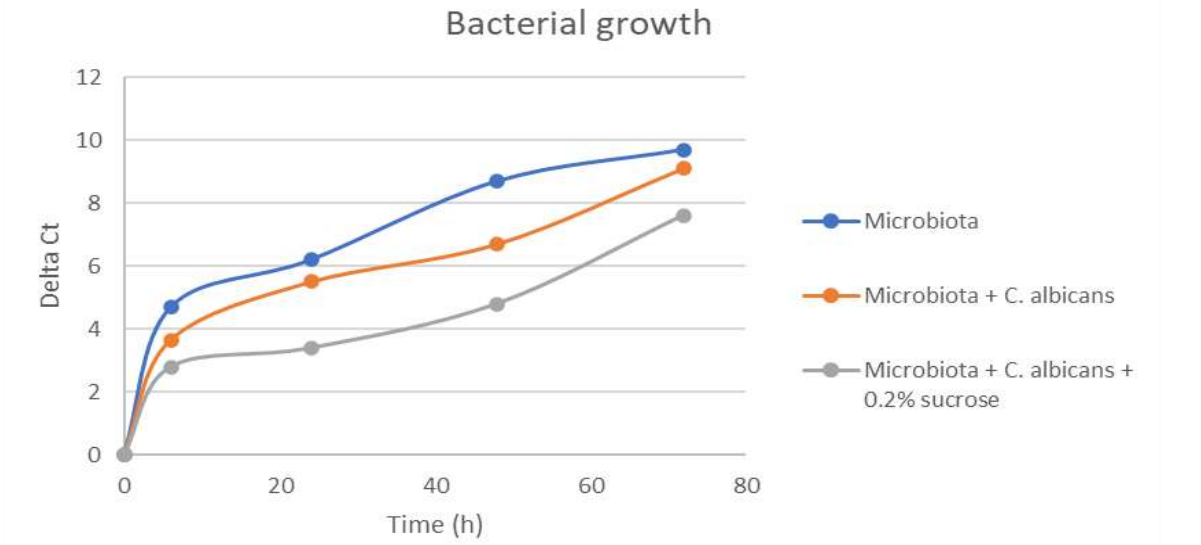


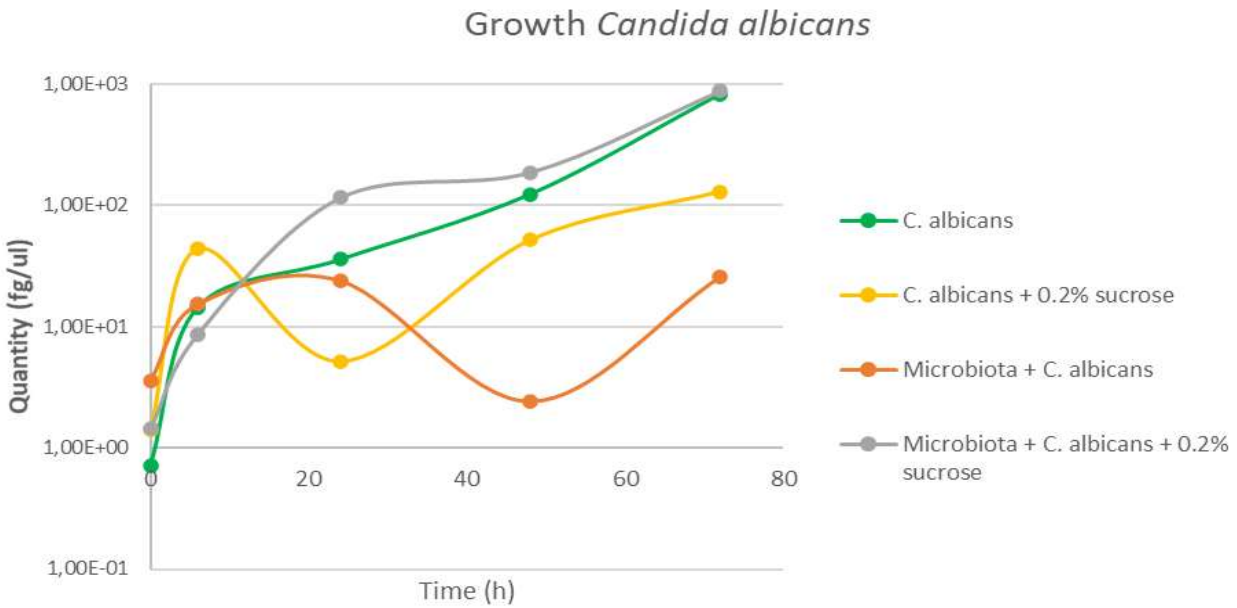
Candida albicans germination tubes secreting candidalysin on intestinal cells. Stained by candidalysin Immunofluorescence (Alexafluor 488 green) Phalloidin (yellow), Calcofluor white (blue) and DAPI (purple-blue). The white arrow indicate an invasion pocket. (photo: TNO & Nikon Europe)

Macrophage recognition of fungal infections



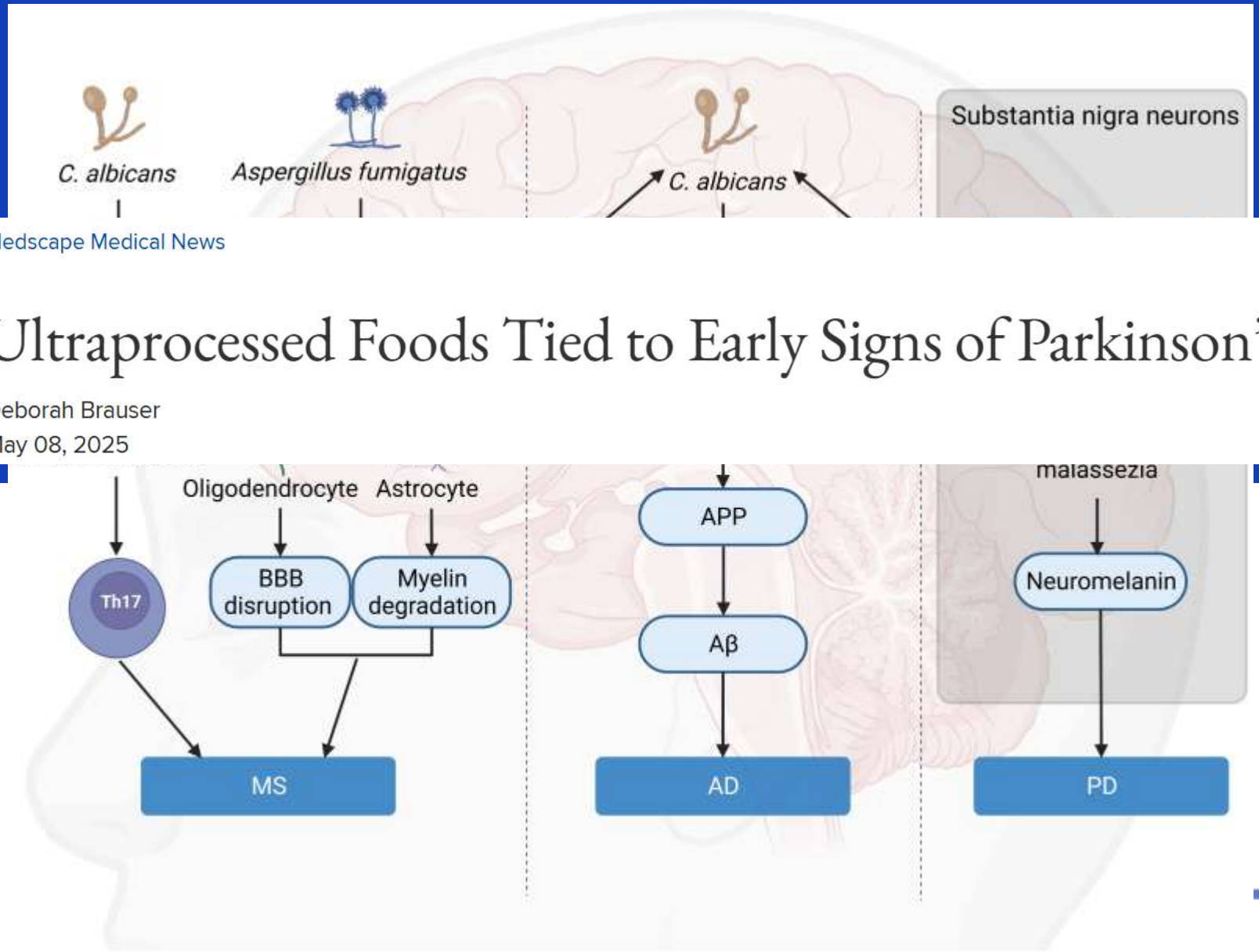
Microbiome-Candida model





Candida albicans growth is inhibited by the Microbiome but can be restored by the addition of sucrose without major detoriating effects on the microbiome growth

