日本生物制造前沿研究（2018~2023）

Biomanufacturing in Japan: frontier research from 2018 to 2023

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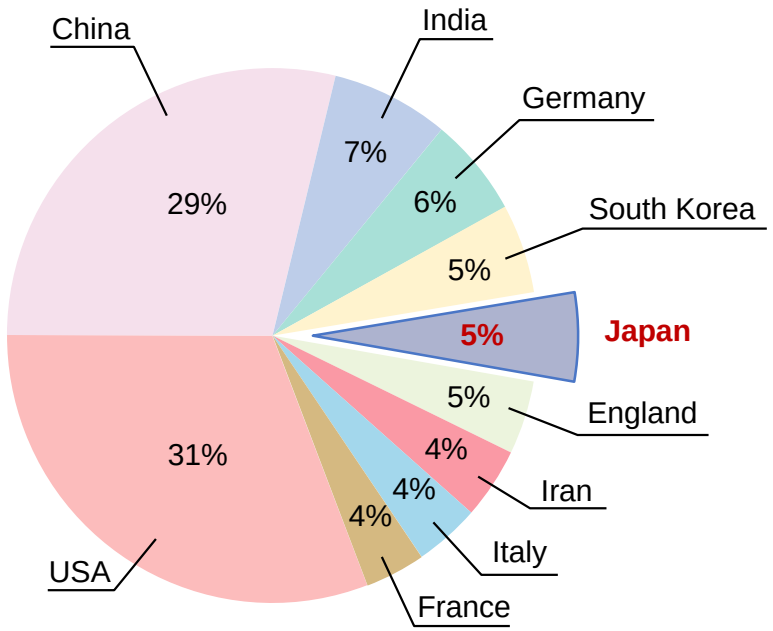
1 日本在生物制造领域的角色 Japan's role in biomanufacturing

日本在生物制造（BM）领域取得了重大进展，包括新型材料、先进工艺和多学科上的应用等。然而，由于某些发展政策的原因，相关研究尚未在国际上得到广泛关注

Japan has made significant progress in the field of biomanufacturing (BM), including new materials, advanced processes, and multi-disciplinary applications. However, due to certain development policy reasons, relevant research has not received much attention internationally

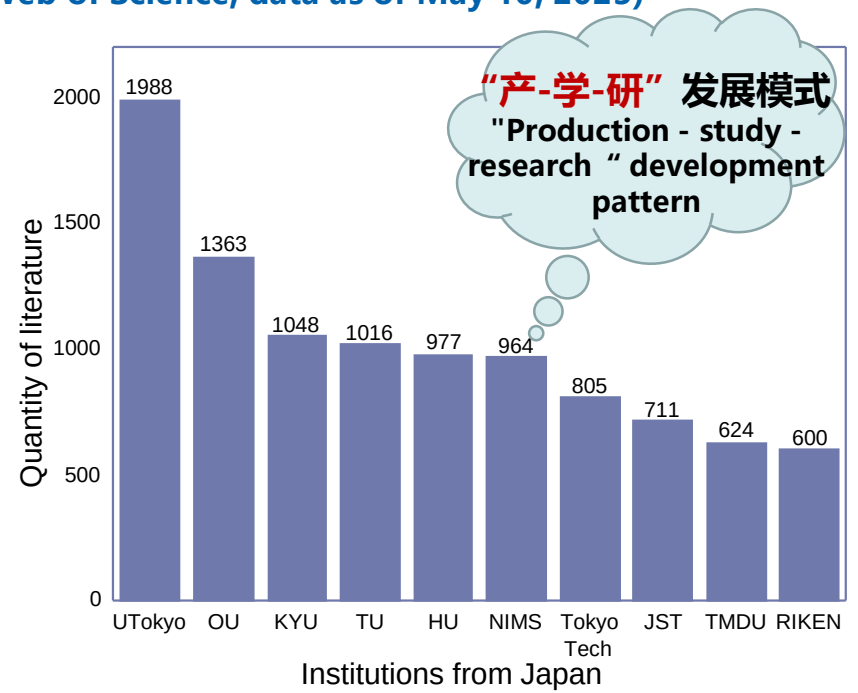
生物制造研究成果统计（“Web of Science”，数据截至2023年5月10日）

Statistics of biomanufacturing research results (Web of Science, data as of May 10, 2023)



