



Probiotics

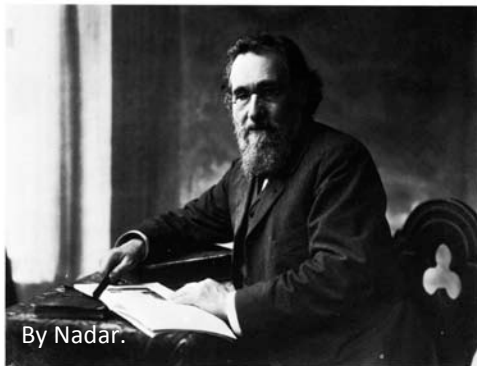
“live microorganisms which when administered in adequate amounts confer a health benefit on the host” (WHO/FAO)



History of Safe Use



Humans have ten times more bacterial cells in their gastrointestinal tract than human cells in their body. A beneficial relationship with the gut microflora is essential for good health.



The Bacillus of Long Life. By Loudon M. Douglas. 1911.
<http://www.gutenberg.org/files/31691/31691-h/31691-h.htm>



www.ua.edu/biz/en/q818771/

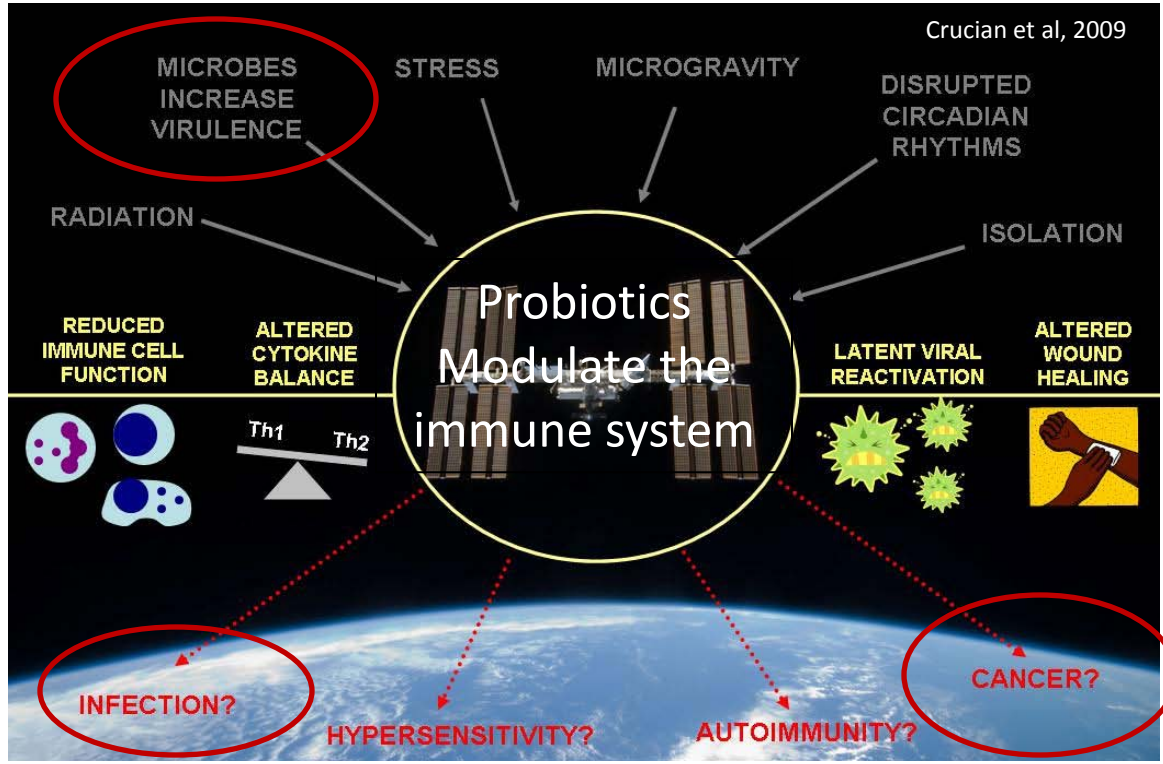
Probiotics	GRAS list number
<i>Bacillus coagulans</i>	GRN 378 (Pending)
<i>Bifidobacterium animalis</i> subsp. <i>lactis</i> strain Bf-6	GRN 377
<i>Bifidobacterium lactis</i> Bb-12	GRN 49
<i>Bifidobacterium longum</i> strain BB536	GRN 268
<i>Lactobacillus acidophilus</i> NCFM	GRN No. 357
<i>Lactobacillus reuteri</i> DSM 17938	GRN 254
<i>Lactobacillus rhamnosus</i> HN001 (DR20)	GRN 281
<i>Lactobacillus rhamnosus</i> GG	GRN 231