Fungi and Neurodegenerative diseases



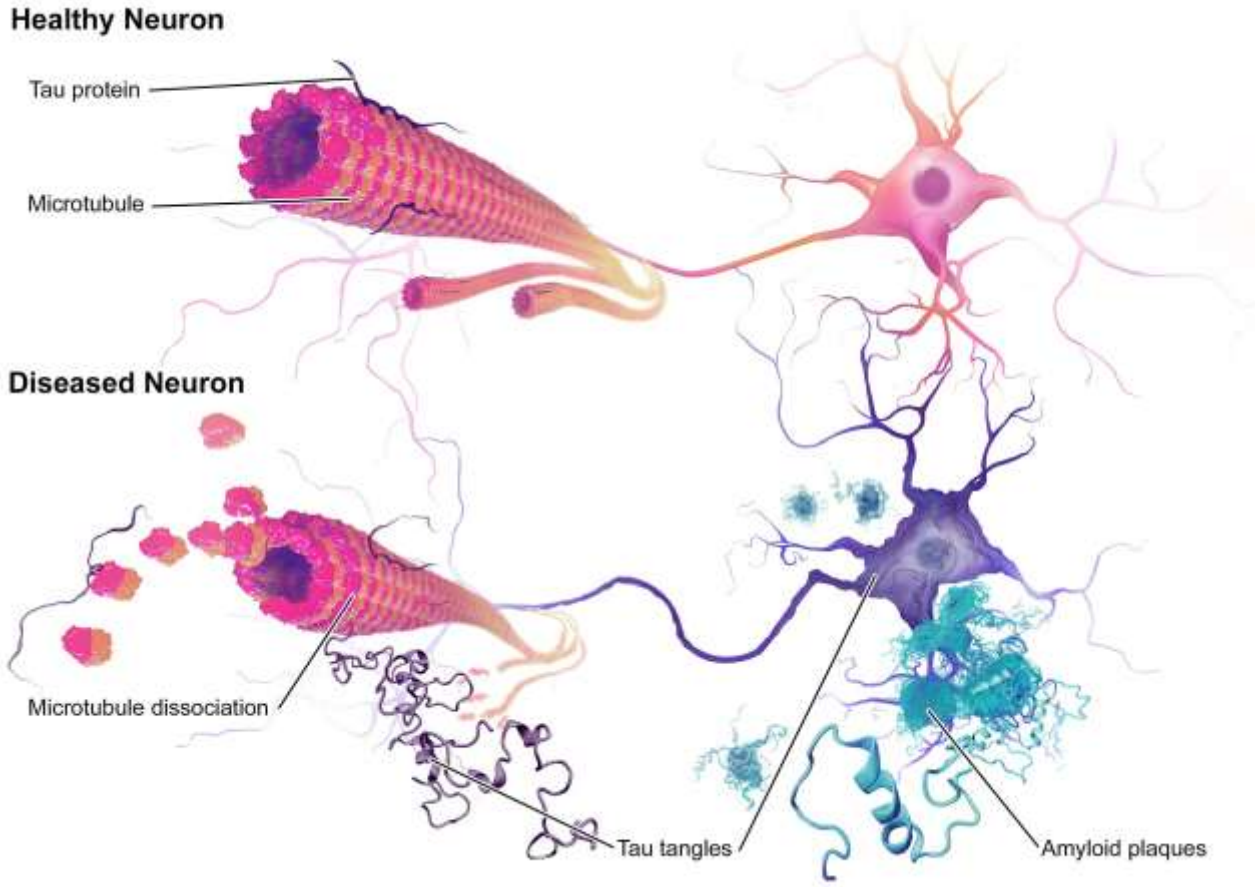
Medscape Medical News

Ultraprocessed Foods Tied to Early Signs of Parkinson's

Deborah Brauser
May 08, 2025

Wu C. The roles of fungus in CNS autoimmune and neurodegeneration disorders. Front Immunol. 2023

Amyloid Plaques are Composed of a Protein, Amyloid Beta, and Exhibit Strong Antifungal Activity Against Candida albicans

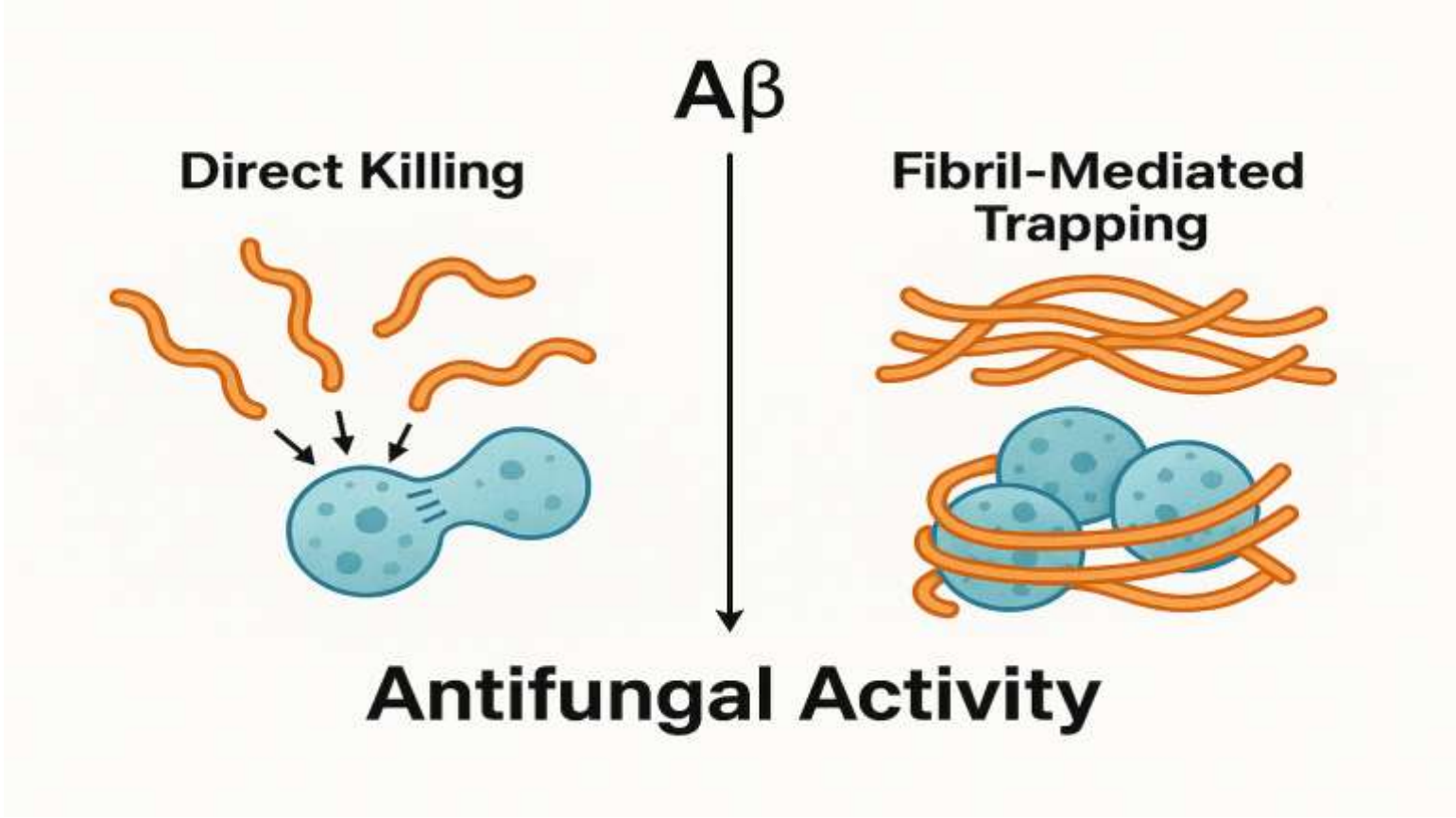


Antifungal	MIC (microgram/ml)
Fluconazol	0.25-16
Itraconazol	0.031
Voriconazol	0.031-1
Amfotericine B	0.016-4
Caspofungine	0.031-1
Amyloïde bèta	0.78

Aβ is not just a pathological byproduct; it functions as an innate immune effector.

