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Replacement as an aging intervention

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Substantial progress in aging research continues to deepen our understanding of the fundamental mechanisms of aging, yet there is a lack of interventions conclusively shown to attenuate the processes of aging in humans. By contrast, replacement interventions such as joint replacements, pacemaker devices and transplant therapies have a long history of restoring function in injury or disease contexts. Here, we consider biological and synthetic replacement-based strategies as aging interventions. We discuss innovations in tissue engineering, such as the use of scaffolds or bioprinting to generate functional tissues, methods for enhancing donor–recipient compatibility through genetic engineering and recent progress in both cell therapies and xenotransplantation strategies. We explore synthetic approaches including prostheses, external devices and brain–machine interfaces. Additionally, we evaluate the evidence from heterochronic parabiosis experiments in mice and donor–recipient age-mismatched transplants to consider whether systemic benefits could result from personalized replacement approaches. Finally, we outline key challenges and future directions required to advance replacement therapies as viable, scalable and ethical interventions for aging.

Despite substantial advancements in aging research, a complete understanding of what causes aging remains elusive[1]. Decades of study have revealed numerous biological changes associated with aging, yet the intricate interplay among these factors continues to confound a definitive explanation[2–4]. The human body's regenerative capabilities progressively diminish with age, further complicating efforts to counteract degenerative processes. This enduring uncertainty has inspired a shift away from strategies that solely aim to slow or repair molecular damage toward innovative approaches that replace compromised tissues and systems with engineered alternatives. Rather than addressing each deteriorative process in isolation, these emerging replacement-based strategies offer a promising avenue to restore functionality and overcome the limitations of conventional interventions (Fig. 1).

Replacement therapies have targeted age-related decline for centuries (Fig. 2). Early prosthetics, such as wooden toes from ancient Egypt or Etruscan dentures, aimed to restore function[5,6]. Advances such as eyeglasses, ear trumpets and blood transfusions laid the groundwork for modern therapies[7–9]. By the 20th century, replacement therapies became more targeted. Cornea transplants addressed blindness resulting from corneal disease or injury[10]. Joint replacements offered effective solutions for degenerative conditions such as osteoarthritis[11]. Pacemakers transformed cardiac care by regulating heart rhythms[12], and dialysis machines substituted kidney function for patients with end-stage renal disease[13]. Hematopoietic stem cell (HSC) transplantation provided life-saving treatment for hematologic conditions through replenishment of the immune system[14]. In 1955, the first successful organ transplant used a kidney from a deceased donor[15]. Today, solid organ transplants are commonplace, with over 44,000 procedures performed annually in the USA[16]. These advancements turned previously fatal conditions into treatable diseases, considerably improving health and extending lifespan for many patients.

This Perspective explores both biological and synthetic replacement technologies, examining their potential for broader aging interventions. We discuss advancements aimed at making replacement interventions accessible as preventative treatments for aging, with the

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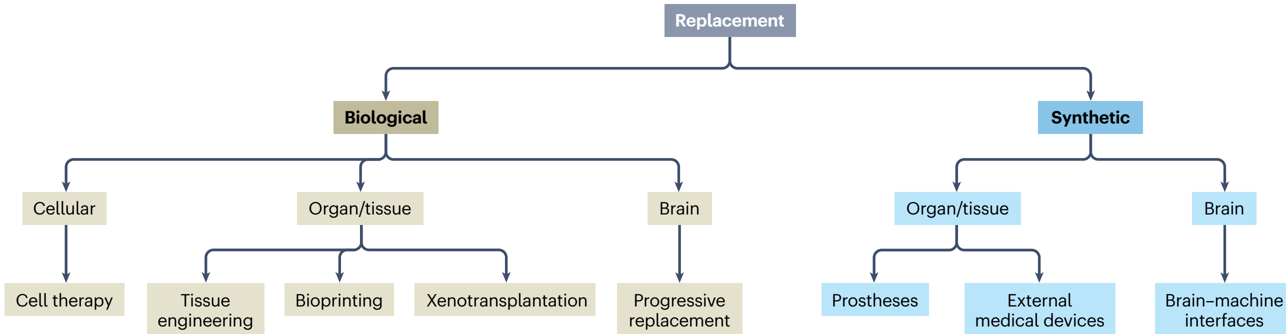

Fig. 1 | Overview of approaches for replacement interventions in aging. Approaches at the cellular level, the organ–tissue level and the brain. A combination of biological and synthetic interventions may be required for multitissue replacement. Note that the brain is an organ, but we have chosen to classify it separately for the sake of clarity.

goal of extending healthy lifespan, defined as both the total duration of life and the proportion spent in good health. Established practices such as joint replacements and prosthetics could be adapted to replace cells, tissues and even parts of the brain. As these methods continue to evolve, they offer alternative strategies for targeting aging, improving patient care and making therapies more accessible. Building on the foundational understanding of aging mechanisms, this Perspective examines modern replacement technologies as potential solutions to extend healthy lifespan while addressing challenges of accessibility and scalability.

Replacement therapies for aging: evidence and feasibility

Transplantation as a foundation for replacement interventions

Solid organ transplantation restores function and extends life, serving as a foundation for replacement therapies in aging. Solid organ transplantation often involves heterochronic transplantation or donor–recipient age-mismatched transplants, where outcomes are influenced by both donor and recipient age. Young recipients of aged organs face higher risks of acute rejection and primary graft dysfunction[17], and older recipients generally experience reduced rejection rates, due to an age-related dampened immune response[17].

Older grafts in younger recipients can lead to challenges such as primary nonfunction and vascular damage, with liver transplants often presenting additional biliary complications[18]. While older grafts may show reduced survival, their impact often depends on the age gap between donor and recipient, with larger gaps being more important in younger recipients. Long-term survival rates decrease when young recipients receive organs from donors over 10 years older, compared with receiving age-matched or younger organs[19]. However, these effects may be confounded by absolute organ age rather than donor–recipient mismatches. Controlling for absolute age, independent of mismatch, is essential to understand the role of intrinsic organ aging.

Additionally, heterochronic transplantation of hearts, kidneys and livers reduces lifespan of young recipients receiving aged organs[20,21]. Despite these risks, older grafts remain viable options when carefully matched with appropriate recipients. These observations highlight the effect of donor age on recipient health and underscore the need for further research into donor age and pre-existing damage. While solid organ transplantation is a foundational replacement therapy, experimental models such as heterochronic parabiosis (HPB) offer valuable insights into the rejuvenating effects of youthful environments.

Evidence from HPB

Experiments with heterochronic tissue and blood-sharing models suggest that exposure to a youthful systemic environment may extend lifespan. Introducing young circulatory components to older animals reverses aging biomarkers such as inflammation and stem cell decline[22–24]. In a pioneering 1989 study, muscle transplantation between young (2–3 months old) and aged (24 months old) rats demonstrated that young muscle grafted into old rats retained its regenerative abilities[25].

HPB, in which an old organism and a young organism share circulation, extends lifespan in aged organisms by rejuvenating aged cells through exposure to a youthful environment. In one study, after 3 months of HPB and 2 months of separation, old mice exhibited improved physiological conditions and increased lifespan[26]. Longer exposure correlated with greater rejuvenation, supported by epigenetic aging clocks that revealed lasting effects even after separation.

Additionally, HPB restores Notch signaling activation, along with the proliferation and regenerative capacity of aged satellite cells. Notch signaling, essential for regulating satellite cell activity and fate determination, diminishes with age, leading to impaired muscle regeneration[27]. Numb, an antagonist of Notch signaling, is asymmetrically distributed during satellite cell division, ensuring that one daughter cell promotes differentiation into myogenic lineages while the other retains its progenitor state[28]. Components in young serum can reverse molecular and cellular aspects of age-related decline in satellite cell activation, whereas old serum impairs muscle repair[27].

Beyond muscle tissue, HPB has improved function in the liver[27], the central nervous system[29], bone[26], the heart (hypertrophy)[30] and the brain (Alzheimer's disease)[31]. In aged mice, HPB reverses age-related cognitive impairments and synaptic plasticity deficits, enhancing memory and learning[23]. These effects appear mediated by the cyclic adenosine monophosphate response in the aged hippocampus.

Although these findings are compelling, it is important to acknowledge potential confounding factors in HPB studies. These might include stress from the surgical procedure, inflammatory responses, immune interactions and possible metabolic or behavioral changes due to restricted mobility. Beyond experimental models, practical considerations such as the invasiveness of procedures, immune compatibility and the scalability of current replacement methods must be addressed to translate these findings into clinical applications.