全球前十国家BM研究成果所占比例

Proportion of BM research output in the top ten countries



日本从事BM研究的前十家机构

Japan's top ten institutions engaged in BM research

日本BM领域著名学者及机构

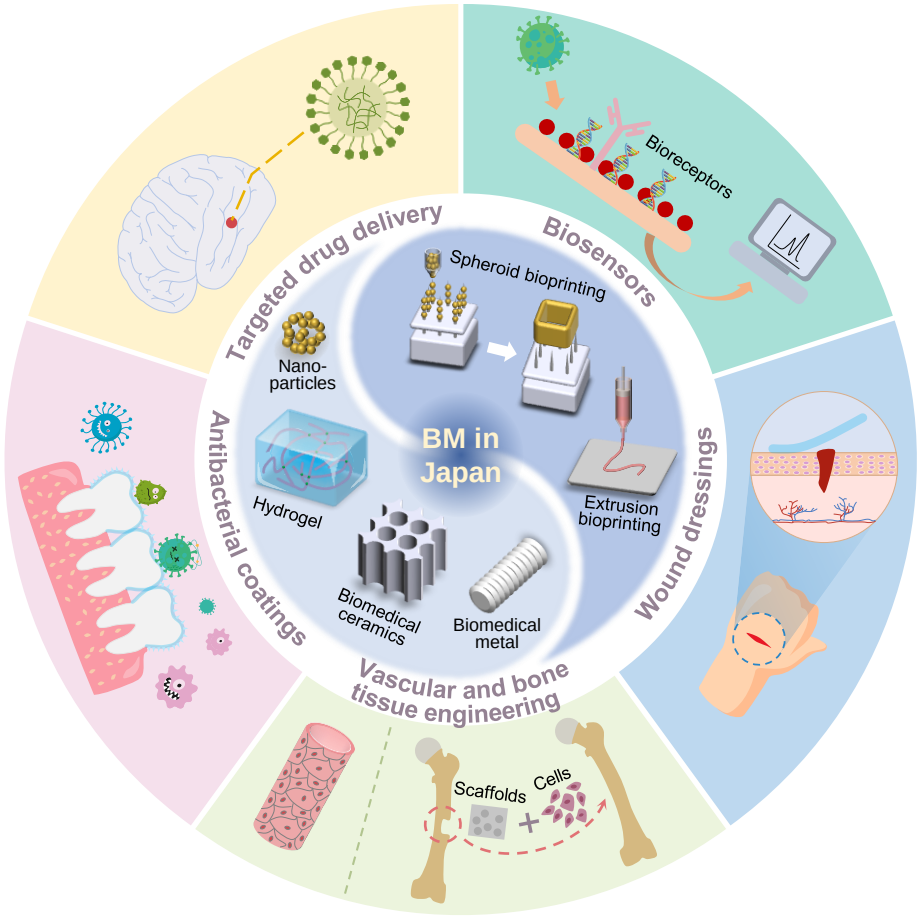
Famous scholars and institutions in Japanese BM

Representative scholars	Affiliations
Takayoshi Nakano	Osaka University
Pezzotti Giuseppe	Tokyo Institute of Technology
Kunio Ishikawa	Kyushu University
Yasuhiko Tabata	Kyoto University
Jian Ping Gong	Laboratory of Soft & Wet Matter
Hiroyuki Koide	Shizuoka University
Equo Kobayashi	Tokyo Institute of Technology
Koichi Nakayama	Saga University
Kazunori Kataoka	Innovation Center of NanoMedicine
Hirofumi Miyaji	Hokkaido University
Takahiro Kanno	Shimane University
Ick Soo Kim	Shinshu University
Tetsushi Taguchi	University of Tsukuba
Enoch Y. Park	Research Institute of Green Science and Technology
Koji Sode	Tokyo University of Agriculture and Technology

日本BM最新进展 Latest progress of Japanese BM

日本在生物制造（BM）领域上的进展主要包括生物医用材料、生物3D打印和生物医学应用三个方面
Japan's progress in the field of BM mainly includes three aspects: biomedical materials, bio-3D printing, and biomedical applications

- 生物制造
  - 生物医学材料 **Biomedical materials**
    - 金属类生物医用材料 Metallic biomedical materials
    - 陶瓷生物医用材料 Ceramic biomedical materials
    - 高分子生物医用材料 Biomedical polymers
  - 生物3D打印 **Biological 3D printing**
    - 挤出式生物打印（常用） Extrusion bio-3D printing
    - 球体生物打印（新方法） Spheroid bio-3D printing
  - 生物医学应用 **Biomedical applications**
    - 靶向药物递送 Targeted drug delivery
    - 抗菌涂层 Antibacterial coatings
    - 血管/骨组织工程 Vascular and bone tissue engineering
    - 伤口敷料 Wound dressings
    - 生物传感器 Biosensors



日本BM最新进展 Latest progress of Japanese BM

➢ 生物医用材料 Biomedical materials

生物医用金属材料主要被植入人体内，起到治疗、修复、替代人体组织或器官的作用

Biomedical metal materials are mainly implanted in the human body to treat, repair, and replace human tissues or organs

Takayoshi Nakano

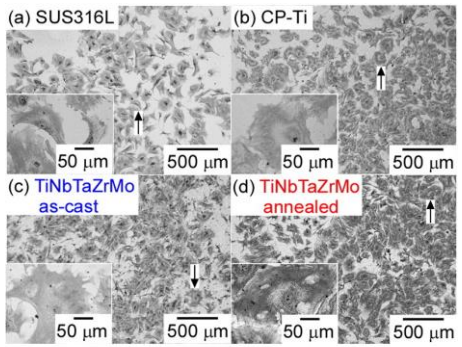
NAKANO LABORATORY
Biomaterials and Structural Material Design Area, Division of Materials Science and Engineering, Graduate School of Engineering, Osaka University