The Alzheimer's disease-associated amyloid β-protein is an antimicrobial peptide *Stephanie J. Soscia et al., 2010; PLOS*

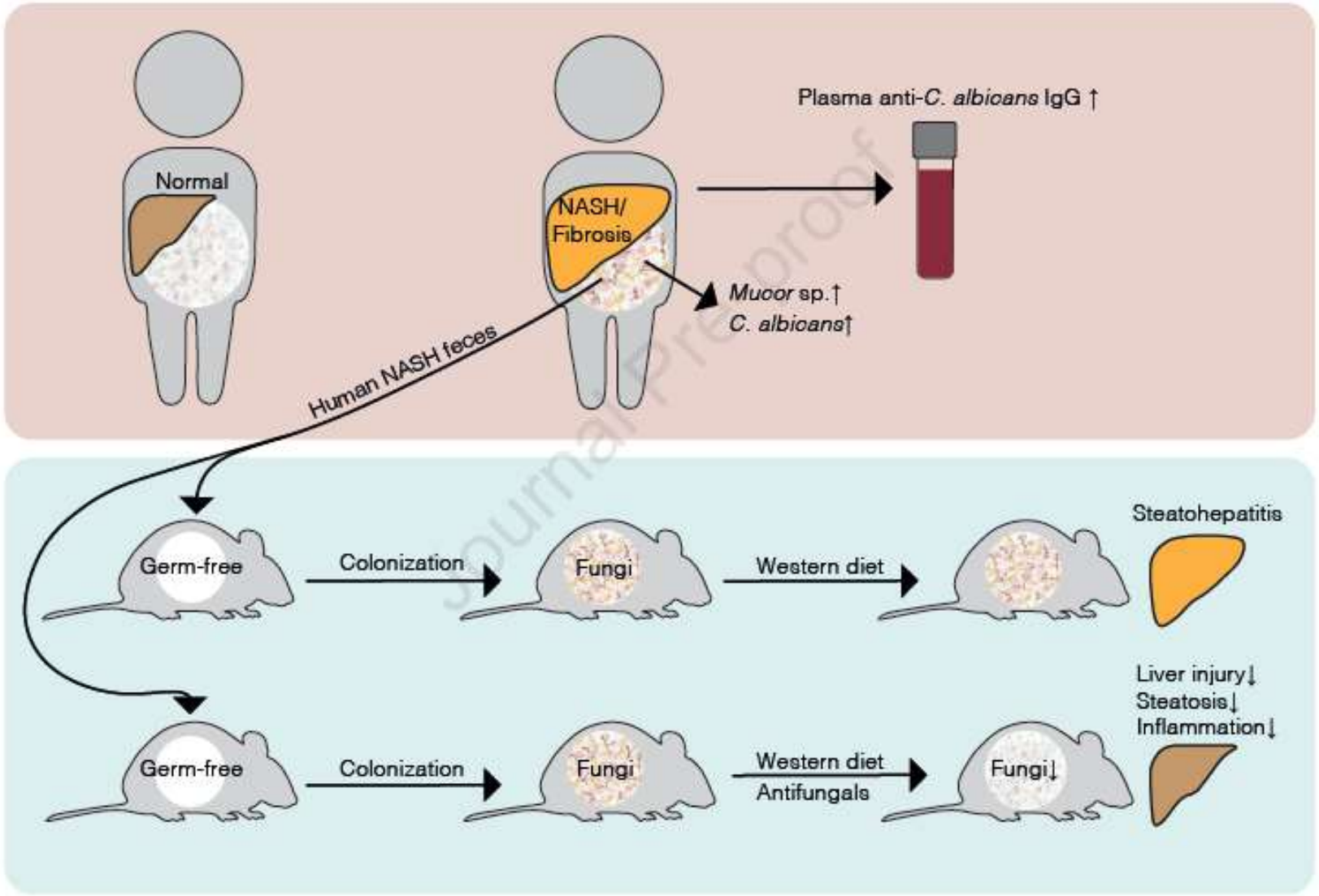
Aβ Antifungal Mechanisms



Fungi and Neurodegenerative diseases

DISEASE	GUT MICROBIOME DYSBIOSIS	FUNGAL SPECIES	DETECTION IN THE BRAIN
Multiple Sclerosis (MS)	Mycobiome alterations	*Candida albicans, Aspergillus*	Fungal DNA and antigens detected in brain tissue
Parkinson's Disease (PD)	Linked (gut dysbiosis, incl. fungi)	*Malassezia*	Fungal DNA and antigens detected in brain tissue
Alzheimer's Disease (AD)	Linked (gut-brain axis, fungal metabolites)	*Candida albicans*	Fungal DNA and antigens detected in brain tissue
Schizophrenia	Yes (Candida overgrowth, gut-brain axis)	*Candida albicans*	C. albicans antigens and immune response detected in brain

Causal Relationship of The Fecal Mycobiome and Non-alcoholic Fatty Liver Disease



The fecal mycobiome in non-alcoholic fatty liver disease
Münevver *et al.*,
Journal of Hepatology
Nov. 2021

interventions with pre and probiotics and lifstyle interventions

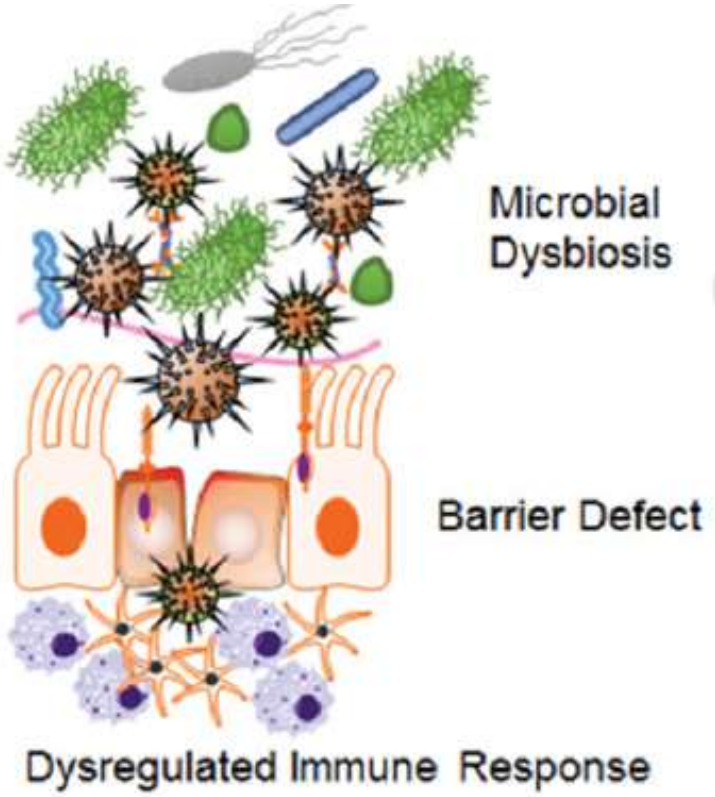
- Combining probiotics and prebiotics with lifestyle interventions offers a promising, evidence-based approach to support cognitive health in people with mild cognitive impairment (MCI).

