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- Industrial Microbiologist
- 40 years experience (brewing and pharmaceutical industries; university)
- 30 years experience working with Clostridium species

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- 30 years experience with the acetone-butanol-ethanol (ABE) fermentation process, which uses Clostridia to convert sugars to ABE.
- Published over 50 refereed articles and reviews on ABE process. Acknowledged worldwide expert.

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Our environment is rich in microbial diversity

- Bacteria are very small one-celled organisms about 0.2-2µm wide and 1-10µm long*

- A teaspoon of soil productive soil generally contains 100 million to 1 billion individual bacteria*

- An acre of land may contain a ton of bacteria representing of a million different species*

*The Role of Soil Bacteria , JJ Hoorman (Ohio State University fact sheet SAG-13-11)

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The vast diversity of microbes in NZ is unknown

Group	Marine	Land-based	Freshwater
Bacteria[2]	**40**	**309**	**341**
Protozoa (single-celled eukaryotes – organisms whose cells have membrane-bound nuclei)	1,663	671	465
Chromista (group of eukaryotes other than protozoa)	855	158	922
Plants	626	5,165	1,107
Fungi[3]	3	6,781	255
Animals	12,637	20,337	2,410
Total[4]	15,824	33,421	5,500

New Zealand's native species

There are an estimated 80,000 native species in New Zealand. Almost 55,000 of these have been identified and about 30,000 have been scientifically described, named and classified.

Number of known[1] native species in New Zealand, 2007

Notes:

(1) This includes the numbers of described species plus known species that have not yet been described.

(2) The numbers given for bacteria are based mainly on cultured species in New Zealand. Some of these have not been broken down according to their environment - most are land-based.

(3) The numbers given for aquatic species of fungi are approximate.

(4) The totals provided do not equal the sum of the rows as there is some overlap due to different life-history stages in different environments (for example, aquatic larval stages and land-based adult stages

From the environment report Environment New Zealand 2007 (ISBN: 978-0-478-30191-5)

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The acetone-butanol-ethanol (ABE) fermentation process

- uses *Clostridium acetobutylicum* or *Clostridium beijerinckii.* Sporeformers. Anaerobic.
- Commercialised in WW 1 as source of industrial chemicals from sugars.
- Between 1920 and 1985, commercial plants operating in UK, USA, Japan, China, Europe, Russia, South Africa.

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- Typical scale 20,000 - 50,000 litres in banks of 10-20.
- Hygienic design and operation.
- Petrochemical sources of ABE dominated from 1960 onwards.
- From 2000, biofuels make a “comeback”.
- Commercial ABE plants currently operating in China, Brazil.
- ABE - producing bacteria are easily isolated from anaerobic environments worldwide. Non-pathogenic.
- Many ABE - producing bacteria have been imported into NZ, with MAF permits, over the last 30 years, with no evidence of any adverse impact on soil, biodiversity, aquifers, or any anaerobic environment.

No evidence of any adverse impact on environment or biodiversity in NZ or Globally.

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Analogy between ABE process and and Lanzatech's process

- Similar anaerobic fermentation technology, hence expertise available.

  Use of anaerobic clostridia. But LanzaTech strain does not sporulate.

- LanzaTech process uses gas; ABE process produces waste gas ($C0_{2} + H_{2}$)

- ABE uses sugars. LanzaTech uses $C0_{2}$, hence uses a greenhouse gas rather than potential food.

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- Production of fuel and useful chemicals from greenhouse gases is environmentally sensible.
- Biorefineries, based on $C0_{2,}$ will become a reality due to high cost of oil and environmental concerns.