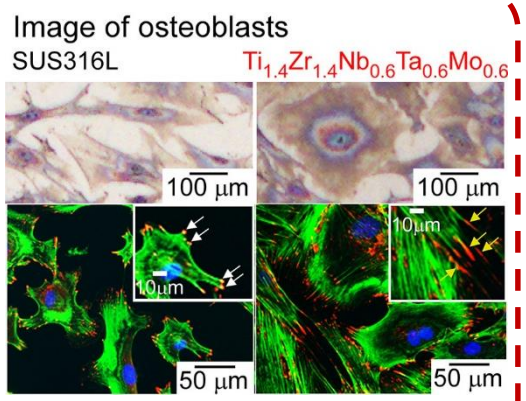
生物材料物理特性评估 Evaluation of physical properties of biomaterials

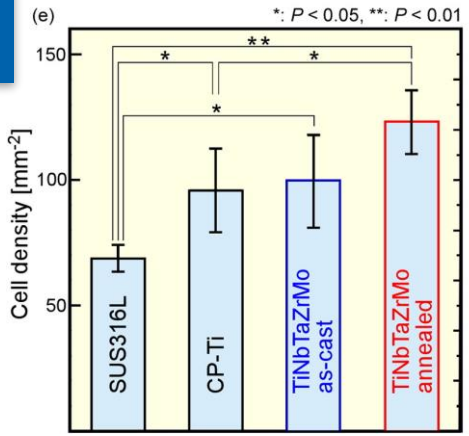
生物组织再生技术 Biological tissue regeneration technology

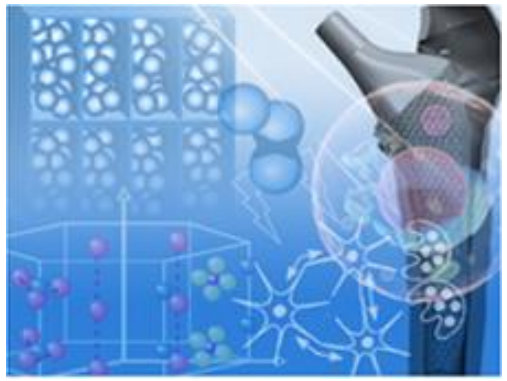
生物组织逐层各向异性排列和结构 Layer by layer anisotropic arrangement and structure of biological tissue

生物医用高熵合金









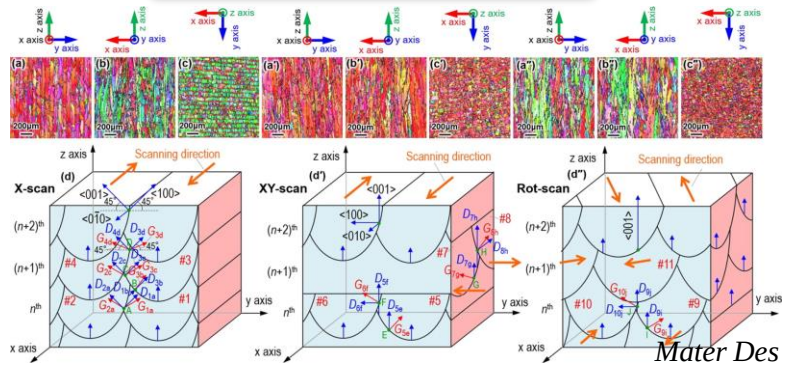
High entropy alloy for biomedical purposes

- **调整元素组成、含量和微观结构** Adjust element composition, content and microstructure

Scripta Mater

晶体层状微观结构

Crystal layer microstructure



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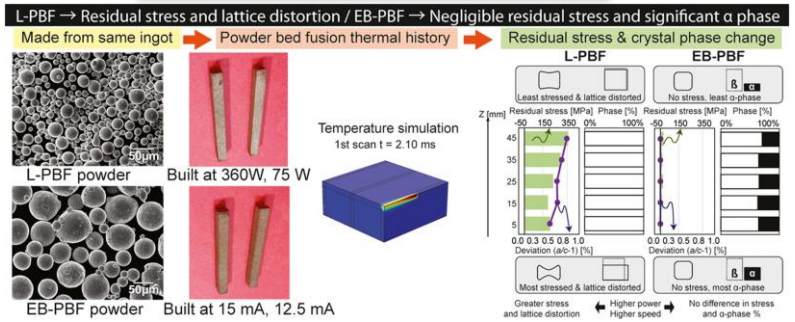
金属增材制造