- Probiotics and prebiotics improve gut microbiome balance, reduce inflammation, and enhance cognitive function.

- Lifestyle interventions such as physical activity, nutrition, and cognitive engagement show strong evidence for slowing cognitive decline.

Microbiome Restoration for Treatment of Alzheimers

Dysbiosis



Dysregulated Immune Response

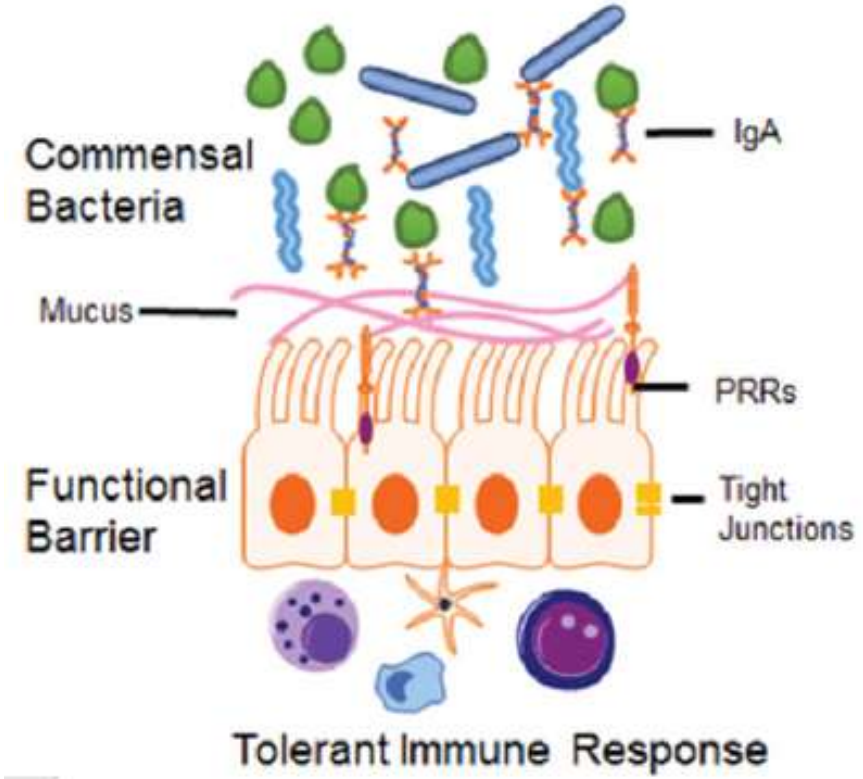
Low production of SCFA & Serotonin

High levels of Pathogens

Probiotic

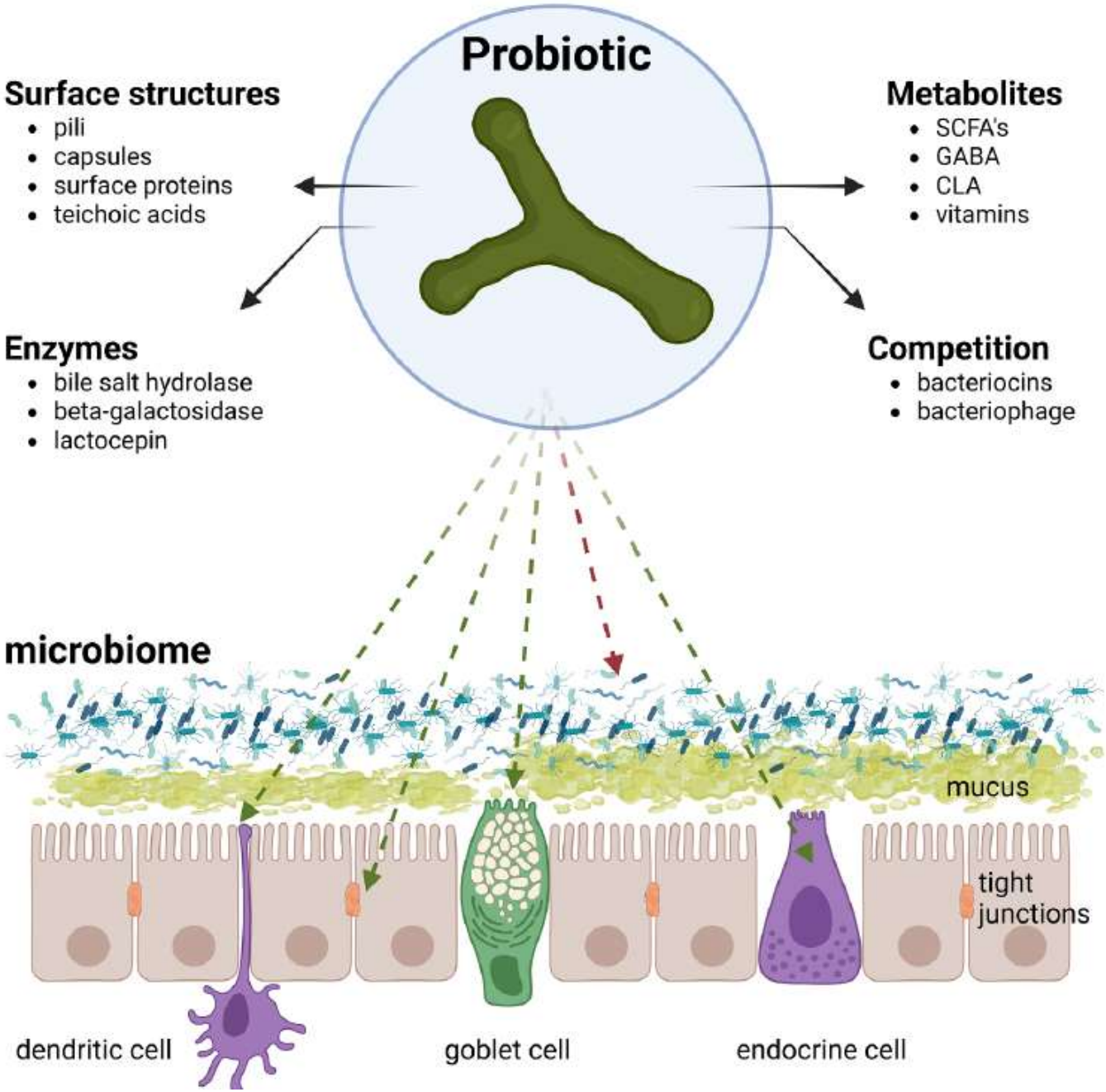
Prebiotics

Gut Homeostasis



Tolerant Immune Response

Probiotics

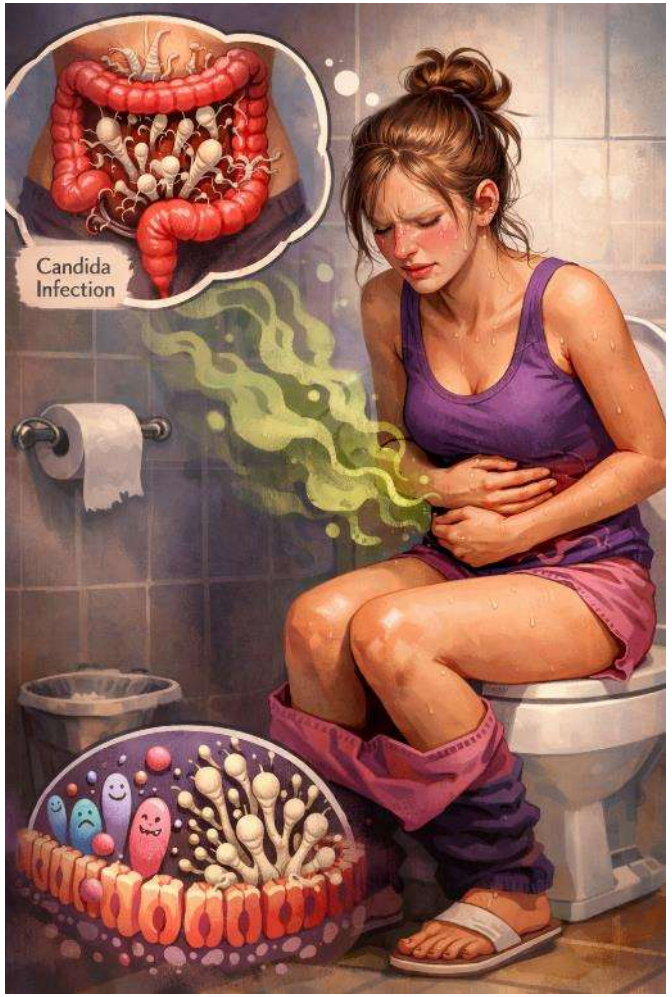


Sanders ME, Hill C.
The microbiome: An actor or stage for the beneficial action of probiotics, prebiotics, synbiotics, and postbiotics? Cell Host Microbe. 2025 Jun 11