It is also clear that HPB, as conducted in mice, cannot be applied to humans. Efforts to identify specific rejuvenating factors in the blood of young animals have had mixed success to date[32]. Initial attempts to transfuse the blood or plasma of young individuals into older ones were terminated by the Food and Drug Administration (FDA) due to the risks associated with blood transfusions[33]. Another possibility is that HPB works through the removal of noxious factors or metabolites in the blood of the old animal, achieved simply via a dilution effect. Recently, therapeutic plasma exchange, a process that isolates blood cells from plasma and reinfuses only the cells, replacing the old plasma with a saline solution enriched with albumin and immunoglobulins, has shown early evidence of benefit in a recently reported

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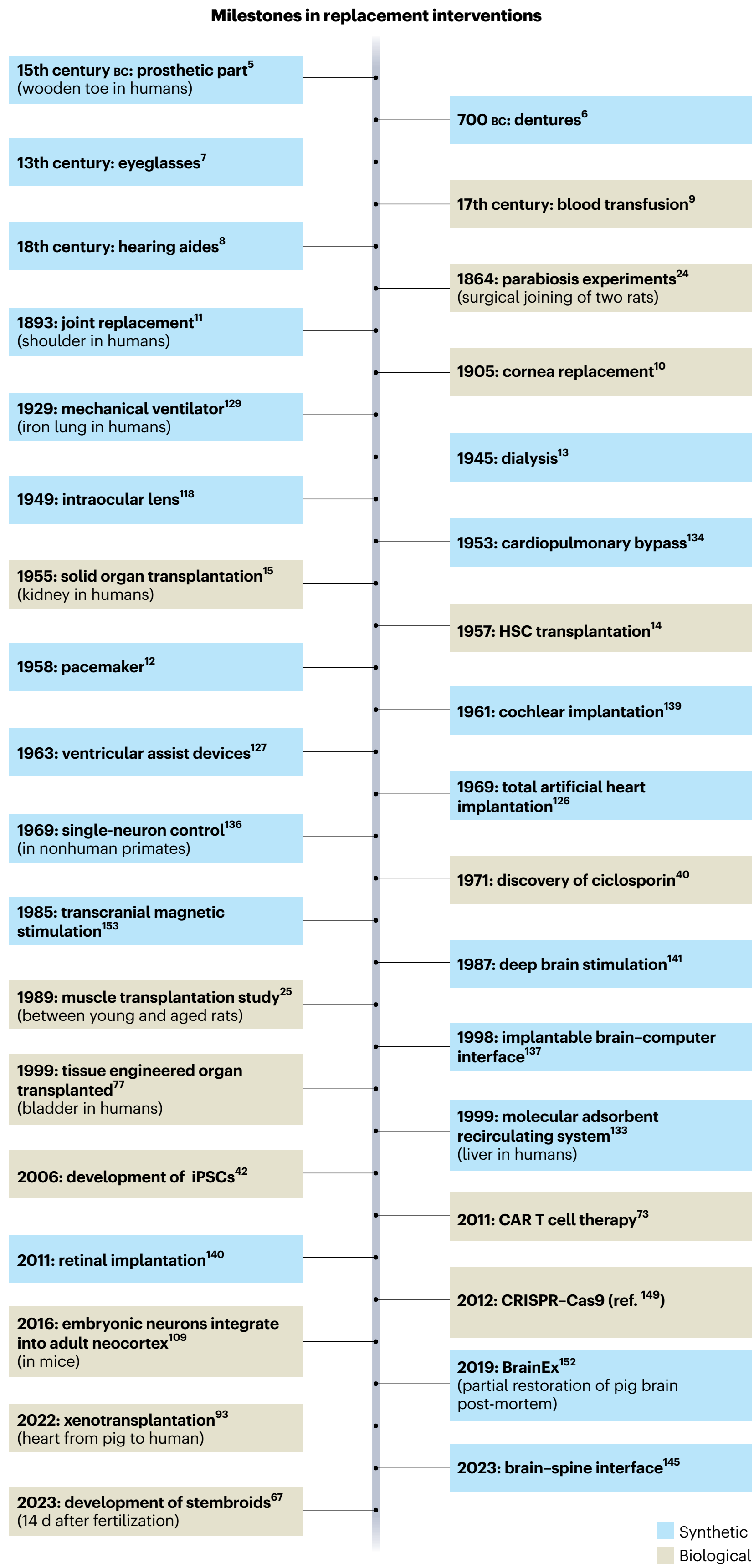

Fig. 2 | Timeline of milestones in replacement interventions for aging. Important milestones in the development of replacement interventions, spanning from ancient prosthetics to modern biotechnological advances. Each milestone is categorized as either biological (brown) or synthetic (blue), highlighting the interplay of these approaches over time. Events are presented chronologically, showcasing advancements in the cellular, organ–tissue and brain categories as well as key technologies that have supported these developments.

clinical trial. The multiomic study found that a biweekly therapeutic plasma exchange protocol supplemented with intravenous immunoglobulin significantly rejuvenated biological age, evidenced by improvements across various epigenetic clocks and molecular markers, with no negative effects reported[34].

Feasibility of replacement therapies for aging

Current methods for organ and tissue replacement are effective but invasive and generally reserved for severe conditions. These methods are often insufficient to meet demand, as evidenced by over 100,000 individuals on the US organ transplant list (https://www.organdonor.gov/). Even for recipients, substantial post-transplantation challenges persist[35], including graft-versus-host disease[36], acute rejection[37], chronic rejection[38] and an increased infection risk due to immunosuppressive therapies[36]. Rejection rates also vary by organ, with kidney, heart and pancreas transplants facing higher rejection rates than liver transplants[39].

Human leukocyte antigen matching traditionally lowered rejection risk in transplantation. However, even in kidney transplantation, its importance has been reduced due to advancements in immunosuppressive therapies and desensitization protocols[40]. These innovations have enabled transplants with less-compatible donors, although lifelong immunosuppressive regimens to prevent rejection and maintain graft function remain necessary[41]. Emerging approaches, such as induced pluripotent stem cells (iPSCs) and clustered regularly interspaced short palindromic repeats (CRISPR)-based genetic editing, show promise for reducing these complications. iPSCs mitigate immune rejection by using the patient's own cells[42], and CRISPR enables precise genome modifications to correct defects or enhance compatibility of allogeneic or xenogeneic cells[43].

Aging does not uniformly affect all organs. Plasma proteome analyses reveal that 20% of the population experiences accelerated aging in one organ, and 1.7% show multi-organ aging[44]. Interorgan communication networks are essential for maintaining systemic homeostasis during stress or injury, involving soluble factors, extracellular vesicles and circulating cells that facilitate cross-talk between tissues[45]. Key organs, such as the liver and endocrine glands, regulate metabolism, hormonal signaling and inflammation. Mesenchymal stromal cells mobilize to injury sites, releasing molecules that promote local repair while also influencing distant organs[46]. Targeting key organs involved in interorgan communication could serve as a 'minimum unit of replacement,' potentially triggering systemic benefits[47].

Plasma proteomic biomarkers could help to prioritize replacing rapidly aging organs before critical dysfunction. For instance, replacing a rapidly aging kidney might mitigate systemic declines without broader interventions. By contrast, multi-organ aging may require an integrated approach, addressing multiple systems to prevent cascading failures. This personalized strategy could enhance resource efficiency and ensure that replacement therapies deliver maximum benefits for healthy lifespan extension while avoiding unnecessary procedures (Fig. 3).

Biological advancements and biomaterials are also shaping the future of replacement therapies. Innovations in bioreactors, microfluidics and high-performance bioprinters have advanced organ scaffolding and tissue engineering[15,48]. Greater understanding of biological systems, such as the immune system[49] and the brain[50], alongside computational biology and machine learning, continues to advance replacement therapies.

However, challenges remain, particularly for aging populations undergoing invasive surgeries. Older patients face increased risks of cognitive decline and infections after major surgeries, such as a heart transplant or hip replacement[51]. These complications probably result from inflammatory responses to surgical trauma and reduced recovery capacity[51]. While clinical follow-ups often focus on survival during the first month after discharge, emerging studies are systematically monitoring cognitive and physical function over longer periods[52]. With these feasibility considerations in mind, we next explore biological strategies to harness the body's regenerative capacities.