Metal additive manufacturing



- **改进加工工艺** Improve processing technology

Addit Manuf

日本BM最新进展 Latest progress of Japanese BM

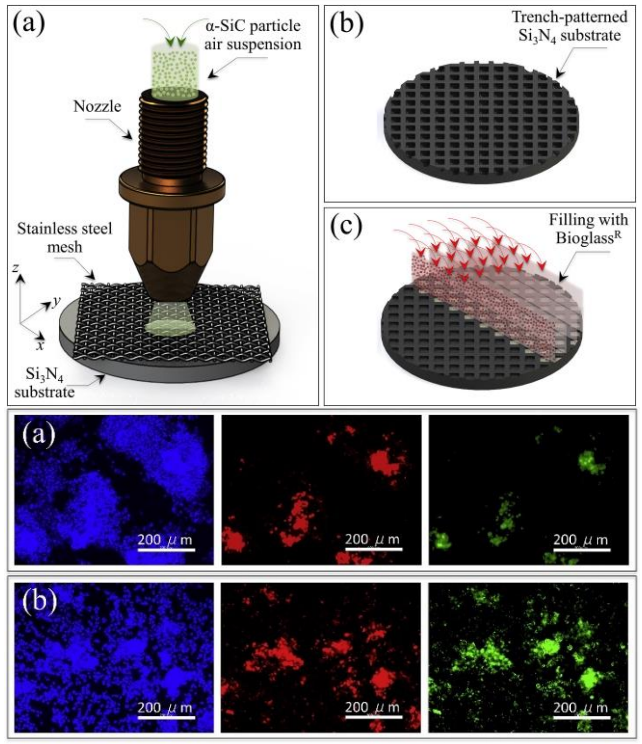
➢ 生物医用材料 Biomedical materials

高耐磨性、低摩擦系数以及良好的生物相容性使生物医用陶瓷在承重部件、关节置换、填充物、药物输送平台和仿生支架等方面中广泛应用

High wear resistance, low friction coefficient and good biocompatibility make biomedical ceramics widely used in load-bearing parts, joint replacements, fillers, drug delivery platforms and bionic stents

高能激光源图案化

High energy laser source patterning

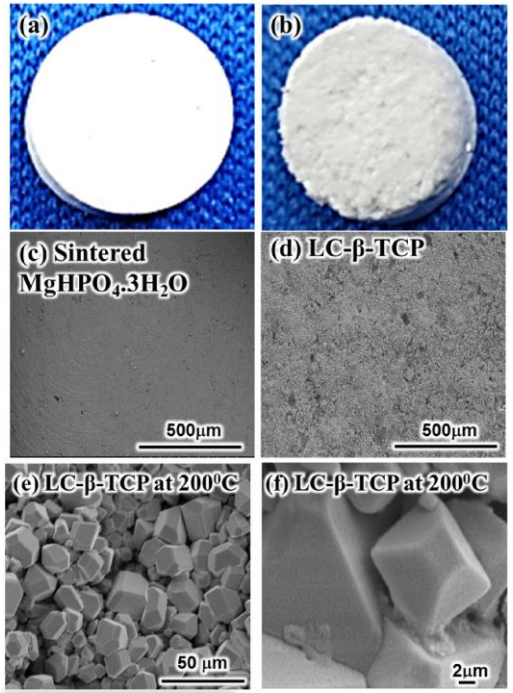


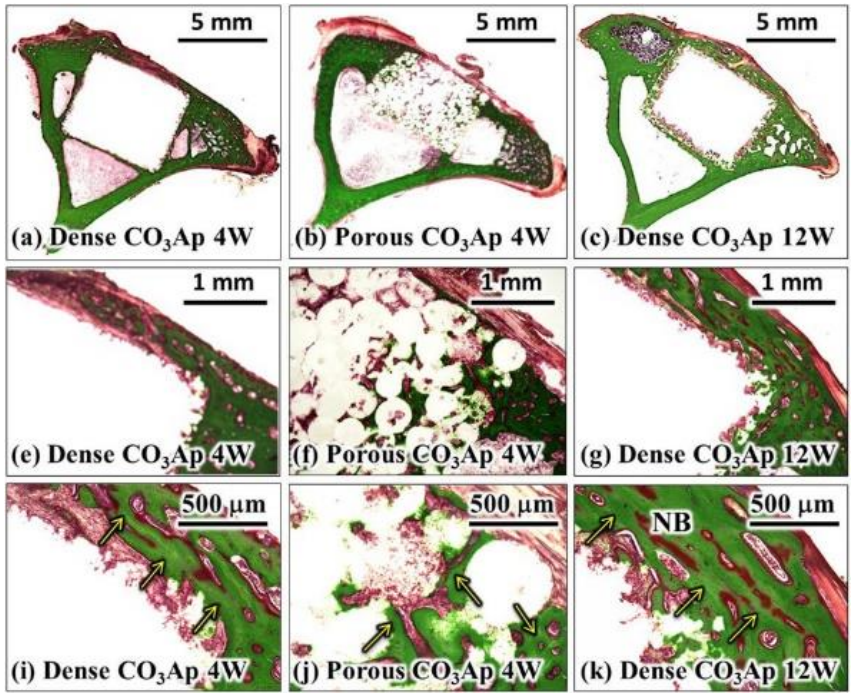
- **生物玻璃填充β-Si_3N_4**
  Bioglass filled with β-Si_3N_4

