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PROGRESS AND PROSPECTS OF BIONANOROBOTICS AT PRESENT STAGE OF DEVELOPMENT OF SCIENCE AND TECHNOLOGY. NECESSITY AND OPPORTUNITY OF MODERNIZATION OF BIONANOROBOTICS FOR MOLECULAR BIOMANUFACTURING

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After overcoming the cellular barrier and the emergence of "tissue chips" and multicellular engineering living systems, the goals and objectives of molecular production changed and these changes required changes for bionanorobotics, because bionanorobotics is focused on automated molecular production.

Keywords: mass molecular production, biointegration, "tissue chips", organs-on-a-chip, M-CELS, convergence, divergence, biofabrication, biomanufacturing, living system, life form, molecular biomachines, biointegrated technologies, soft robotics.

REFERENCES

1. Ratkin L.S. *Nanotekhnologicheskie shkoly Rossii: etapy stanovleniya i mezhdunarodnaya kooperatsiya* [Russian nanotechnology schools: stages of formation and international cooperation] // Nano- and microsystem technology. 2012. № 4 (141). C. 15-20.

2. Kamm R.D. et al. Perspective: The promise of multi-cellular engineered living systems APL bioengineering. 2018. Vol. 2. №. 4. P. 040901.

3. Tyrrell James. How do you define biofabrication today? [Электронный ресурс] https://physicsworld.com/a/how-do-you-define-biofabrication-today. 27.02.2018

4. Fatehullah A., Tan S.H., Barker N. Organoids as an in vitro model of human development and disease // Nature cell biology. 2016. Vol. 18. № 3. Pp. 246-254.

5. Friston K. et al. Knowing one's place: a free-energy approach to pattern regulation // Journal of the Royal Society Interface. 2015. Vol.12. № 105. P. 20141383.

6. Abutalipov R.N., Zammoev A.U. *Poisk, issledovanie i razvitie tekhnologiy bionanorobototekhniki dlya ustoychivogo razvitiya gornykh territoriy v epokhu shestogo tekhnologicheskogo uklada* [Search, research and development of bionanorobotics technologies for the sustainable development of mountain territories in the new techno-economic paradigm] // *Ustoychivoye razvitiye gornykh territoriy* [Sustainable development of mountain territories]. 2018. T. 10. № 3(37). Pp. 447-457. DOI: 10.21177/1998-4502-2018-3-447-457.

7. Abutalipov R.N., Zammoev A.U., Zagazezheva O.Z. *Interreprezentativnyye seti (IRS) i reprezentativnost' VR vizualizatsii nanostruktur i protsessov v nanosrede* [Interreprezentative network (IRN) and representativeness VR visualization of nanostructures and processes in nano-medium] // News of the Kabardino-Balkarian Scientific Center of the Russian Academy of Sciences. 2016. № 4 (72). Pp. 5-9.

8. Abutalipov R.N., Zammoev A.U. *Domennaya model' kognitivnoy infokommunikatsionnoy sistemy dlya intellektual'nogo meditsinskogo onlayn-servisa na baze bionanosensornykh ustroystv* [Cognitive infocommunication system domain model for intelligent medical online service based on biosensor devices] // Slavic Forum. 2018. № 1. Pp. 104-113.

9. Kriegman S. et al. A scalable pipeline for designing reconfigurable organisms // Proceedings of the National Academy of Sciences. 2020. Vol. 117. № 4. Pp. 1853-1859.

10. Macklin D.N., Ruggero N.A., Covert M.W. The future of whole-cell modeling // Current opinion in biotechnology. 2014. Vol. 28. Pp. 111-115.

11. Arshinov V.I. *Konvergentnye tekhnologii v kontekste postneklassicheskoy paradigmy slozhnosti* [Convergent technologies in the context of the post-non-classical paradigm of complexity] // *Slozhnost'. Razum. Postneklassika.* [Complexity. Mind. Postnonclassics]. 2015. № 3. Pp. 42-54. DOI: 10.12737/13564

12. Arshinov V.I., Budanov V.G. *Kvantovo-slozhnostnaya paradigma. Mezhdistsiplinarnyy kontekst* [Quantum complexity paradigm. Interdisciplinary context]. Kursk: University book. 2015. 121 p.