Biological approaches for replacement therapies

Harnessing cellular therapies for aging interventions

Cell therapies, already approved by the FDA for diseases such as cancers and autoimmune conditions (Table 1), include stem cell-based therapies (for example, HSC transplantation and mesenchymal stromal cell transplantation) and non-stem cell-based therapies (for example, pancreatic islet[53] or hepatocyte transplantation[54]). Immune cell therapies, such as chimeric antigen receptor (CAR) T therapy, are also in use[55]. Cell therapies offer distinct advantages over gene therapies by enabling multiplex editing and proofreading of somatic cells ex vivo. This avoids ethical concerns of germline editing, as changes are not heritable, and reduces the regulatory burden and time frames associated with clinical trials for germline-targeted therapies[56,57].

HSC transplantation treats hematologic diseases such as acute leukemia, lymphoma and inherited blood disorders (such as sickle cell disease)[49,58]. Additionally, it is effective for nonhematologic conditions, including rare genetic disorders such as Wiskott–Aldrich syndrome and severe combined immunodeficiency, for which early intervention can be curative. HSC transplantation has also been used experimentally for autoimmune diseases such as rapidly progressive multiple sclerosis and systemic sclerosis[59,60]. The process involves ablation of malignant cells, healthy HSC collection, transplantation and engraftment. For allogeneic transplants, graft-versus-host disease management is crucial.

Current ablation methods are highly invasive and typically reserved for patients for whom no other treatments are effective. Emerging approaches, such as anti-CD117 antibody–drug conjugates, have demonstrated initial efficacy but require validation[61]. Although not yet clinically approved, these innovations could transform HSC transplantation into a minimally invasive option for aged but otherwise healthy individuals.

Cell niches or microenvironments are crucial for maintaining stem cell function and regenerative potential, essential for successful replacement therapies. Aging alters niches through extracellular matrix stiffening, inflammation and disrupted signaling, which all impair stem cell activity[62]. Rejuvenating niches, by blocking inflammatory cytokines such as TNF and TGF-β or reducing matrix stiffness, can restore stem cell function and regenerative capacity[62].

Cellular therapies also hold promise for age-related conditions such as age-related macular degeneration and osteoarthritis. For age-related macular degeneration, iPSC-derived retinal pigment epithelium cells support photoreceptor survival and can partially restore visual function in damaged retinal tissues[63]. Similarly, mesenchymal stromal cell transplantation has yielded encouraging results in treating osteoarthritis by reducing inflammation and improving joint function when delivered directly into the joint[64].

Furthermore, an important challenge for cellular replacement therapies is sourcing cells. Autologous cell therapies use cells collected from the recipient that can be expanded or reprogrammed into iPSCs and differentiated into the desired cell type. However, some cell types are difficult to produce due to expensive or complex differentiation and expansion protocols[65].

Stembroids, structured stem cell-based embryo models, offer an alternative for generating autologous cells. Stembroids can reproduce nearly all lineages and compartments of post-implantation human embryos[66]. They provide a source of autologous cells without the barriers or additional steps associated with stem cell differentiation protocols, making them suitable for various types of applications. To date, scientists working with Renewal Bio have successfully grown stembroids up to 14 d after fertilization[67]. With advancements in culture conditions, seeding densities and vascularization, it may become possible to extend development further. This extension would grant access

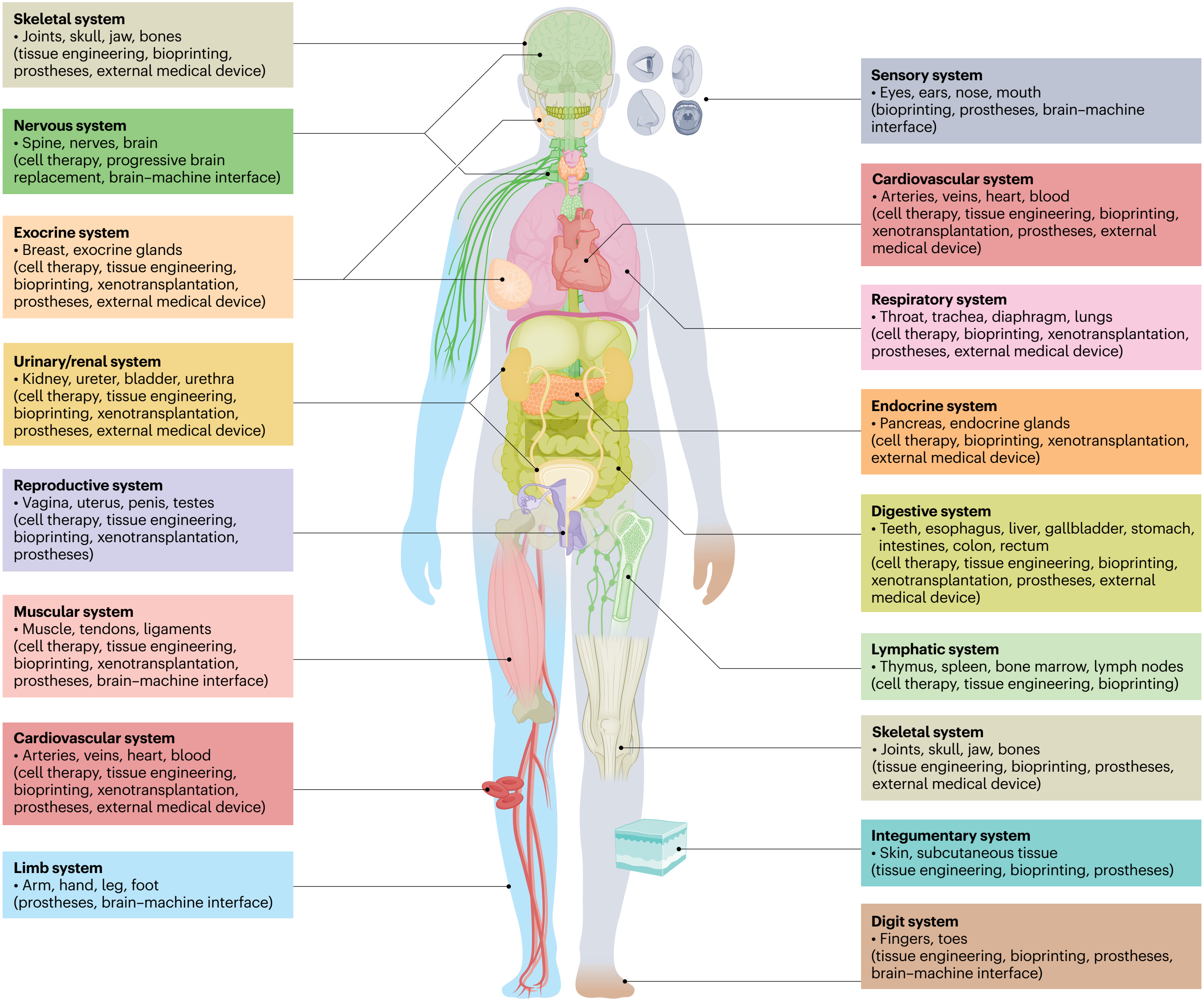

Fig. 3 | Overview of anatomical systems and potential replacement methods. This schematic maps potential replacement methods to key anatomical systems in the human body. Examples include the skeletal system (for example, prostheses for joint replacements), the nervous system (for example, brain–machine interfaces for neural implants) and the urinary–renal system (for example, xenotransplantation for the kidney). Color-coded anatomical icons emphasize the diversity of potential synthetic and biological replacement technologies aimed at addressing aging. Note that, although the figure highlights many organs and body parts, not every structure or potential replacement approach is represented. Adapted from an original created in BioRender. Vega, G. (2025) https://BioRender.com/m80t259.

to cell types that are difficult to achieve through iPSC differentiation protocols alone, such as liver cells after 23 d[68], HSCs between days 27 and 40 (ref. 69), oocytes after 70 d[70] and beta cells after 84 d[71].

Nonstem cell therapies, such as pancreatic islet transplantation, are also effective. Pancreatic islet transplantation was approved by the FDA in 2023 for treating adults with type 1 diabetes who do not achieve target glycated hemoglobin levels[72]. This minimally invasive approach involves isolating pancreatic islets from a deceased donor and infusing them into the recipient's liver via a percutaneous trans-hepatic procedure. The islets engraft and begin producing insulin, regulating blood glucose levels. Despite requiring anti-rejection medications, 85% of recipients remain insulin independent after 1 year[53]. Improved iPSC-derived beta cells could extend this approach to prevent age-related pancreatic decline without immune rejection, extending healthy lifespan.