Mater Sci Eng C

低温溶解沉淀法

Low temperature solution-precipitation method





- **高成本效益 High cost effectiveness**
- **出色的骨传导性 Excellent bone conductivity**
- **可用于治疗大面积骨折或骨肿瘤切除引起的骨缺损**
  Can be used to treat bone defects caused by large area fracture or bone tumor resection

Mater Lett

日本BM最新进展 Latest progress of Japanese BM

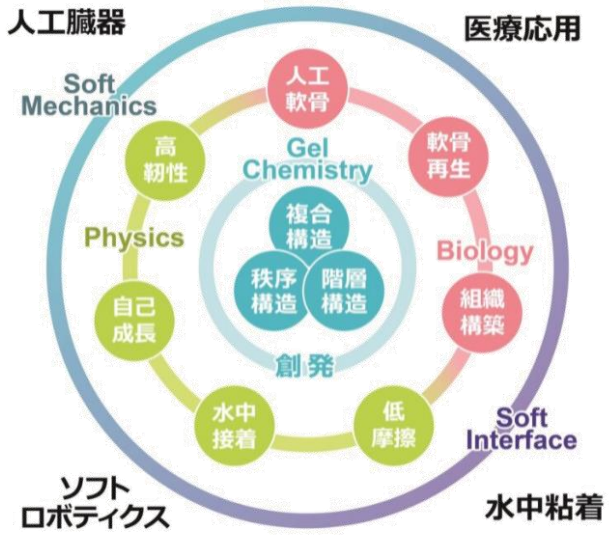
➢ 生物医用材料 Biomedical materials

生物医用聚合物 Biomedical polymers

Laboratory of Soft & Wet Matter

GONG Jian Ping

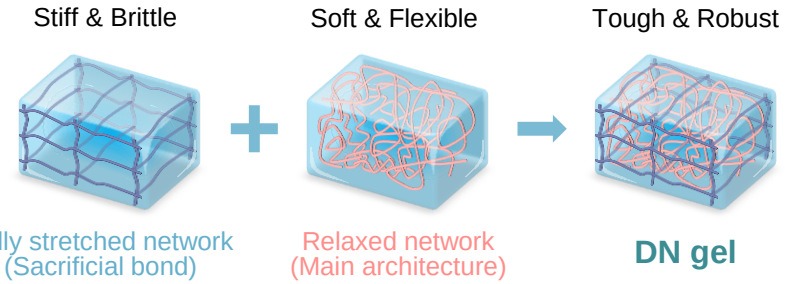
受生物结构启发，创造和应用具有优异功能的聚合物凝胶 The creation and application of polymer gels with excellent functions inspired by biological structures



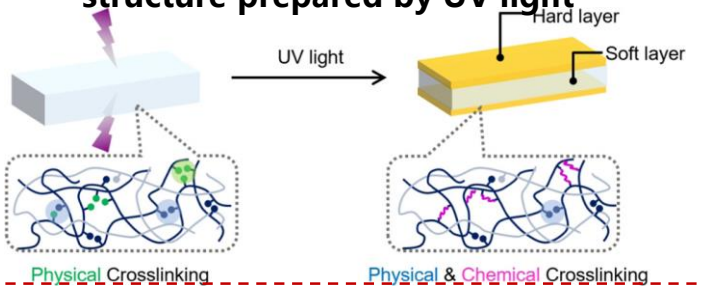
高韧性双网络水凝胶

Acs Appl Mater Interfaces

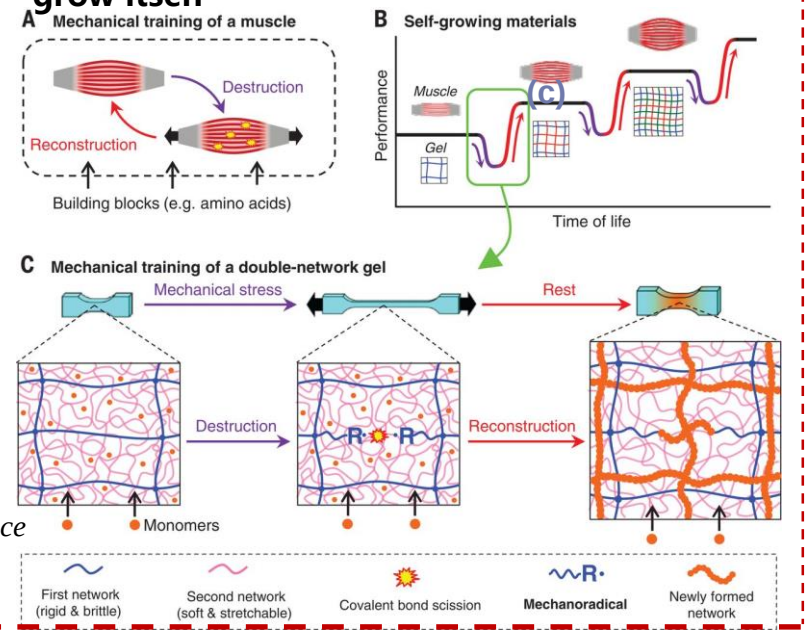
(a) 双网络水凝胶结构
Double network hydrogel structure