TNO innovation for life

Example from practice

Koosje Janssen



Candida albicans case from practice

Woman (20)

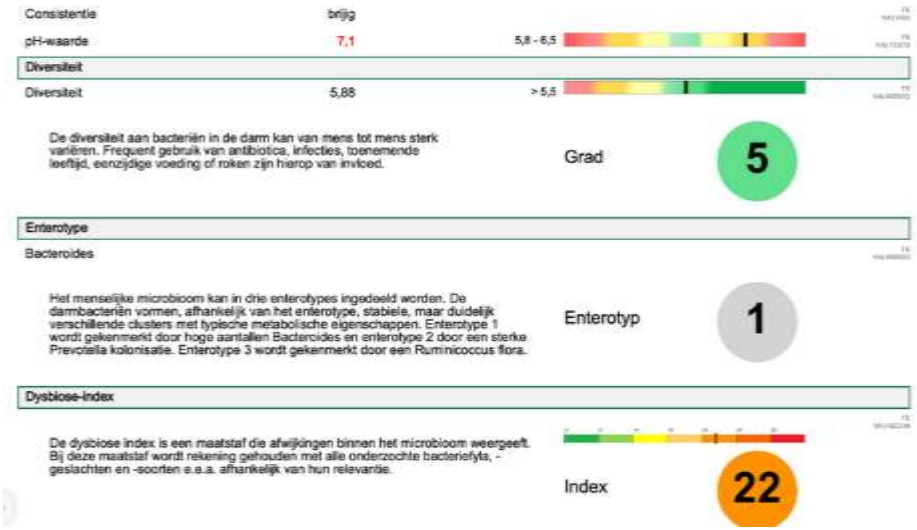
- Started after food poisoning (January 2024)
- Variable bowel movements, a lot of diarrhea but sometimes not going to toilet for three days.
- Excessive fatigue
- Gas in the abdomen
- FODMAP DIET with a dietician but reintroducing foods is not successful

- Did not go out of the house (not far) because of diarrhea
- Large impact on social life

Diet:

- High in sugar
- High in processed foods
- Lactose-free
- Few vegetables & fruits

Fecal analysis



Consistentie	brijig	
pH-waarde	7,1	5,8 - 6,5
Diversiteit		
Diversiteit	5,88	> 5,5

De diversiteit aan bacteriën in de darm kan van mens tot mens sterk variëren. Frequent gebruik van antibiotica, infecties, toenemende leeftijd, eenzijdige voeding of roken zijn hierop van invloed.

Grad **5**

Enterotype

Bacteroides

Het menselijke microbioom kan in drie enterotypes ingedeeld worden. De darmbacteriën vormen, afhankelijk van het enterotype, stabiele, maar duidelijk verschillende clusters met typische metabolische eigenschappen. Enterotype 1 wordt gekenmerkt door hoge aantallen Bacteroides en enterotype 2 door een sterke Prevotella kolonisatie. Enterotype 3 wordt gekenmerkt door een Ruminicoccus flora.

Enterotyp **1**

Dysbiose-index

De dysbiose index is een maatstaf die afwijkingen binnen het microbioom weergeeft. Bij deze maatstaf wordt rekening gehouden met alle onderzochte bacteriefyla, -geslachten en -soorten e.e.a. afhankelijk van hun relevantie.

Index **22**

Malabsorptie			
Calprotectine	93,31	mg/l	< 50
Alfa-1-antitripsine	58,6	mg/dl	< 27,5
Extra parameter(s)			
Secretoir Immunoglobuline A	2185,0	µg/ml	510 - 2040
ß-defensine	>300,00	ng/ml	15 - 60
Leaky gut: Zonuline, Histamine			
Zonuline	>800,00	ng/ml	< 55
Histamine in feces	1272,0	ng/ml	< 959

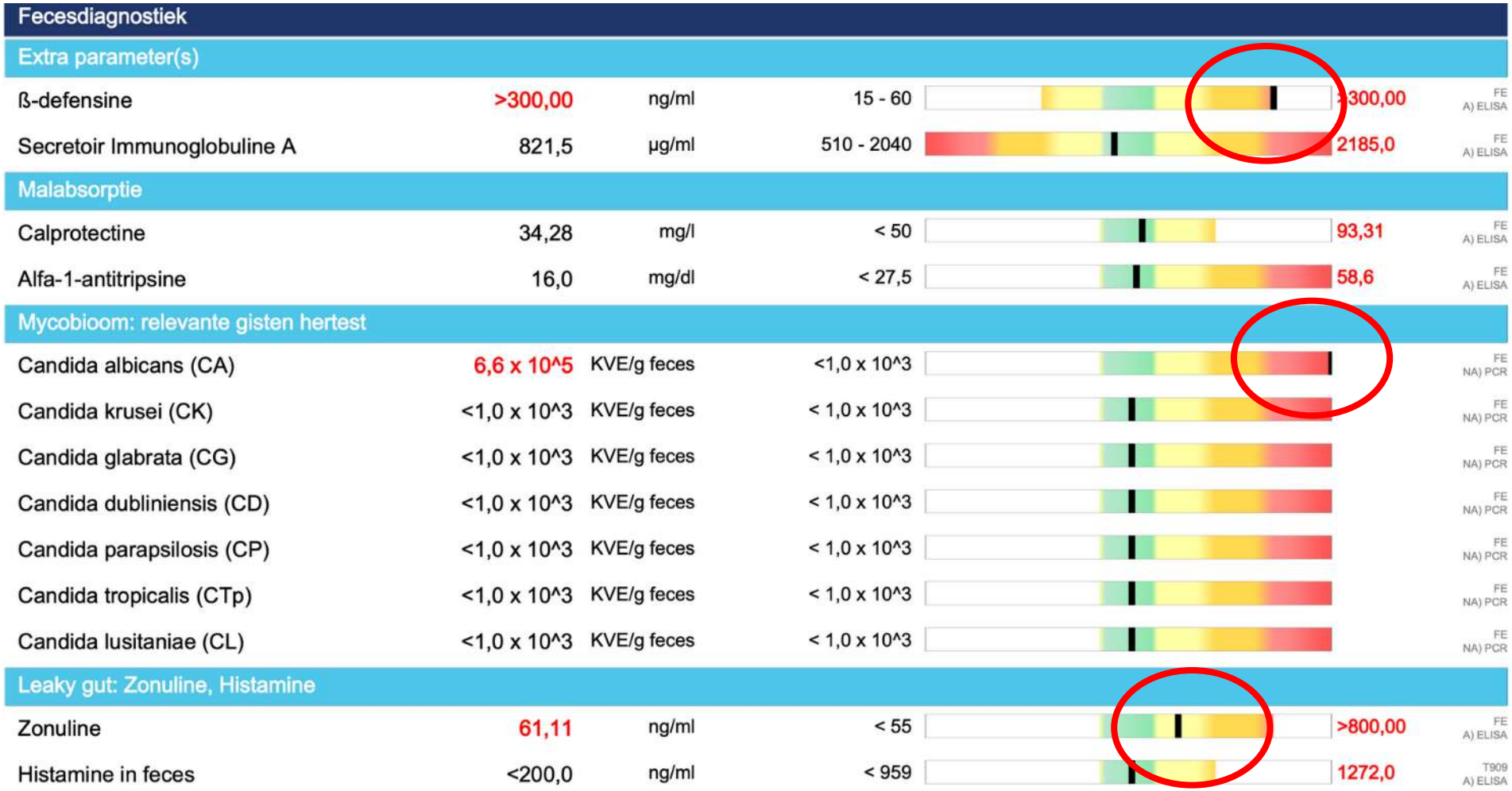
Mycobioom: relevante gisten			
Candida albicans (CA)	6,3 x 10^5	KVE/g feces	<1,0 x 10^3
Candida krusei (CK)	<1,0 x 10^3	KVE/g feces	< 1,0 x 10^3
Candida glabrata (CG)	<1,0 x 10^3	KVE/g feces	< 1,0 x 10^3
Candida dubliniensis (CD)	<1,0 x 10^3	KVE/g feces	< 1,0 x 10^3
Candida parapsilosis (CP)	<1,0 x 10^3	KVE/g feces	< 1,0 x 10^3
Candida tropicalis (CTp)	<1,0 x 10^3	KVE/g feces	< 1,0 x 10^3
Candida lusitaniae (CL)	<1,0 x 10^3	KVE/g feces	< 1,0 x 10^3