13. Knyazeva E.N. *Transdistsiplinarnye strategii issledovaniy* [Transdisciplinary research strategies] // Bulletin of TPGU. 2011. № 10(112). Pp. 193-201.

14. Prigozhine I., Stengers I. *Poryadok iz khaosa: novyy dialog cheloveka s prirodoy* [Order from chaos: a new dialogue between man and nature]. Per. from English M.: Progress. 1986. 432 p.

15. Abutalipov R.N., Zammoev A.U. *Aktual'nye metodologicheskie problemy mezhdistsiplinarnykh issledovaniy v oblasti bionanorobototekhniki* [Actual methodological problems of interdisciplinary research in the field of bionanorobotics] // News of the Kabardino-Balkarian Scientific Center of the Russian Academy of Sciences. 2019. № 6(92). Pp. 10-20.

16. Abutalipov R.N., Zammoev A.U., Nagoev Z.V. *Bionanorobototekhnika: kontseptualizatsiya, problematika i zadachi issledovaniy* [Bionanorobotics: conceptualization, problems and research objectives] // News of the Kabardino-Balkarian Scientific Center of the Russian Academy of Sciences. 2016. № 6. Pp. 11-17.

17. Abutalipov R.N., Zammoev A.U. *Aspekty problemy regional'nogo upravleniya i koordinatsii vysokotekhnologichnykh proektov* [Aspects of the problem of regional management and coordination of high-tech projects] // News of the Kabardino-Balkarian Scientific Center of the Russian Academy of Sciences. 2019. № 6. Pp. 60-66.

18. Cvetkovic C. et al. Three-dimensionally printed biological machines powered by skeletal muscle // Proceedings of the National Academy of Sciences. 2014. T. 111. № 28. Pp. 10125-10130.

19. Matas J., James S., Davison A.J. Sim-to-real reinforcement learning for deformable object manipulation. [Electronic resource]. URL: arXiv preprint arXiv:1806.07851. 2018.

20. Abutalipov R.N., Zammoev A.U., Denisenko V.A. *Vybor biologicheskogo nanostrukturnogo obyekta dlya issledovaniya yego svoystv s tochki zreniya paradigmy mekhatroniki* [The choice of a biological nanostructured object for studying its properties from the point of view of the mechatronics] // News of the Kabardino-Balkarian Scientific Center of the Russian Academy of Sciences. 2016. № 6(74). Pp. 30-37.

21. Abutalipov R.N., Zammoev A.U., Anchekov M.Yu. *Perspektivy primeneniya mikro- i nanosistemnoy tekhniki v biologii i meditsinskoy diagnostike. Problemy i zadachi LOC (laboratoriy na chipe)* [Perspectives of application of micro- and nanosystem equipment in biology and medical diagnostics. Problems and tasks of LoC (laboratories on the chip)] // News of the Kabardino-Balkarian Scientific Center of the Russian Academy of Sciences. 2016. № 6 (74). Pp. 5-10.

22. Abutalipov R.N., Zammoev A.U. *Perspektivy primeneniya magnitosom na nizhnem urovne fizicheskogo domena kognitivnoy infokommunikatsionnoy sistemy meditsinskogo onlayn-servisa na baze bionanoservisnykh ustroystv* [Prospects of the application of the magnetosome at the low level of the physical-domain of cognitive infocommunications system of medical online service on the basis of biosensor devices] // *Materialy vtoroy Mezhdunarodnoy nauchnoy konferentsii «Modeli myshleniya i integratsiya informatsionno-upravlyayushchikh sistem»* [Materials of the second International scientific conference "Thinking models and the integration of information and control systems"]. 2018. Pp. 201-205.

23. Zammoev A.U., Abutalipov R.N. *Kataliticheskiye samokhodnyye nanodvizhiteli – osnova elementnoy bazy dlya proyektirovaniya nanomekhatronnykh ustroystv i sistem dlya bionanomashin v bionanorobototekhnike* [Catalytic self-propelled nanomovers - the basis of the element base for the design of nanomechatronic devices and systems for bionanomachines in bionanorobototechnics] // News of the Kabardino-Balkarian Scientific Center of the Russian Academy of Sciences. 2018. № 6-2(86). Pp. 149-156.

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