(b) 紫外光制备夹层结构坚韧水凝胶
Tough hydrogels with sandwich structure prepared by UV light

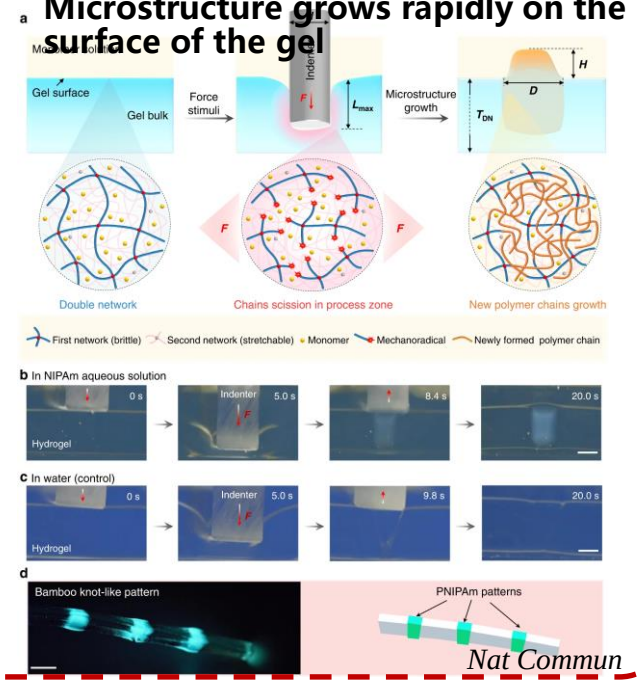


(c) 机械训练诱导的材料自我生长
Mechanical training induces material to grow itself



Science

(d) 凝胶表面上快速生长微观结构
Microstructure grows rapidly on the surface of the gel



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日本BM最新进展 Latest progress of Japanese BM

➢ “Kenzan”球状体生物3D打印 “Kenzan” spheroid bio-3D printing

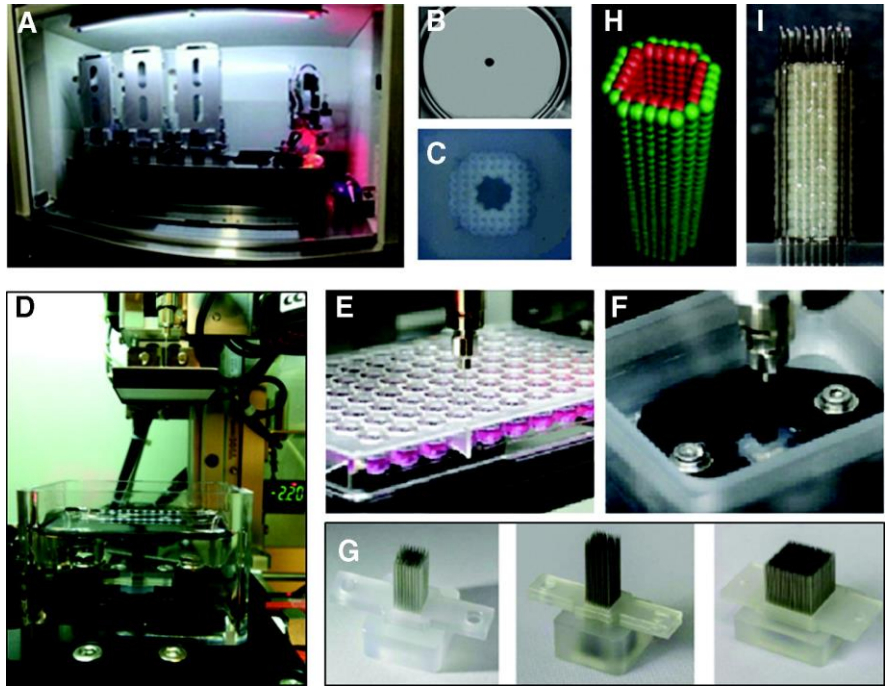
Nakayama Lab首次推出基于微针（“Kenzan”）的球体组装工艺，可直接精确地“打印”细胞球体，不依赖于支架，保证高生物兼容性

Nakayama Lab first introduced a microneedle-based (" Kenzan ") sphere assembly process that accurately "prints" cell spheres directly, without relying on scaffolds, guaranteeing high biocompatibility