Initial treatment

Started with the old school approach:

1. Reducing inflammation, DAO and a standard probiotic (4wks)
2. Started herb treatment to reduce candida infection in combination with a probiotic (standard)
3. Additional supplements (multi + omega-3)
4. Diet:
    - No Sugars
    - Low Histamine

But after 4 months....



Fecesdiagnostiek				
Extra parameter(s)				
ß-defensine	>300,00	ng/ml	15 - 60	>300,00 FE A) ELISA
Secretoir Immunoglobuline A	821,5	µg/ml	510 - 2040	2185,0 FE A) ELISA
Malabsorptie				
Calprotectine	34,28	mg/l	< 50	93,31 FE A) ELISA
Alfa-1-antitripsine	16,0	mg/dl	< 27,5	58,6 FE A) ELISA
Mycobioom: relevante gisten hertest				
Candida albicans (CA)	6,6 x 10^5	KVE/g feces	<1,0 x 10^3	FE NA) PCR
Candida krusei (CK)	<1,0 x 10^3	KVE/g feces	< 1,0 x 10^3	FE NA) PCR
Candida glabrata (CG)	<1,0 x 10^3	KVE/g feces	< 1,0 x 10^3	FE NA) PCR
Candida dubliniensis (CD)	<1,0 x 10^3	KVE/g feces	< 1,0 x 10^3	FE NA) PCR
Candida parapsilosis (CP)	<1,0 x 10^3	KVE/g feces	< 1,0 x 10^3	FE NA) PCR
Candida tropicalis (CTp)	<1,0 x 10^3	KVE/g feces	< 1,0 x 10^3	FE NA) PCR
Candida lusitaniae (CL)	<1,0 x 10^3	KVE/g feces	< 1,0 x 10^3	FE NA) PCR
Leaky gut: Zonuline, Histamine				
Zonuline	61,11	ng/ml	< 55	>800,00 FE A) ELISA
Histamine in feces	<200,0	ng/ml	< 959	1272,0 T909 A) ELISA

Continued treatment

Old school approach continued…

1. Reducing inflammation, DAO and a standard probiotic (4wks)
2. Started herb treatment to reduce candida infection in combination with a probiotic (standard)
3. Additional supplements (multi + omega-3)
4. Diet:
    - No Sugars
    - Low Histamine

After another 3 months....

Fecesdiagnostiek				
Extra parameter(s)				
ß-defensine	>300,00	ng/ml	15 - 60	>300,00 FE A) ELISA
Secretoir Immunoglobuline A	279,3	µg/ml	510 - 2040	821,5 FE A) ELISA
Zonuline	124,16	ng/ml	< 55	61,11 FE A) ELISA
Mycobioom: relevante gisten hertest				
Candida albicans (CA)	7,1 x 10^5	KVE/g feces	<1,0 x 10^3	FE NA) PCR
Candida krusei (CK)	<1,0 x 10^3	KVE/g feces	< 1,0 x 10^3	FE NA) PCR
Candida glabrata (CG)	<1,0 x 10^3	KVE/g feces	< 1,0 x 10^3	FE NA) PCR
Candida dubliniensis (CD)	<1,0 x 10^3	KVE/g feces	< 1,0 x 10^3	FE NA) PCR
Candida parapsilosis (CP)	<1,0 x 10^3	KVE/g feces	< 1,0 x 10^3	FE NA) PCR
Candida tropicalis (CTp)	<1,0 x 10^3	KVE/g feces	< 1,0 x 10^3	FE NA) PCR
Candida lusitaniae (CL)	<1,0 x 10^3	KVE/g feces	< 1,0 x 10^3	FE NA) PCR

A different approach

Initial treatment did not resolve problems, nor did it clear Candida.

I learned about the concept of the gut ecosystem and started to work on treatment along these lines

The personalized, ecosystem-targeted treatment consisted of:

- MyOwnBlend
- Same additional supplements (multi, omega-3) + MSM
- Same diet (low sugars)

L. rhamnosus GG	2
Bacillus coagulans Unique IS-2	2
S. Boulardii CNCM-I-1079	2
L. acidophilus LA02	2
DJ repair	2
PHGG	3
Enterococcus faecium + Bacillus subtilis	2

After 3 months MyOwnBlend

Fecesdiagnostiek				
Extra parameter(s)				
ß-defensine	225,8	ng/ml	15 - 60	>300,00 FE A) ELISA
Secretoir Immunoglobuline A	929,0	µg/ml	510 - 2040	279,3 FE A) ELISA
Zonuline	70,92	ng/ml	< 55	124,16 FE A) ELISA
Mycobioom: relevante gisten hertest				
Candida albicans (CA)	<1,0 x 10^3	KVE/g feces	<1,0 x 10^3	FE NA) PCR
Candida krusei (CK)	<1,0 x 10^3	KVE/g feces	< 1,0 x 10^3	FE NA) PCR
Candida glabrata (CG)	<1,0 x 10^3	KVE/g feces	< 1,0 x 10^3	FE NA) PCR
Candida dubliniensis (CD)	<1,0 x 10^3	KVE/g feces	< 1,0 x 10^3	FE NA) PCR
Candida parapsilosis (CP)	<1,0 x 10^3	KVE/g feces	< 1,0 x 10^3	FE NA) PCR
Candida tropicalis (CTp)	<1,0 x 10^3	KVE/g feces	< 1,0 x 10^3	FE NA) PCR
Candida lusitaniae (CL)	<1,0 x 10^3	KVE/g feces	< 1,0 x 10^3	FE NA) PCR

Second MyOwnBlend

we did another MOB
+ Multi
+ omega-3

Additional to that I itroduced a green juice with pomegranate extract and a green powder

Diet

- No Sugars, No Sugars, No processed-food

DJ repair	3
Microbiotia booster - vezelcomplex	1
Acaciavezels	1
Bifido booster	1
Barrier	3
Akkermansia muciniphila, gepasteuriseerd	2
E. coli MC231	1
Enterococcus faecium + Bacillus subtilis	1
L fermentum ME-3	2

After another 2 months MyOwnBlend

Test	Uitslag	Eenheid	Normbereik	Vorig onderzoek
Fecesdiagnostiek				
Extra parameter(s)				
ß-defensine	215,3	ng/ml	15 - 60	225,8
Zonuline	60,00	ng/ml	< 55	70,92