Immunotherapies are a separate subcategory of nonstem cell therapies. Among them, CAR T therapy has been highly successful in reducing fatalities from hematological cancers, such as leukemias and lymphomas. CARs are synthetic receptors designed to recognize specific antigens on cancer cells and induce signaling pathways that activate immune responses. First conceptualized in the late 1980s, CAR T therapy was approved by the FDA in 2017 (ref. 73). The process involves collecting a patient's T cells, genetically modifying them ex vivo to express CARs, expanding the modified cells and reinfusing them back into the patient. The engineered CAR T cells home to cancer cells, bind to them via the CARs and activate intracellular signaling cascades that drive their destruction[73] (Fig. 4a).

Beyond oncology, CAR T therapy is being investigated for autoimmune diseases, with CARs typically designed to deplete autoreactive B cells that drive autoantibody production. Early clinical trials have reported beneficial outcomes for diseases such as lupus and multiple sclerosis[74]. Additionally, efforts to target regulatory T cells aim to restore immune balance by suppressing overactive immune responses, potentially expanding CAR T applications to other autoimmune

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Table 1 | FDA-approved cell therapies and their current indications

Target	Indication	Therapy
Allogeneic HSC	Hematopoietic and immunologic reconstitution	OMISIRGE (omidubicel-onlv)
Allogeneic keratinocyte and fibroblast	Oral soft tissue regeneration for mucogingival conditions, severe burns	GINTUIT (allogeneic cultured keratinocytes and fibroblasts in bovine collagen), STRATAGRAFT (allogeneic cultured keratinocytes and dermal fibroblasts)
Allogeneic thymic tissue	Congenital athymia	RETHYMIC (allogeneic processed thymus tissue)
Autologous chondrocyte	Cartilage defects of the knee	MACI (autologous cultured chondrocytes on a porcine collagen membrane)
Autologous fibroblast	Cartilage defects of the knee	LAVIV (azficel-T)
CAR T	Multiple myeloma, large B cell lymphoma, melanoma, mantle cell lymphoma	ABECMA (idecabtagene vicleucel), BREYANZI (lisocabtagene maraleucel), CARVYKTI (ciltacabtagene autoleucel), KYMRIAH (tisagenlecleucel), TECARTUS (brexucabtagene autoleucel), YESCARTA (axicabtagene ciloleucel)
Cord blood stem cell	Hematopoietic and immunologic reconstitution	ALLOCORD (HPC, cord blood), CLEVECORD (HPC, cord blood), Ducord (HPC, cord blood), HEMACORD (HPC, cord blood), HPC, cord blood (MD Anderson Cord Blood Bank), HPC, cord blood (LifeSouth), HPC, cord blood (Bloodworks)
Dendritic cell-based immunotherapy	Prostate cancer	PROVENGE (sipuleucel-T)
Gene-mediated immunotherapy	High-grade, BCG-unresponsive nonmuscle invasive bladder cancer (gene-mediated immunotherapy)	ADSTILADRIN (nadofaragene firadenovec-vncg)
Modified autologous HSC	Metachromatic leukodystrophy, sickle cell disease, cerebral adrenoleukodystrophy, β-thalassemia	LENMELDY (atidarsagene autotemcel), LYFGENIA (lovotibeglogene autotemcel (lovo-cel)), SKYSONA (elivaldogene autotemcel), ZYNTEGLO (betibeglogene autotemcel)
Pancreatic islet	Type 1 diabetes	LANTIDRA (donislecel)
TCR T cell	Synovial sarcoma	TECELRA (afamitresgene autoleucel)
Tumor-infiltrating lymphocyte	Metastatic melanoma	AMTAGVI (lifileucel)

Information from ref. 60. BCG, Bacillus Calmette–Guérin; HPC, hematopoietic progenitor cell; TCR, T cell receptor.

diseases, chronic infections and tissue repair[55]. Although cellular therapies enable targeted replacement, addressing the complexity of entire organs may require advancements in tissue engineering, bioprinting or xenotransplantation.

Organ and tissue replacement approaches

Engineering functional tissues and organs

Tissue engineering integrates cells, biomaterials and bioprinting technologies to develop functional tissues and organs. The process typically begins by isolating and expanding cells ex vivo and then seeding them onto biodegradable scaffolds that provide structural support[15].

Scaffolds, serving as temporary structural frameworks, can be constructed from natural materials (for example, collagen and hyaluronic acid) or synthetic polymers (for example, polyglycolic acid and poly(lactic-co-glycolic acid)[75]). The composition substantially influences cell proliferation, differentiation and tissue-specific function. Techniques such as electrospinning produce nanofibers, mimicking the extracellular matrix for cell attachment and organization. Natural scaffolds can be obtained through decellularization by removing cells from donor organs while preserving the extracellular matrix structure using detergents, physical treatments and enzymes to remove cellular components, followed by sterilization to ensure safety[76].

Once the scaffold is prepared, it is seeded with cells, which proliferate and differentiate to form functional tissue constructs. This approach has been applied in clinical settings for tubular and hollow nontubular organs, such as urethras, vaginas and bladders, showing sustained function in the long term[76–80]. These successes demonstrate the feasibility of engineered organs and establish a foundation for advancing strategies to address more-complex solid organs. Engineered constructs can aid wound healing, with engineered skin accelerating ulcer recovery in aging patients[81]. Another example is engineered esophageal tissue, which could address age-related strictures or resections[82].

As the field advances towards solid organs, such as the liver, the heart or kidneys, challenges arise in replicating precise vascular structural organization, which remains difficult with conventional tissue-engineering methods alone[83].

Bioprinting advances for organ development

To overcome these challenges, bioprinting has emerged as a promising strategy, offering high precision in spatially placing cells and biomaterials to replicate intricate tissue architectures. Extrusion-based bioprinting, which uses pressure-assisted systems to dispense bioinks, is widely used for scaffold generation, achieving resolutions of 150–350 μm[75]. Scaffold-free approaches, such as using organ building blocks, composed of 10^4 cells of a single type, support formation of multicellular constructs, allowing for the recreation of more-complex tissues. Another important advantage of using organ building blocks is the reduced build time, enabling bioprinting to occur within the window of cell viability[84].

Bioprinting builds on the principles of engineering simpler tissues, such as skin and cartilage, which are already clinically used. However, recreating fine vasculature remains a major obstacle[15]. Lack of vascular networks causes necrosis in tissues larger than a few millimeters. Embedded bioprinting techniques, such as sacrificial writing into functional tissue[85], address this problem (Fig. 4b). Sacrificial inks are printed within the tissue matrix and, upon removal, leave behind a perfusable network that supports long-term tissue viability.

Bioprinting offers a novel avenue for addressing aging-related organ failure and tissue degeneration of solid vascularized organs. For instance, bioprinted kidneys, for conditions such as chronic kidney disease, could reduce dependence on dialysis and help address donor shortages[75]. Cardiac patches may provide a way to repair heart damage from myocardial infarction or heart failure, and advances in vascularized bioprinting raise the possibility of producing fully functional hearts for transplantation in the future[86]. Similarly, bioprinted livers could support metabolic function in patients with cirrhosis, and bioprinted lung tissues may offer new options for treating conditions such as chronic obstructive pulmonary disease and pulmonary fibrosis[75].