Immune dysregulation in spaceflight and probiotic benefits



Antagonize pathogens



Protect against infection

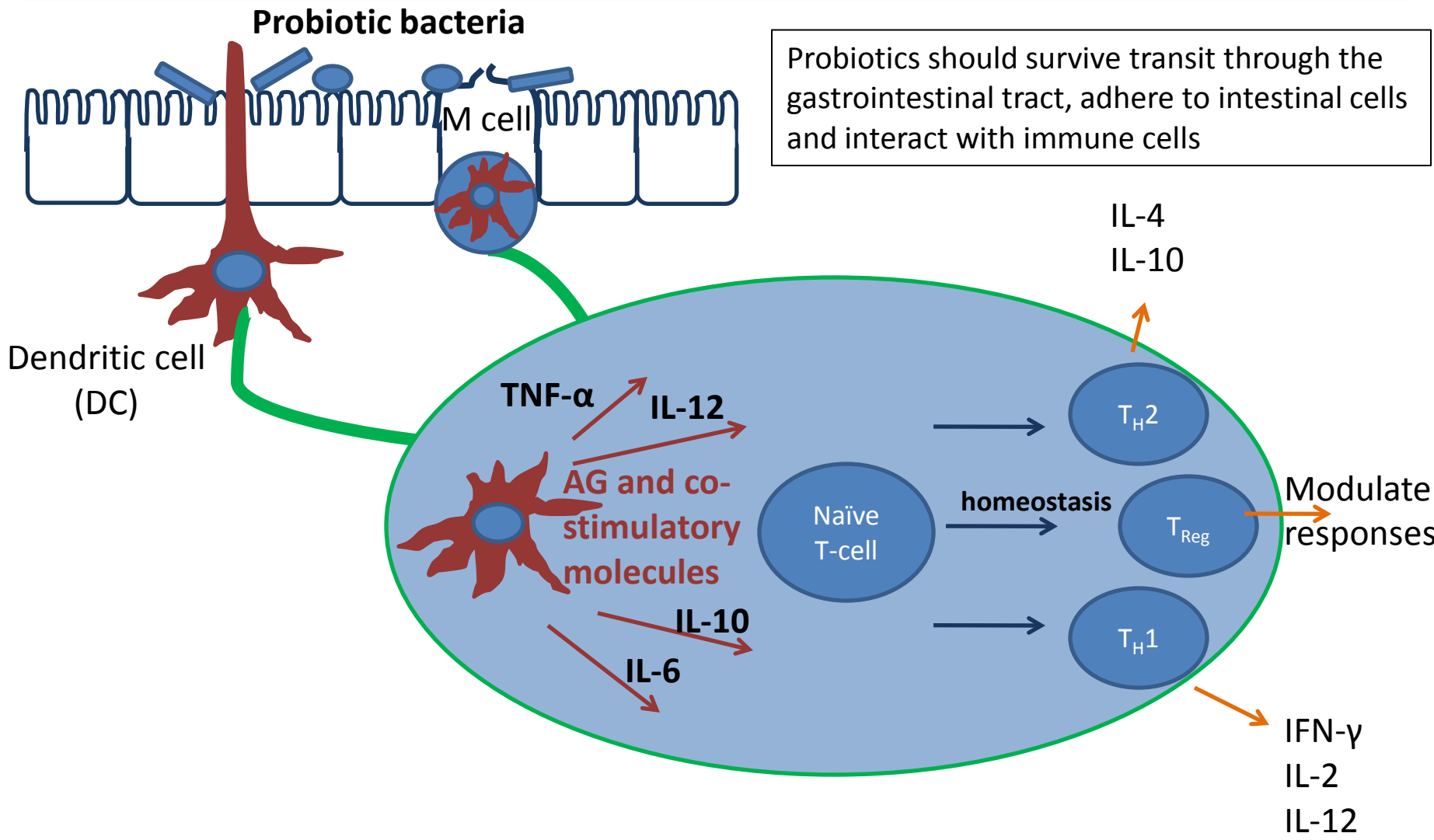
Prevent and treat antibiotic associated diarrhea