→ She started to eat more sugar and process foods like she normally did, but still a big compromised to what she supoced to eat

And after yet another 2 months

Fecesdiagnostiek				
Extra parameter(s)				
ß-defensine	>300,00	ng/ml	15 - 60	215,3 FE A) ELISA
Zonuline	53,18	ng/ml	< 55	60,00 FE NA) ELISA
Mycobioom: relevante gisten hertest				
Candida albicans (CA)	<1,0 x 10^3	KVE/g feces	<1,0 x 10^3	FE NA) PCR
Candida krusei (CK)	<1,0 x 10^3	KVE/g feces	< 1,0 x 10^3	FE NA) PCR
Candida glabrata (CG)	<1,0 x 10^3	KVE/g feces	< 1,0 x 10^3	FE NA) PCR
Candida dubliniensis (CD)	<1,0 x 10^3	KVE/g feces	< 1,0 x 10^3	FE NA) PCR
Candida parapsilosis (CP)	<1,0 x 10^3	KVE/g feces	< 1,0 x 10^3	FE NA) PCR
Candida tropicalis (CTp)	<1,0 x 10^3	KVE/g feces	< 1,0 x 10^3	FE NA) PCR
Candida lusitaniae (CL)	<1,0 x 10^3	KVE/g feces	< 1,0 x 10^3	FE NA) PCR

Results after ecosystem treatment with MyOwnBlend

- Abdominal complaints: still somewhat variable, recovery from eating 'something wrong' takes longer than with her boyfriend.
- **She is now willing to attend events.**
- **The reaction to food is indeed much less than when we started.**
- There is still some air in the stomach, but it doesn't bother her, although she does have occasional burping or flatulence (every day).
- Bowel movements are usually normal, but there is the occasional diarrhea.
- **No more real stomach pain**

She still didn't eat more than 3 kinds of vegetables and fruit was a problem for her too
She was focusing on having back her cookies and processed food

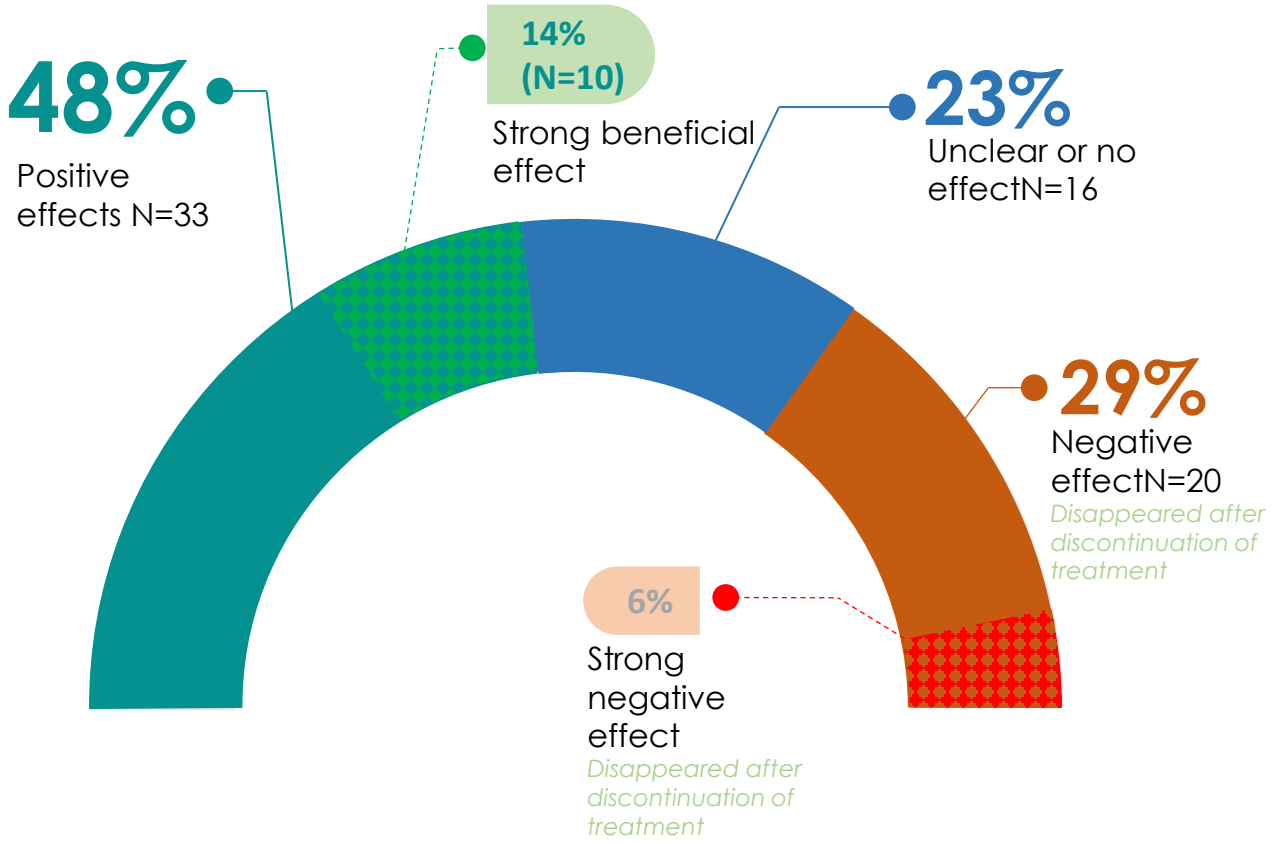

Updates

Strong improvement in pilot with QFS patients who have been ill for an average of 16 years.

Microbiome Center

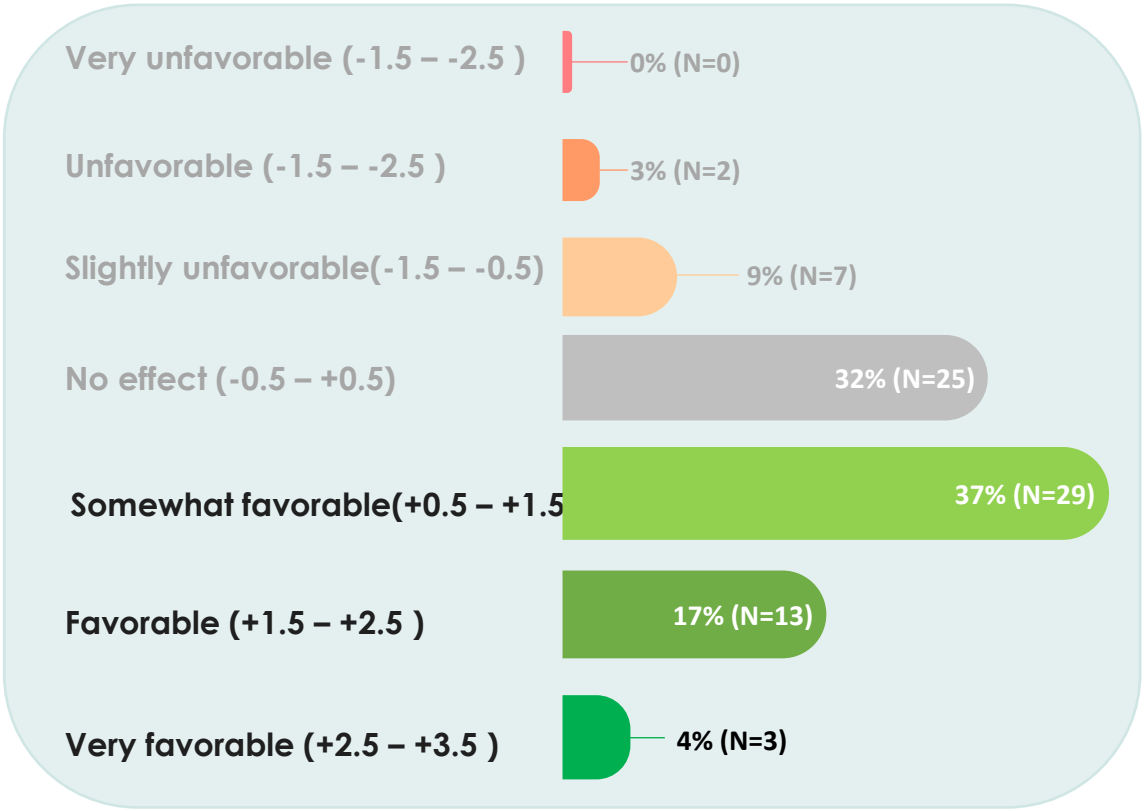
48% see improvement in general well-being(n=69)

"How are you doing (in the past week(s)?"