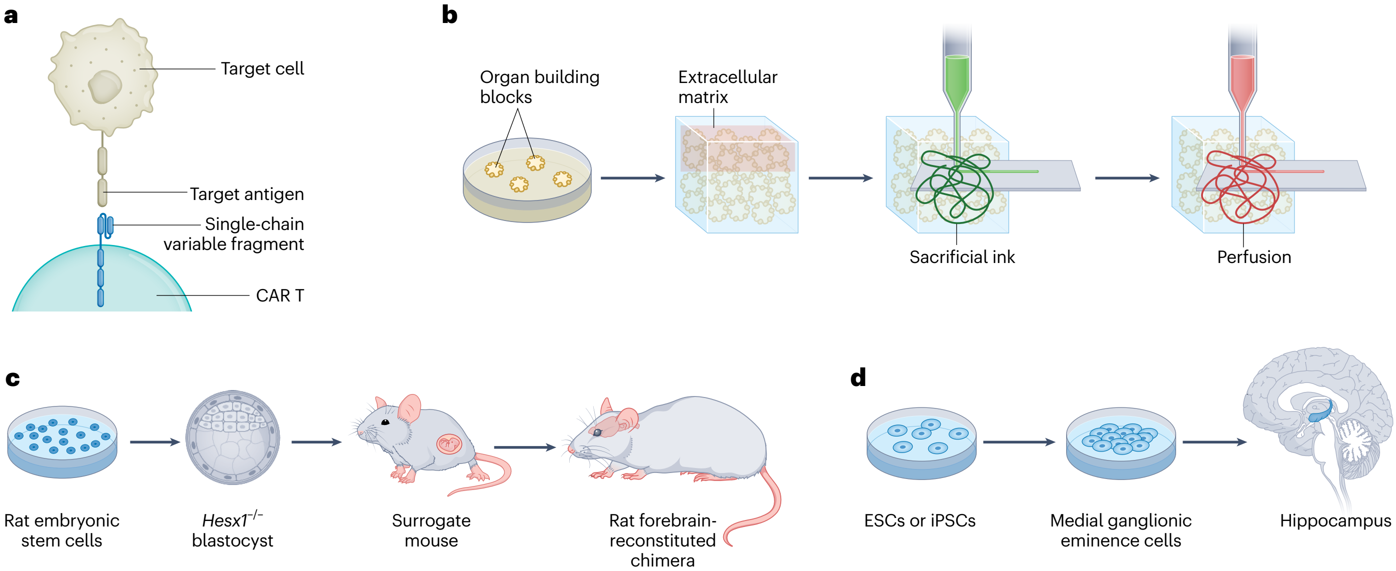

Fig. 4 | Overview of mechanisms and generation techniques within each category of biological replacement. a, Mechanism of CAR T cellular therapy designed to recognize a specific antigen on the target cell. The CAR is composed of an extracellular single-chain variable fragment, which binds to the target antigen on the surface of the target cell. The intracellular domain of the CAR includes signaling molecules that trigger activation, leading to selective immune cell responses to destroy the target cell. **b**, Bioprinting process using organ building blocks and the extracellular matrix. The organ building blocks are grown and printed into an extracellular matrix solution, and a sacrificial ink is printed into the tissue matrix to allow for vascular perfusion. **c**, The generation of a rat forebrain-reconstituted chimera in a mouse using CRISPR–Cas9 gene editing. Rat embryonic stem cells are injected into the *Hesx1*$^{-/-}$ blastocyst and implanted into a surrogate, resulting in the chimeric organism. **d**, Generation of medial ganglionic eminence cells derived from embryonic stem cell (ESC) or iPSC culture, used for replacement of hippocampus tissue in the forebrain. Adapted from an original created in BioRender. Vega, G. (2025) https://BioRender.com/m95b561.

However, a critical barrier is scaling up cell production for full-sized organs. Generating a clinically relevant organ may require up to 100 billion cells, highlighting the need for efficient cell expansion systems[84]. High-capacity bioreactors will be essential for producing these volumes, enabling the generation of patient-specific cells in the necessary quantities[87].

Xenotransplantation and cross-species organ use

Xenotransplantation provides a potential source of young, healthy organs from pigs due to their organ size compatibility, lower viral transmission risk and feasibility of genetic modifications to reduce immunogenicity[88]. Similar to bioprinting, xenotransplantation aims to address organ shortages in age-related diseases such as chronic kidney disease, heart failure, cirrhosis and chronic obstructive pulmonary disease. Bioprinting involves constructing organs from scratch, whereas xenotransplantation leverages genetic engineering to overcome immunological barriers.

Early kidney xenotransplant experiments in nonhuman primates used porcine donors with 69 edits (removing glycan antigens, overexpressing human transgenes and inactivating endogenous retroviruses), achieving survival up to 2 years[89]. Pig kidneys have also been transplanted into brain-dead human recipients, functioning for 54 h without rejection[90].

Long-term survival in nonhuman primates was first achieved using non-FDA-approved CD40 and CD154 blockade[91]; however, a more recent study showed that baboons receiving pig kidneys with ten genetic modifications survived a median of 261 d under FDA-compliant immunosuppression[92]. In March 2024, surgeons at Massachusetts General Hospital successfully transplanted a genetically modified pig kidney from eGenesis into a human patient[93]. Although the patient died 2 months later, the cause was believed to be unrelated to the xenotransplant.

Heart xenotransplantation has shown similar promise: heterotopically transplanted pig hearts in baboons survived up to 945 d, and orthotopically transplanted hearts supported life for up to 195 d[94]. Preservation methods influenced outcomes, with heart perfusion systems proving superior to crystalloid solutions in preventing overgrowth[94]. Pig-to-human heart xenotransplantation was performed in two brain-dead human recipients using donors with ten genetic modifications, with monitoring conducted for 66 h. One donor heart failed due to size mismatch, and the other was accepted by the recipient. In contrast to nonhuman primates, the absence of ex vivo perfusion was not a barrier to immediate graft function[95].

Chimerism, involving cells or tissues from two organisms, offers another potential path to generating human organs in large mammals with reduced rejection. Deleting genes, such as that encoding insulin-like growth factor 1 receptor in mouse embryos, creates a 'cell competitive niche' that avoids early developmental arrest and enables interspecies blastocyst complementation[96]. Optimized approaches, such as C-CRISPR-based blastocyst complementation, rapidly screen genes for organ development by injecting chimera-competent donor stem cells into mutant host blastocysts lacking specific developmental genes. This single-step process, combining multiguide RNA knockouts with blastocyst complementation, has produced rat forebrain tissue in mice, paving the way for generating human organs in other species[97] (Fig. 4c).

Future strategies could avoid killing sentient animals altogether. For example, *Lhx1*-knockout mice develop without anterior head structures despite normal body axis development[98]. Neural blastocyst complementation ablates neural progenitors, leaving an empty forebrain niche. These strategies could enable full organogenesis without neural tissue via somatic cell nuclear transfer.

Neural regeneration and replacement therapies

The brain presents unique challenges for replacement due to complex neural networks, the need for precise connectivity and limited neurogenesis in adults[99,100]. Replacing the entire brain at once is not feasible without losing an individual's self-identity[101]. However, progressive brain replacement has been proposed as a strategy to incrementally substitute parts of the brain with healthy tissue[102].

Clinically, stem cell-derived cells replace damaged brain tissue[103]. BlueRock's MSK-DA01 and Neurona's NRTX-1001, both in clinical trials, target Parkinson's disease and epilepsy, respectively[104,105]. MSK-DA01 uses embryonic stem cells to restore motor and nonmotor functions by replacing dopamine-producing neurons[104], and Neurona's NRTX-1001 involves transplanting γ-aminobutyric acid (GABA)ergic interneurons derived from pluripotent stem cells to reduce seizures[105] (Fig. 4d). These approaches may also benefit other age-related neurodegenerative conditions.

Emerging therapies also show potential for diseases such as Alzheimer's disease, Huntington's disease and amyotrophic lateral sclerosis. Neural progenitor transplantation improves memory and reduces amyloid-β plaques in Alzheimer's disease models[106]. iPSC-derived striatal neurons are being tested to replace medium spiny neurons lost in Huntington's disease[107], and stem cell-based therapies for amyotrophic lateral sclerosis, including spinal cord delivery of mesenchymal stromal cells or astrocyte progenitor cells, aim to support motor neurons and reduce neuroinflammation[108].

Early research into progressive brain replacement found that transplanted embryonic neurons integrate into adult neocortical circuits[109]. In mice, neocortical grafting led to functional tissue in the primary visual cortex capable of processing visual inputs within 4–8 weeks. Additionally, stem cell-derived cortical organoids transplanted into the somatosensory cortex of newborn rats integrated into circuits controlling sensory processing and behavior[110].

Advances in neuron layering, subtype composition and vascularization have improved graft integration[111]. However, replacing other brain cell types and white matter, including axonal tracts and myelin sheaths, remains challenging[112]. Addressing these challenges could accelerate treatments for central nervous system damage from strokes, trauma, neurodegeneration and aging. While current studies focus on integrating transplanted cells into existing host circuits, replicating lost neural networks with original connectivity and architecture remains a conceptual goal. Achieving this may require innovative solutions that combine biological and synthetic technologies.

Developing synthetic approaches for replacement

Redefining prostheses for functional restoration

Prostheses are synthetic replacements for body parts, including limbs, corneas, joints, maxillofacial structures, breasts and heart valves[113,114] (Table 2). Beyond replacing parts, they restore specific bodily functions. As brain–machine interfaces advance, prostheses could become more scalable, helping individuals with conditions such as diabetes, peripheral artery disease and congenital limb malformations. Additionally, prostheses may be used preventatively to extend healthy lifespan to counter muscle atrophy, improve balance and reduce falls and hospitalizations associated with aging[115].

Substantial advancements have occurred in limb prostheses. Soft robotics enhance upper limb dexterity, excelling in gripping and releasing, and hard prostheses perform better in unilateral movements[116]. Lower-limb prostheses require hard materials for stability, replicating knee, ankle and toe biomechanics[117].

