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BIOLOGICAL PATTERNS: NOVEL INDICATORS FOR PHARMACOLOGICAL ASSAYS

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INTRODUCTION

Algae, protozoa, and spermatozoa form macroscopic patterns while mobile, analagous to thermally driven convection cells. Interest within the fluid dynamics arena has increased to demonstrate theories of gravity-related mechanisms. The appearance of these bioconvective patterns is the result of fluid dynamic instability (protozoa and algae) and wave-forming hydrostatic mechanisms (spermatozoa). Definitive KC-135 aircraft studies have clearly demonstrated the existence of several mechanisms governing cell viability and movement.

The research focus of ground experiments has been to 1) further characterize these mechanisms driving bioconvective pattern formation in simple cellular organisms; 2)study the relationship between variable gravity and the streaming patterns observed in dense cultures of free-swimming organisms; 3) to devise simple ground tests to determine future bioprocessing needs; and 4) to devise and patent toxicity assays for detecting metallic ions and pharmacological products.

CONTENT

As part of Marshall Space Flight Centers' summer faculty fellowship program (SFFP) within the biophysics branch, development of bioassays for detecting metallic ions and pharmacological products has been devised utilizing the pattern forming abilities of these organisms as a macroscopic detector of chemicals and biologically active agents. The addition of cadmium at varying concentrations to these biological cultures has been shown to effect the mobile function, and hence the macroscopic patterns of the protozoa, Tetrahymena Pyriformis.

Sperm motility is essential for the penetration and genetic investments of the oocyte (1). Conceivably, every ejaculate contains some minute percentage of abnormal spermatozoa (motile or immotile), but absolute criteria for variations in sperm normality due to microgravity influences have yet to be established. It is therefore of interest to monitor pattern formation as a sensitive indicator of cell viability and function. In addition to these ground tests, the SFFP project has persued initial activities of cryopreservation and storage of spermatozoa and other single cells. In preliminary findings of post-thaw survival of spermatozoa, the rate of thaw (30 seconds versus 65 seconds in water-bath maintained at 36°C) and medium type used to preserve cells greatly affects the percent survival rates. Herein, these and other factors influencing cryopreservation will need to be closely evaluated prior to reliance on low gravity test designs.

CONCLUSIONS

Variable gravity testing using the KC-135 demonstrated clearly that biological pattern formation was definitively shown to result from gravity alone (protozoa), and not from oxygen gradients in solution. Motile pattern formation of spermatozoa are driven by alternate mechanisms, and apparently are not affected by short-term changes in gravity. The chemical effects found appear to be secondary to the primary effect of gravity. Cryopreservation may be the remedy to the problem of 'spare' or 'standing order' biological samples for testing of space lab investigations, but further studies are necessary.

REFERENCES

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