57% favourable to very favourable effect on combined complaints (n=79)

Categorized as a score from -4 (strongly negative) to +4 (strongly positive)



Bifidobacterium longum ES1

- *Bifidobacterium longum* ES1 is isolated from healthy breast-fed infant[1].
- Uniquely studied for celiac disease (CD):
  - CD is not just genetic, also microbiome related[1,2]
  - A dozen in vitro and animal studies e.g.[1] (fig)
  - RCT in children with celiac disease, showing improved immune activity[3].
  - RCT in non-celiac disease gluten sensitivity showing reduction of complaints[1].
- There is also evidence for:
  - Reduction of IBS symptoms, including abdominal pain and diarrhea[4]
  - Reduction of anxiety[4]
  - Improve sad mood[1]
  - Improve atopic eczema[5]
  - Improve barrier function, inflammation, inhibit pathogens, lower oxidative stress, etc…
- Typical use: Gluten sensitivity or celiac disease with GI complaints

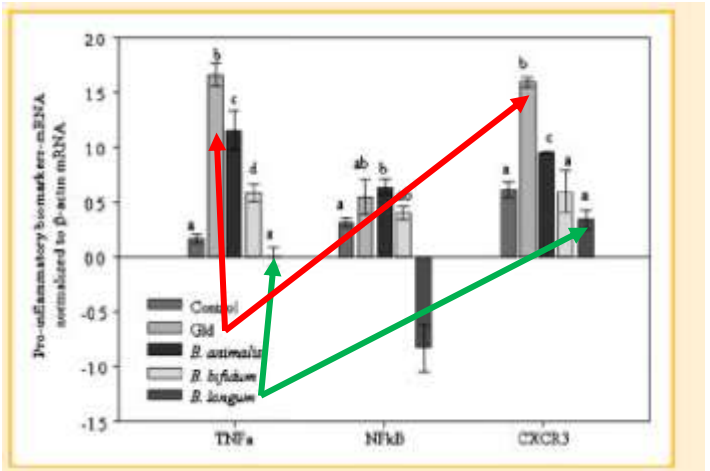
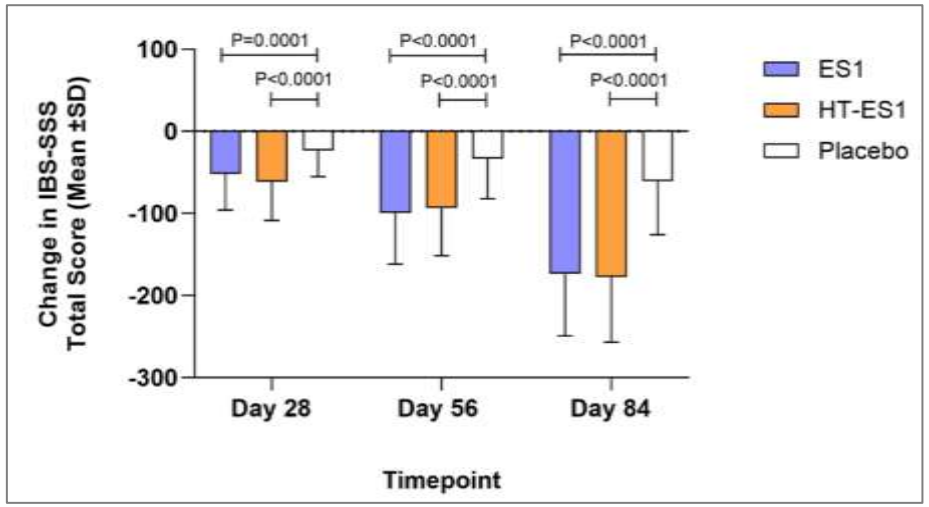
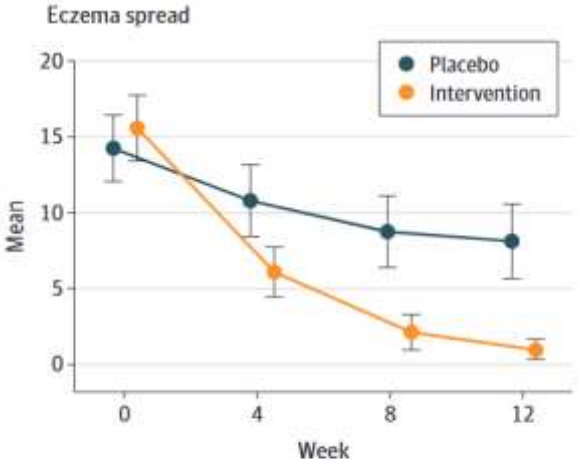
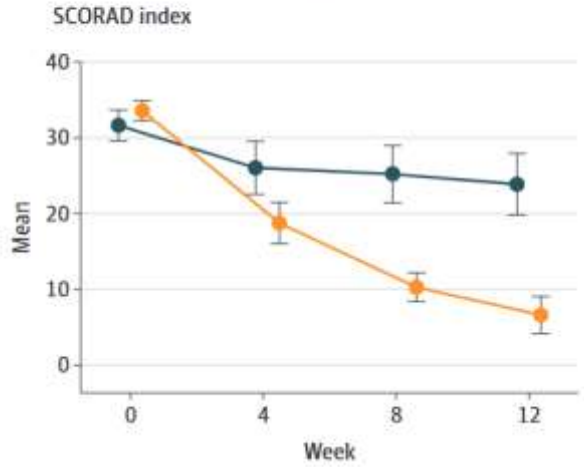


Fig. 3. mRNA expression of pro-inflammatory biomarkers (TNF-α, NF-κB, and chemokine CXCR3 receptor) in Caco-2 cell cultures exposed to the dialyzable fraction (0.25 mg/ml) from digests of gliadins (Gld), inoculated or not with bifidobacteria. Results are expressed as mean ± standard deviation (n = 5). Different superscript letters indicate statistically significant ($P < 0.05$) differences for each of the biomarkers analyzed.







1. Di Pierro, F. et al.Minerva Gastroenterol Dietol.66,.(2020)
2. Girbovan, A. et al.Med Microbiol Immunol.206,.83–91.(2017)
3. Luz, V. C. C. et al.Front. Med. Technol.6,.(2024)
4. Olivares, M. et al.Br J Nutr.112,.30–40.(2014)
5. Navarro-López, V. et al.JAMA Dermatol.154,.37.(2018)

New ingredients coming soon…

- Synbio
  - Mixture of *L. rhamnosus* IMC501 + *L. paracasei* IMC502
  - Evidence for e.g. bloating, constipation, **fatigue**, etc.

- Live *Akkermansia muciniphila* akk11
  - First live option in Europe
  - Can help in case Akkermansia reservoir in gut is gone
  - Evidence for e.g. weight management, metabolic dysfunction, etc.

- Taurine
  - Occurs naturally in all mammals, but production decreases with age
  - Evidence for e.g. metabolic dysfunction, exercise performance, neurological indicators.
  - Microbiome actions: major conjugating partner for bile acids, anti-inflammatory effects, modulate composition

- *L. reuteri* MC251
  - Our second own strain!
  - Genetically almost identical to well-studied *L. reuteri* DSM 17938
  - Studied for e.g. infant colic, gastrointestinal health, immune modulation, **methane SIBO**

- We hope to get *Christensenella minuta* LX03
  - Well-know for its association with overweight
  - Butyrate producer

Do you have any questions?

Thank you for your attention!