Beyond limbs, prostheses include prosthetic teeth[6], intraocular lenses[118] and prosthetic joints for hips, knees (Fig. 5a) and shoulders[119]. Other examples include maxillofacial prostheses[120], breast prostheses[121] and prosthetic heart valves[122]. Some supporting prostheses consist of elastomeric sleeves with pneumatic actuators to restore heart pumping[123], artificial urinary sphincters for urethral control[124] and hydrogel scaffolds aiding skin regeneration[125].

Heart-focused prostheses represent an important category. With cardiovascular disease prevalent among older adults, these devices help to sustain heart function and extend lifespan. Implantable pacemakers regulate arrhythmias[12], and total artificial hearts, such as SynCardia or BiVACOR, replace ventricles in end-stage heart failure, serving as life-extending solutions or bridges to transplantation[126]. Similarly, ventricular assist devices also aid with blood pumping[127] (Fig. 5b).

External devices for sustaining vital functions

External medical devices replace bodily functions temporarily or long term in patients with organ failure or during surgeries. These devices can replace functions of entire organs due to age-related decline, including the lungs, pancreas, heart, liver or kidneys, substantially extending patient lifespan.

Extracorporeal membrane oxygenation supports lung function by oxygenating blood and removing carbon dioxide, providing life-saving support for patients with severe respiratory or cardiac failure[128]. Mechanical ventilators, more commonly used respiratory devices, assist breathing in conditions such as acute respiratory distress syndrome, chronic obstructive pulmonary disease or pneumonia or during anesthesia[129,130]. Insulin pumps and continuous glucose monitors manage pancreatic endocrine functions in patients with diabetes by monitoring blood glucose levels and administering insulin as needed[131].

Renal replacement therapies, including dialysis and portable wearable artificial kidneys, filter blood to remove waste and excess fluids[132]. Similarly, liver support systems such as the molecular adsorbent recirculating system[133] (Fig. 5c) and Prometheus provide extracorporeal blood detoxification in patients with liver failure[133]. Cardiopulmonary bypass, also known as the heart–lung machine, sustains circulation and oxygenation during cardiac surgeries by replacing heart and lung function[134]. Extracorporeal membrane oxygenation is used long term in critical care (Fig. 5d), and cardiopulmonary bypass is temporarily used during surgeries[134]. Finally, as biology and technology converge, brain–machine interfaces offer the potential to address age-related cognitive and motor deficits by combining neural and synthetic systems.

Brain–machine interfaces for neural restoration

Rejuvenating the brain is challenging due to complex neural networks, precise connectivity needs and limited adult neurogenesis. Brain–machine interfaces offer a potential synthetic solution. These interfaces establish communication between the brain and external devices to replace or augment neural signals, addressing cognitive or motor deficits seen in age-related conditions such as neurodegenerative diseases and frailty[135].

Brain–machine interfaces originated in 1969 when Eberhard Fetz demonstrated that a monkey could control the firing of a single motor cortex neuron to move a dial through reward-based learning[136]. This work laid the foundation for early motor devices functioning as rudimentary brain–machine interfaces. Later advancements introduced implantable multi-electrode arrays in the motor cortex[137], enabling control of devices such as computer cursors[138] and robotic arms[138] and movement restoration in individuals with paralysis[50] (Fig. 6a).

Beyond motor control, brain–machine interfaces have expanded to sensory enhancements. First used in 1961, cochlear implants have provided auditory restoration for individuals with hearing loss[139], and retinal implants, introduced in 2011, provide visual prostheses for blindness[140]. Deep brain stimulation represents another application of brain–machine interface technology (Fig. 6b). Deep brain stimulation delivers electrical impulses via implanted electrodes to modulate neural activity and treat conditions such as Parkinson's disease, dystonia, epilepsy and obsessive–compulsive disorder[141].

Although early brain–machine interfaces demonstrated encouraging outcomes, they were hampered by invasiveness, external wiring and constant power requirements. Recent innovations, such as Neuralink's fully implantable, wireless and battery-powered motor cortex chips, address these challenges. Neuralink's implant, with 1,024 electrodes and Bluetooth connectivity, processes and transmits neural data wirelessly. In 2024, Neuralink's PRIME study demonstrated full cursor control in a human using a chip implanted beneath the scalp, with no visible hardware.

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Table 2 | FDA-approved synthetic body parts for each anatomical system

System	Parts	Type	Indications
Limb	Leg	Prosthetic leg (above knee or below knee)	Replacement of absent or amputated leg
Limb	Arm	Prosthetic arm (above elbow or below elbow)	Replacement of absent or amputated arm
Limb	Foot	Prosthetic foot	Replacement of absent or amputated foot
Limb	Hand	Prosthetic hand	Replacement of absent or amputated hand
Digits	Toes	Prosthetic toes	Replacement of absent or amputated toes
Digits	Fingers	Prosthetic fingers	Replacement of absent or amputated fingers
Cardiovascular	Heart	Ventricular assist devices, total artificial hearts, elastomeric sleeves, pacemakers, cardiopulmonary bypass, implantable cardioverter defibrillators, mechanical heart valves, automated external defibrillator, intra-aortic balloon pump, septal occluder devices	Support or replace heart function in heart failure, rhythm management, support during surgery, valve replacement, emergency defibrillation, support for circulation
Cardiovascular	Arteries	Arterial stents, angioplasty balloons	Treat arterial blockages and stenosis
Cardiovascular	Veins	Venous stents, venous catheters, inferior vena cava filters	Treat venous blockages and stenosis, provide venous access, prevent pulmonary embolism
Digestive	Liver	Molecular adsorbent recirculating system, Prometheus system	Liver support in acute or chronic liver failure
Digestive	Esophagus	Esophageal stents	Treat esophageal blockages
Digestive	Stomach	Gastric bands, gastric balloons, gastrostomy tubes, gastric electrical stimulation devices	Weight loss, nutrition support and gastric motility disorders
Digestive	Intestines	Intestinal stents, enteral feeding tubes, ileostomy bags	Treat intestinal obstructions, nutritional support, manage ostomies
Digestive	Colon	Colonic stents, colostomy bags	Treat colonic obstructions, manage ostomies
Digestive	Gallbladder	Biliary stents, biliary catheters, cholecystostomy tubes, lithotripsy systems	Treat biliary obstructions, drain bile, manage gallbladder issues, fragment stones
Digestive	Rectum	Rectal stents, artificial bowel sphincter	Treat rectal obstructions, manage fecal incontinence
Digestive	Teeth	Dental implants, crowns, bridges, dentures	Replace missing or decaying teeth
Exocrine	Breast	Breast implants	Reconstructive breast surgery
Exocrine	Lacrimal glands	Punctal plugs, artificial tears	Manage dry eye syndrome, improve tear retention
Integumentary	Skin	Skin grafts, synthetic skin, hydrogel scaffolds	Wound coverage, skin regeneration
Integumentary	Subcutaneous tissue	Subcutaneous implants	Augmentation and repair of subcutaneous defects
Muscular	Muscle	Myoelectric prosthetic limbs, muscle implants, neuromuscular electrical stimulation devices	Limb replacement, muscle augmentation, improve muscle function
Muscular	Tendons	Synthetic tendon grafts	Tendon repair or replacement
Muscular	Ligaments	Synthetic ligament grafts	Ligament repair or replacement
Nervous	Spine	Spinal cord stimulators, artificial disks, vertebral augmentation devices, exoskeletons	Pain management, disk replacement, vertebral fracture stabilization, mobility enhancement
Nervous	Nerves	Synthetic nerve conduits, nerve wraps, nerve stimulators	Nerve repair, pain management, nerve function restoration
Nervous	Brain	Deep brain stimulators, neuroprostheses, cerebral spinal fluid shunt systems, brain–machine interfaces	Movement disorder treatment, brain function restoration, hydrocephalus management, assistive communication
Reproductive	Vagina	Vaginal mesh implants, vaginal pessaries	Pelvic organ prolapse treatment, vaginal support structure
Reproductive	Penis	Penile implants	Erectile dysfunction treatment
Respiratory	Lungs	Extracorporeal membrane oxygenation, mechanical ventilators, continuous positive airway pressure, endobronchial valves, pulmonary stents	Support for severe lung failure, respiratory support, sleep apnea treatment, emphysema management, airway patency
Respiratory	Trachea	Tracheal stents, tracheostomy tubes	Treat tracheal obstructions, provide airway access
Respiratory	Throat	Artificial larynx	Speech restoration after laryngectomy
Respiratory	Diaphragm	Diaphragm-pacing systems	Stimulate diaphragm movement in paralysis
Skeletal	Joints	Knee, hip, shoulder, ankle, elbow	Joint replacement due to arthritis or injury
Skeletal	Skull	Cranial implants, craniofacial prostheses	Skull reconstruction, facial reconstruction
Skeletal	Jaw	Mandible implants, maxilla implants	Jaw reconstruction
Skeletal	Ribs	Rib plating systems	Rib fracture fixation