Reduction in cancer biomarkers in colon

- Increase specific IFN- γ responses and natural killer cell activity
- Reduce cold and flu-like symptoms
- Alleviate gastrointestinal issues
- Prevention of urinary tract infection



Mode of Action





Probiotics in Spaceflight



- Unknowns
 - Alterations in microbial activity
 - Probiotic tolerance in relation to immune changes in spaceflight
- Preliminary Studies
 - Determine changes in growth, stress response, or metabolic activity in an analog growth environment
 - Evaluate probiotic effect on human immune function in an analog environment or spaceflight
 - Identify probiotic candidates for spaceflight





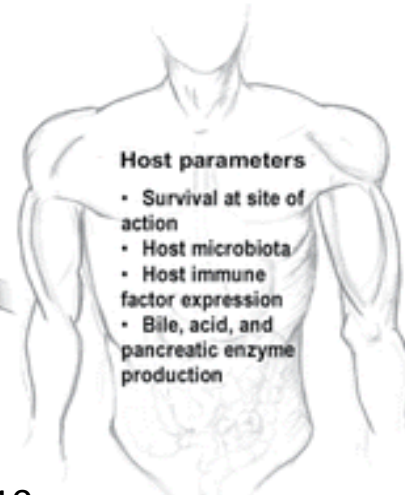
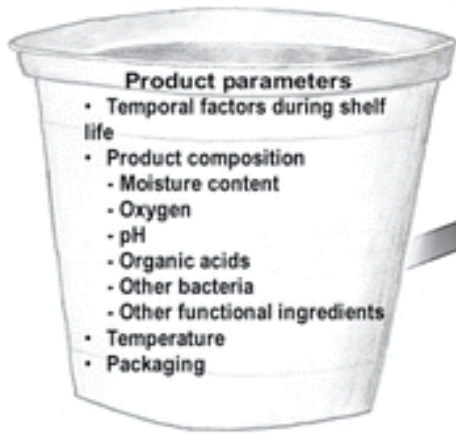
Shelf Life and Food Matrix



Probiotic survival and functionality through shelf life is product specific



Physiological fitness of probiotics is influenced by growth, harvesting, and concentration conditions



Food matrix may impact survival and physiological activity of probiotics in the gastrointestinal tract

Sanders and Marco, 2010



Introduction into Space Food System



- Introduction of probiotics will exceed current flight approved microbial limits.
- Food must have a five year shelf life at ambient temperature.
- A method to introduce probiotics into this system must be determined.

Factor	Limits
Total aerobic count	20,000 CFU/g for any single sample (or if any two samples from a lot exceed 10,000 CFU/g)
Coliform	100 CFU/g for any single sample (or if any two samples from a lot exceed 10 CFU/g)
Coagulase positive <i>Staphylococci</i>	100 CFU/g for any single sample (or if any two samples from a lot exceed 10 CFU/g)
<i>Salmonella</i>	0 CFU/g for any single sample
Yeasts and molds	1000 CFU/g for any single sample (or if any two samples from a lot exceed 100 CFU/g or if any two samples from a lot exceed 10 CFU/g <i>Aspergillus flavus</i>)