

## Interview with Dr. Natalie Leys and Dr. Rob Van Houdt

### WHO ARE WE INTERVIEWING? (job, studies...)

Dr. Natalie Leys (Head of the Microbiology Research Unit, coordinator of the Space Life Science program at SCK-CEN)

Dr. Rob Van Houdt (specialist in genetic engineering at Microbiology Research Unit at SCK-CEN)

Both of them work for the MELiSSA project (a space research program aiming to develop an artificial ecosystem for regenerative life support systems for long-term space missions to lunar bases or flights to Mars).



### CONTEXT (Why did we do this interview?)

The Melissa project has been a great inspiration for the development of our project. This is why we contacted Dr. Natalie Leys to have more information on the behaviour of microorganisms in microgravity and space conditions. She kindly invited her friend and colleague Dr. Rob Van Houdt.

### INTERVIEW (summary of the interview)

After presenting our project to Dr. Leys and Dr. Rob Van Houdt, we discussed about space conditions, our coculture system. This is the main points we discussed, and their advice.

#### For the coculture:

We have to make sure that the oxygen balance is fixed and control the flow of O<sub>2</sub>. We need to think we need to think about how we will control temperature and pH. We need to check toxic coproducts from *Clostridium Ljungdahlii*.

We must use Gas liquid contactors to control diffusion of gas and take into account the modelisation of our coculture that will be an important part of our project.

She likes the idea of the light switch to choose flavors, but we need to make sure the culture is not too dense for a correct light exposure.

She advised us to separate both compartments for experiments :

- 1) synthetic medium for yeast with ethanol and acetate (to measure the production efficiency of *Clostridium Ljungdahlii* to know the yields)
- 2) using supernatant of *Clostridium Ljungdahlii* and give it to the yeast

She wouldn't choose to test the loop experimentally for the first experiment.

## SPACE CONDITIONS :

They usually don't use the microorganisms we use so she doesn't know how they're gonna react to space conditions.

Microgravity has direct and indirect effects and direct effects which are mechanical forces demonstrated on Human cells. Indirect effect is linked to liquid quiescence. There is no convection and sedimentation in space but cells are suspended. Nutrients are needed by the cells and they diffuse through the medium. This means there could be starvation issues, because nutrients get to all the cells, and also waste accumulation inside cells.

She told us that, in the MELISSA project, they used mixing forces (like pumps or stirring bars) so that cells can have maximum exposure to light and nutrients, and remove gas. We also have to make sure there are no leaks. We might have to define the containment, in space reactors go inside a container, which is inside a container and so on until it's plugged into a wall.

## **Validation of Earth based experiments to space:**

There are mostly safety rules to follow and everything researchers use strain, molecules, chemicals products that are not toxic. In space, only biosafety level 1 organisms are allowed.

Our device must not release gas or liquid. There must be no leaks of liquid or gas. To implement a project in a space station, we need to do an off gazing test. Again, there can not be any free liquids or gas, and also no bubbles so a bubble trap is needed.

## **For yeast production:**

For nutritional purposes, Rob advised us to check conditions of growth and dry weight of proteins and composition of these proteins. And if it is high in protein content, it is a valuable source in space.

Rob also mentioned another strain of *S.cerevisiae*: *Saccharomyces boulardii* CNCM I-745 that is currently used as probiotic.

For harvesting yeast: it is important to not give the medium or supernatant which contain ethanol and urine to astronauts.

## **For *Clostridium Ljungdahlii*:**

We need to search how the biofilm is formed because it will always be easier to work on suspension.

## **For optogenetics:**

They advised us to make sure that the yeast are well exposed to the light.

## ETHICS (her personal opinion)

Eating engineering organisms is still a debate in many European countries, and ESA needs to follow the rules for all Europe. In MELISSA project they do not use GMOs. It's bizarre that

space would disregard GMOs because of its novelty, but it's still difficult due to country relationships.

#### APPLICATION ON EARTH

For space technology to be applied on earth it has to not only be environmentally friendly, it also needs to be economically relevant. WHO recommends the use of fortified foods in African countries.