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Table 2 (continued) | FDA-approved synthetic body parts for each anatomical system

System	Parts	Type	Indications
Urinary/renal	Kidney	Dialyzer, wearable artificial kidneys, kidney stents	Kidney support, dialysis, urine flow maintenance
Urinary/renal	Bladder	Urogynecologic mesh implants, bladder catheters	Pelvic organ prolapse, incontinence treatment, drainage
Urinary/renal	Urethra	Urinary sphincters, urethral stents, urethral catheters	Urinary incontinence management, urethral strictures
Urinary/renal	Ureter	Ureteral stents, ureteral catheters, ureteral balloon dilators	Treat ureteral obstructions, provide ureteral access
Endocrine	Pancreas	Insulin pumps, continuous glucose monitors	Diabetes management
Sensory	Eyes	Retinal implants, phakic intraocular lenses, pseudophakic lenses, corneal implants, ocular prostheses, contact lenses	Vision restoration/correction, corneal replacement, eye replacement
Sensory	Ears	Cochlear implants, hearing aids, auditory brainstem implants, auricular prostheses, middle ear implants	Hearing restoration, hearing amplification, external ear replacement
Sensory	Nose	Nasal implants, nasal stents	Nasal reconstruction, airway strictures

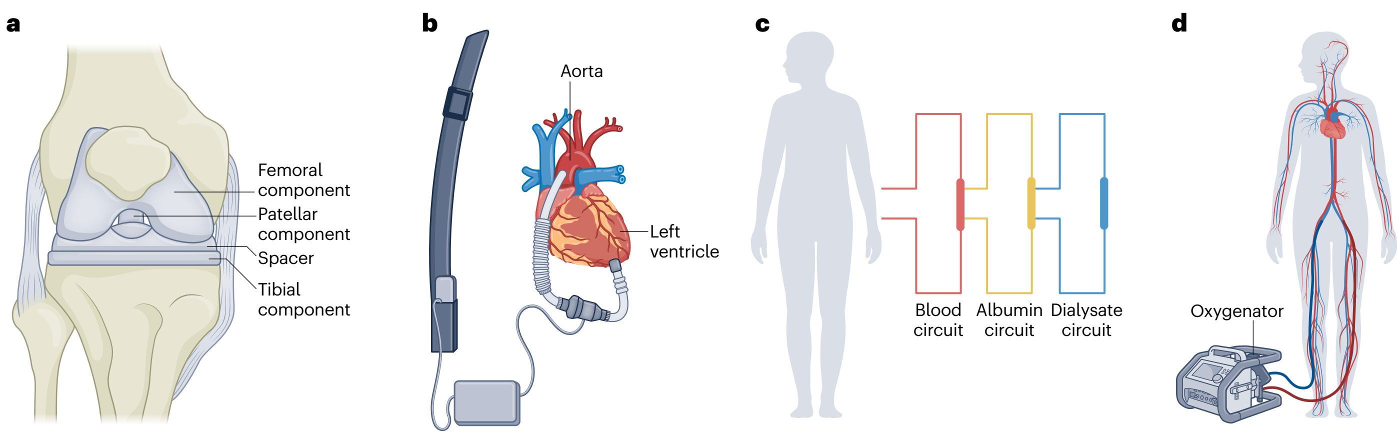

Fig. 5 | Overview of machines and mechanisms of synthetic replacement from prostheses and external medical devices. a, Total knee replacement, including a femoral component, a plastic spacer, a patellar component and a tibial component. **b**, Left ventricular device. Blood is drawn from the left ventricle and pumped by the device into the aorta. **c**, Molecular adsorbent recirculating system. Blood is circulated through a blood circuit, an albumin circuit and a dialysate circuit outside the body to filter and detoxify the blood before being returned to the patient. **d**, Extracorporeal membrane oxygenation system. Blood is drawn from the patient's body, oxygenated and cleared of carbon dioxide in an external circuit before being returned. Adapted from an original created in BioRender. Vega, G. (2025) https://BioRender.com/i03j389.

Minimally invasive approaches are also emerging. Ultrasound neuroimaging uses ultrafast pulse-echo imaging to detect changes in cerebral blood volume and decode brain activity across large regions[142]. Although this technique is less invasive, requiring only an acoustic window, it faces challenges in temporal resolution and cannot directly measure neural activity, relying on hemodynamic responses. Similarly, transcranial magnetic stimulation and temporal interference electrical stimulation offer noninvasive neural modulation. Transcranial magnetic stimulation uses magnetic fields to induce electrical currents in targeted brain regions, offering therapeutic benefits for conditions such as depression, schizophrenia and cognitive decline in older adults[143]. Temporal interference electrical stimulation, an emerging technique, uses two high-frequency electrical currents to create a low-frequency envelope for noninvasive deep brain stimulation. Unlike transcranial magnetic stimulation, temporal interference electrical stimulation could advance neural modulation by targeting deeper pathways, potentially treating conditions such as Parkinson's disease, epilepsy and obsessive–compulsive disorder[144].

Efforts to improve motor function in patients with spinal cord injuries include brain–spine interfaces, which use electrical stimulation to restore leg movement by interpreting brain signals and bypassing disrupted spinal pathways (Fig. 6c). Brain–spine interfaces use implantable cortical devices with electrodes that record brain activity, decode motor intentions and translate them into targeted electrical spinal cord stimulation. This approach has already enabled paralyzed individuals to regain the ability to walk[145].

Although these motor cortex devices currently focus on spinal cord injury rehabilitation, they hold potential for aging populations by restoring motor function, sensory processing and cognitive functions[101]. Furthermore, regenerative peripheral nerve interfaces enable mind-controlled prostheses without the need for brain surgery. As part of these interfaces, small muscle grafts are connected to severed nerves at the amputation site. The grafts generate electrical potentials in response to nerve impulses, which are recorded by embedded electrodes and transmitted to control prosthetic devices[146] (Fig. 6d).

Ethical considerations in replacement therapies for aging

Building on widely accepted practices such as joint replacements, blood transfusions and organ transplantation, replacement therapies offer promise for addressing aging but also raise ethical challenges. High costs and resource demands could limit access and exacerbate disparities, emphasizing the need for scalable and affordable solutions. Organ shortages leave many on waiting lists, fueling harmful practices such as trafficking[147]. Xenotransplantation offers potential solutions but raises concerns about zoonotic diseases and animal welfare, demanding rigorous safety measures and ongoing ethical discussions.

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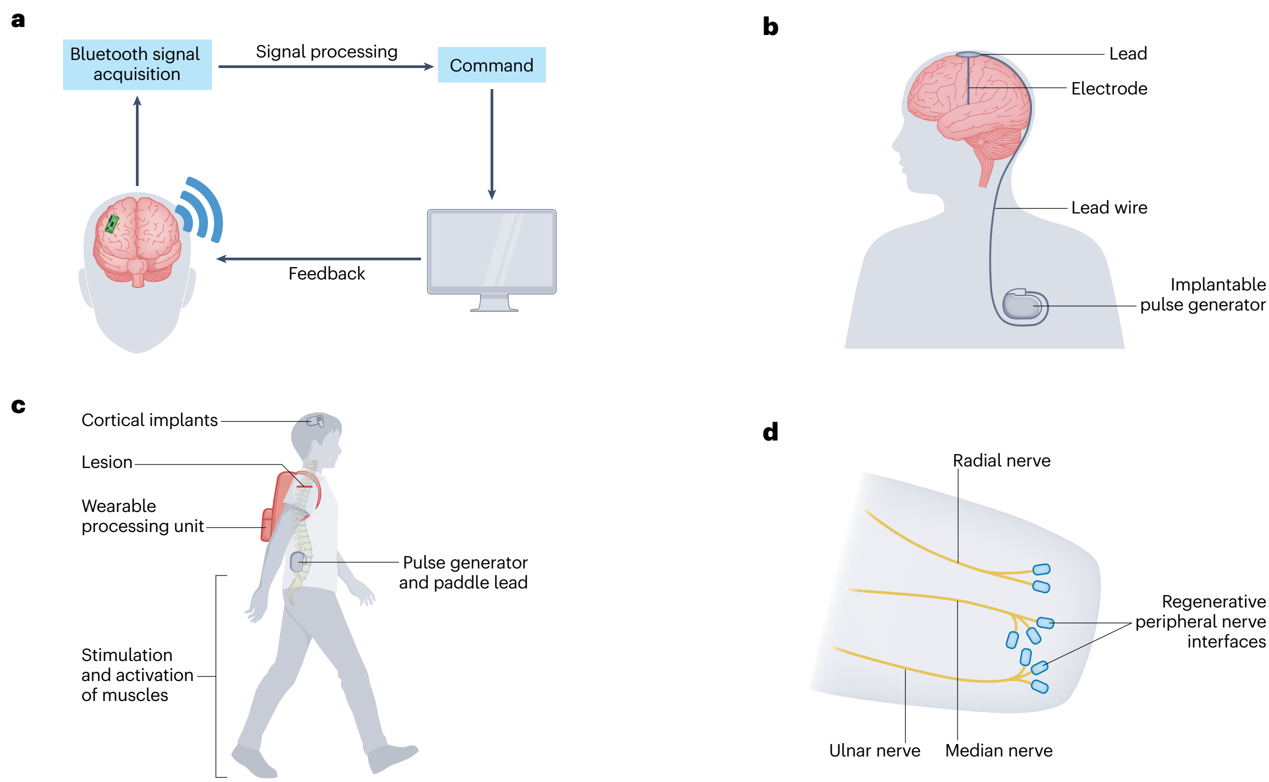

