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SPACE ENVIRONMENT: A CLASSICAL STUDY FOR ALL RESEARCH FIELDS

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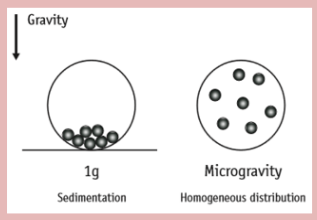
INTRODUCTION

- There is **diversity in the space sector** because there is **diversity in the space environment**.
- Some **properties of space environment** (microgravity environment) are:
  - -absence of convection
  - -absence of sedimentation
  - -low-shear
  - -capability of supporting three-dimensional tissue formation.



Sedimentation takes place under 1g; no sedimentation and particles homogeneously distribute under microgravity

ALL RESEARCH FIELDS OR ALL COURSE HAS APPLICATION TO SPACE

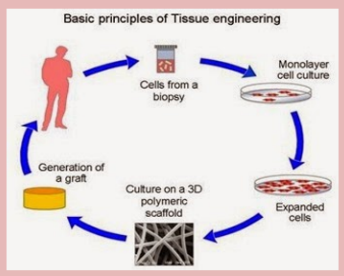
- **Microbiologists** study the behavior of **microorganisms** in the space environment as microorganisms can form biofilm which are mainly antibiotics resistant for **playing essential roles in human health for novel therapeutics and vaccines**.
- **Botanists and agriculturists** study the effects of space environment on **plants growth** and the development of new plant variety adapted to extreme condition, and the production of **better agricultural products**.

Picture Showing Microbial Observations

Picture Showing Planting in a Space Environment

ALL RESEARCH FIELDS OR ALL COURSE HAS APPLICATION TO SPACE CONT'D

- **Biotechnologists** isolate the genes for better growth of plants under space environment and insert into the **wild-type** of plants for use on earth; this platform in relations to **medicine** has also made it possible to grow tissue samples outside the body; making the shelf life of blood banks longer; and granted insights to avoid the spread of cancerous cells.
- **Pharmacists** have discovered better crystals, longer shelf life of drugs, better delivery routes, better packaging of drugs and **overall reduction in the cost of drug production** as benefits of their studies under space environment.



ALL RESEARCH FIELDS OR ALL COURSE HAS APPLICATION TO SPACE CONT'D

- **Physicists or material scientists** research on materials such as silver nanoparticles for **crystals growth**.
- **Chemists** are able to study the different **phases of objects** (solid, liquid and gas) and **their conversions**; and the study of the various **forms of crystallization**.

AWARENESS ON THE VISIBILITY OF RESEARCH OF ALL FIELDS IN SPACE IS NEEDED

- All the mentioned research **persons and fields** are just to mention **a few** in benefits and applications to the space sector.
- Other **non-science oriented courses** such as **law** also have practical applications to space.

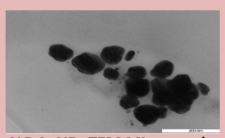
MICROGRAVITY RESEARCH IN NIGERIA

- This is done using simulated microgravity equipment called **Clinostat** won from the United Nations Office for Outer Space Affairs (UNOOSA) (United Nations, 2013). Research on **plants** were carried out at the Microgravity Simulations Laboratory of the Space Agency of Nigeria – National Space Research and Development Agency (NASRDA), Nigeria.
- Many plants (wheat, sorghum, corn, rice, cotton, peanut, okra, cowpea, watermelon, cucumber) has being worked on. They all showed **positive response to simulated microgravity through their root curvature and 8 out of 10 plants had increased growth rate** (Oluwafemi *et al.*, 2018) under simulated microgravity while 2 (Cotton and Sorghum) showed decreased growth rate.
- Development of new plant variety with better agricultural products can be achieved.

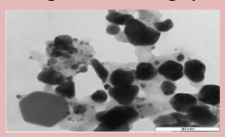
Wheat, Sorghum, Corn, Rice, Cotton, Peanut and Okro Seeds (respectively from left to right) Planted and Mounted on Clinostat

MICROGRAVITY RESEARCH IN NIGERIA CONT'D

- **Silver nanoparticles** (AgNPs) have been utilized as antibacterial and antiviral agents in water purification, medical devices, cosmetics and electronics.
- **Gravity effects** on the microstructure of these materials usually influence their **physical properties**.
- Effects of the space environment on silver nanoparticles (AgNPs) crystals growth has been done.
- Results of the AgNPs research revealed **some modification** in the **crystallites sizes**, **shapes**, **inter planar spacing** between the atoms and elemental compositions in microgravity (MG) AgNPs (Omojola *et al.*, 2018).
- The dislocation density and the specific surface area showed that MG and normal gravity (NG) AgNPs materials are useful in heterogeneous catalysis and adsorptions (Omojola *et al.*, 2018).



NG AgNPs TEM Micrograph



MG AgNPs TEM Micrograph

CONCLUSION

The space sector is now growing fast in the world, and space technologies are currently being used to achieve the Sustainable Development Goals (SDGs) in which microgravity research is part of it. From the various discussions and experimental examples given, it is evident that microgravity applications on plants and materials stimulates economic growth and improves the quality of life of people.

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