Koichi Nakayama

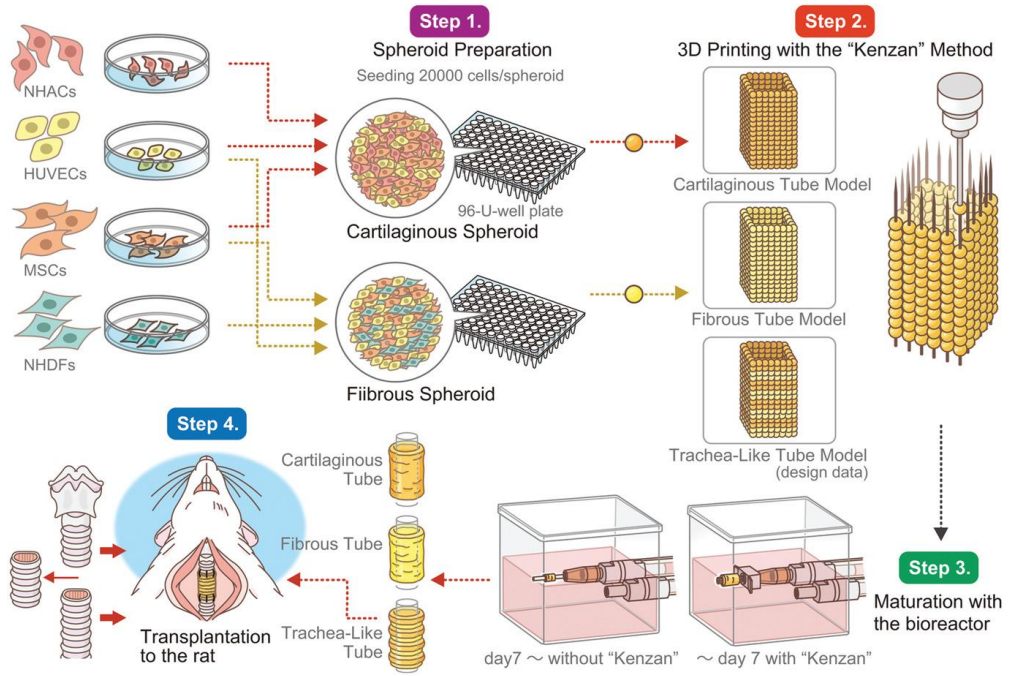
骨科、组织工程、再生医学、生物3D打印、生物制造
Orthopedics, tissue engineering, regenerative medicine, bio-3D printing, biofabrication

商业化生物打印平台 Commercial bioprinting platform



Tissue Eng Part B Rev

“Kenzan”生物3D打印人工气管 "Kenzan" bio-3D printed artificial trachea

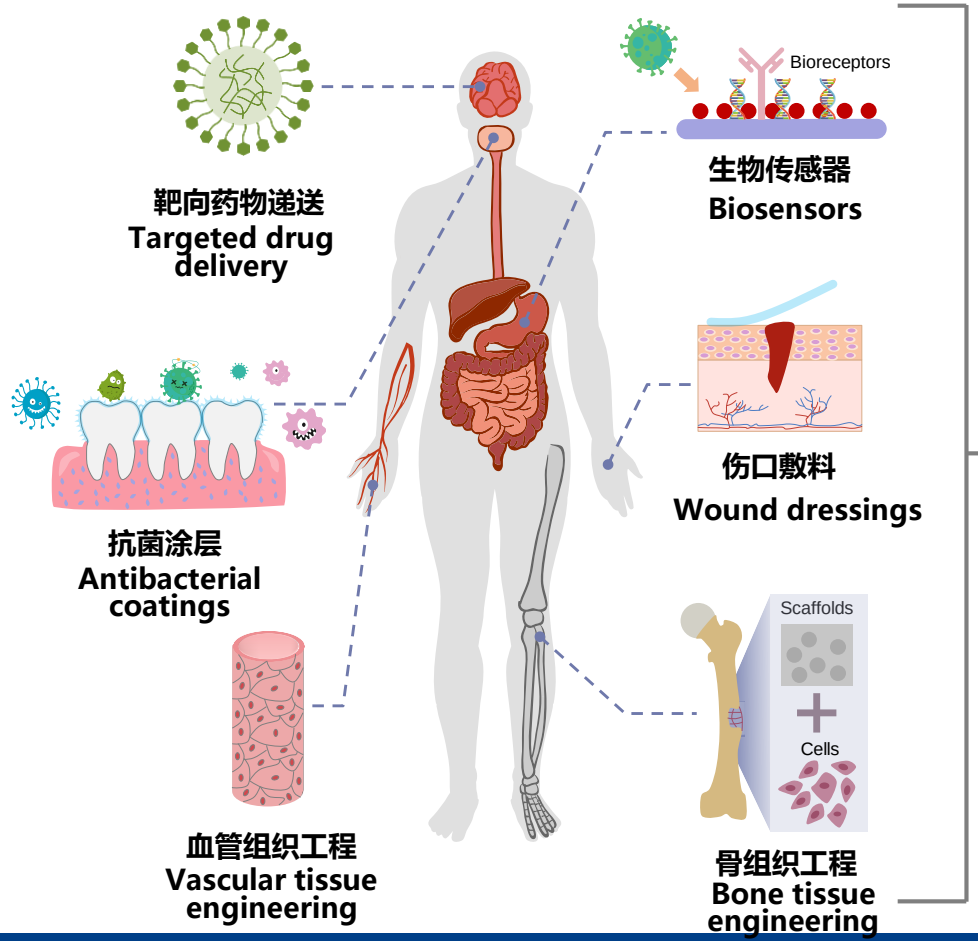


Adv Healthcare Mater

日本BM最新进展 Latest progress of Japanese BM

➢ 生物医学应用 Biomedical applications

“产-学-研”发展模式下生物制造研究成果产业化效率高
The industrialization efficiency of bio-manufacturing research results is high under the development mode of "production-learning-research"

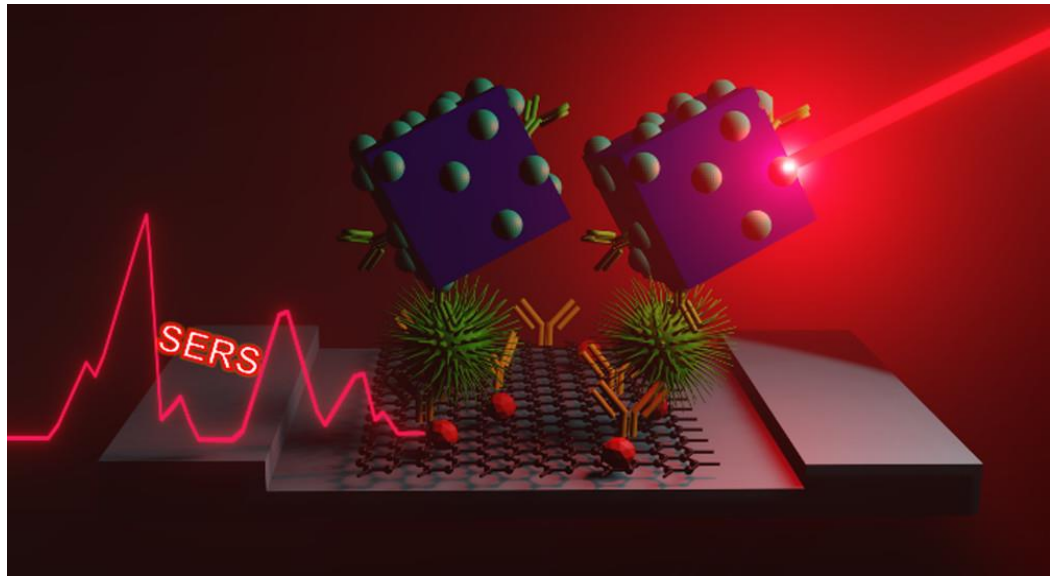


产业化生物医学产品
Industrialization of biomedical products

3 总结 Conclusion

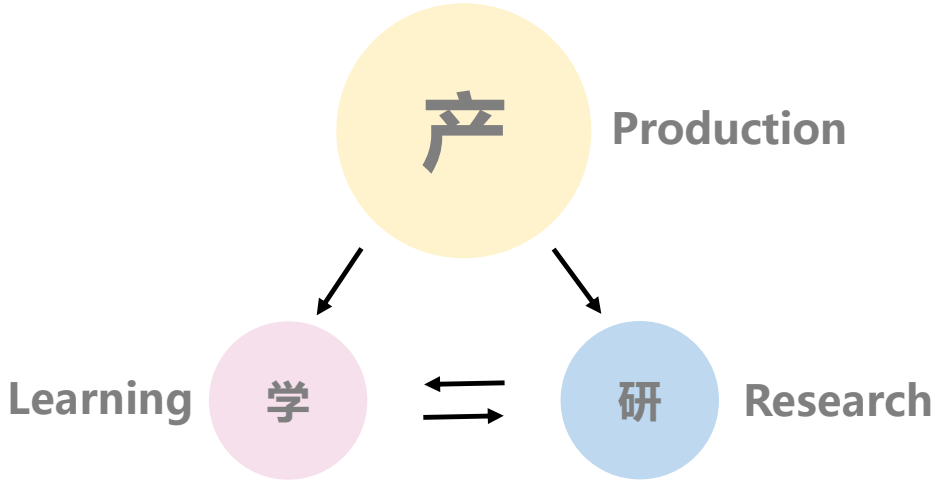
日本BM发展的特点 Characteristics of BM development in Japan

- **强调纳米技术研究的重要性**
  Emphasizing the importance of nanotechnology
- **生物医学成果产业化的领跑者**
  A leader in the industrialization of biomedical achievements



日本BM存在的缺陷 Defects of Japanese BM

- **过度依靠企业发展需求引导研究**
  Over-reliance on enterprise development needs to guide research
- **基础前沿领域发展不突出**
  Progress in basic frontier areas has not been outstanding



日本BM值得借鉴的地方 We can learn from BM in Japan

- **强调技术创新性** Emphasis on technological innovation
- **研究与商业结合** Research meets business

THANKS

谢谢观看，恳请批评指正