Fig. 6 | Overview of devices and interventions in brain–machine interface technology. a, A Bluetooth-enabled brain–machine interface system showing wireless signal acquisition from a cortical implant. The signals are processed and converted into commands, enabling control of devices such as computer cursors, robotic arms and systems for movement restoration. **b**, Deep brain stimulation system with a lead and electrodes implanted in the brain, connected to an implantable pulse generator via a lead wire. This system delivers targeted electrical impulses to modulate neural activity and treat neurological disorders. **c**, A wearable system for spinal cord injury rehabilitation. Cortical implants capture brain signals and transmit them to a wearable unit for processing. The unit sends stimulation commands to a pulse generator and paddle lead implanted near the spinal cord, enabling muscle activation and movement. **d**, Regenerative peripheral nerve interfaces, showing connection of the median, ulnar and radial nerves to grafts with electrodes and wires for prosthetic control of an amputated arm. Adapted from an original created in BioRender. Vega, G. (2025) https://BioRender.com/g52f349.

Human stembroid research faces strict ethical oversight. Most countries enforce a 14-d limit on embryo studies and prohibit synthetic embryo implantation[148]. While nonhuman models such as mice have advanced the field, expanding human applications requires ongoing ethical review.

Emerging technologies such as CRISPR and lentiviral vectors present risks of off-target edits and insertional mutagenesis[149,150], requiring robust testing and oversight. Additionally, progressive brain replacement or brain–machine interfaces may raise concerns about identity preservation and cognitive enhancement misuse.

Ultimately, balancing the risks of invasive procedures, immune rejection and long-term complications against the potential for extended healthy lifespan requires transparency, thorough regulation and stringent evaluation. Ethical considerations must evolve alongside advancements in replacement technologies.

Conclusions and future directions

This Perspective explored current research on replacement therapies, highlighting established methods and future directions. Key development areas include avoiding immunorejection by using autologous cells, sourcing sufficient cell quantities, achieving vascularization in bioprinting and developing stembroids, maturing engineered tissues to full-sized organs, refining surgical procedures, improving neural integration and scaling production.

Supportive technologies, such as cryopreservation and perfusion, are essential for making replacement therapies widespread and cost-effective. Cryopreservation enables long-term storage of cells or organs, allowing patients to develop and grow new organs years before surgery. Although progress has been made, further advances are needed for clinical applications[151]. Perfusion technologies, essential for rewarming cryopreserved tissues, maintain organ viability during transplantation. Systems such as BrainEx have restored circulation in post-mortem pig brains, reactivating cellular functions after ischemia[152]. These technologies ensure functionality and integration of cells or organs after transplantation.

Replacement therapies already address diseases such as cancer, organ failure, epilepsy, joint disease, amputations and paralysis. Many of these are age related, suggesting that replacement techniques could promote healthy longevity. However, transitioning from treating specific conditions to preventative applications for extending lifespan will require further validation.

Finally, both biological and synthetic paths within replacement therapies can yield successful outcomes. Addressing the multitude of changes that occur with aging will probably require a combination of these approaches. Despite challenges, the future is promising. Continued advancements in replacement therapies have the potential to address age-related decline and extend healthy lifespan.

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Author contributions

S.L. conceptualized, wrote and revised the Perspective. E.V. and M.S.-K. oversaw the writing and revision of this Perspective. J.R.P., A.A., G.C. and V.N.G. contributed to revising the manuscript and provided critical feedback.

Competing interests

G.C. declares potential conflicts of interest related to companies involved in transplantation and aging, including eGenesis, Qihan, GC Therapeutics, Cellino, Rejuvenate Bio and Thymmune (further interests, outside of the scope of the current work, can be found in the Supplementary Note). A.A. declares a potential conflict of interest with Precise Bio, related to the bioprinting of human corneas. S.L., J.R.P., V.N.G., M.S.-K. and E.V. have no competing interests.

Additional information

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Replacement as an aging intervention

In the format provided by the authors and unedited

Category	Company or Investor	URL	Location	Yr Company Started	Start of Involvement	End of Involvement	Topic or Investments
BOD	Sigma-Aldrich	http://www.prnewswire.com/news-releases/sigma-aldrich-elects-george-m-church-as-director-63278032.html	St_Louis MO	1934	2009	2015	EMD, chemistry, cells, Board of Directors
Collaboration	Merck KGaA [EMD]	https://www.emdmillipore.com/US/en/about-us/history/qb2b.qB.oVQAAAFBGyFhRKgf,nav	Darmstadt Germany	1688	2009	2012	protein synthesis
Collaboration	Hamilton Company	http://web.archive.org/web/20020703153017/http://www.hamiltoncomp.com/product/syringe/life/multi.html	.			1990	multi-syringe for DNA gels

Collaboration	New England Nuclear	http://www.library.hbs.edu/hc/lehman/company.html?company=new_england_nuclear_corporation	.		1988	DNA immobilization
Collaboration	Polytech Products	http://www.legacy.com/obituaries/bostonglobe/obituary.aspx?page=lifestory&pid=164889994	.		1984	DNA electrotrasfer device
Collaboration	Autodesk	http://www.autodeskresearch.com/projects/cadnano2	.			DNA nanostructures CAD
Collaboration	Aventis	http://www.aventis.com/	.			
Collaboration	BASF grant on metabolic engineering	https://www.basf.com/us/en.html	Mannheim Germany	1865		metabolic engineering
Collaboration	CP Foods	https://en.wikipedia.org/wiki/Charoen_Pokphand_Foods	.			

Collaboration	Hoechst Marion Roussel	http://en.wikipedia.org/wiki/Hoechst_AG	.			
Collaboration	Intelligent Automation	http://www.intelligentbio.com/	.			Automated multiplex DNA sequencing
Collaboration	Lilly	http://www.lilly.com/	.			
Collaboration	MJ Research Inc.	http://investing.businessweek.com/research/stocks/private/snapshot.asp?privcapId=4291421	.			pulsed electrophoresis & Mars DNA detection
Collaboration	Rhone-Poulenc Rorer	http://en.wikipedia.org/wiki/Rh%C3%B4ne-Poulenc	.			
Consulting	Ageing Research at King's College London (ARK)	https://www.kcl.ac.uk/research/ageing-research-at-kings-ark	.	2024	present	
Consulting	Amgen	http://www.amgen.com/	.			

Consulting	Archer Daniels Midland	http://www.adm.com/en-US/Pages/default.aspx	.		
Consulting	Astellas	https://www.astellas.us/	.		
Consulting	Blueprint Medicines	http://www.blueprintmedicines.com/	.		
Consulting	Casdin Capital	https://casdincapital.com/	.		
Consulting	Cray Computer	http://www.cray.com/	.		
Consulting	CRISPR Tx	http://www.crisprtx.com/	.		
Consulting	Driscoll's	https://www.driscolls.com/	.		
Consulting	DuPont	http://www.dupont.com/	.		
Consulting	European Society of Preventive Medicine	https://espm.org/	.		
Consulting	Founders Fund	https://foundersfund.com/	.	2010	synthetic biology
Consulting	Genentech	https://www.gene.com/	.		
Consulting	Hangzhou East Pharmaceutical Town	https://arep.med.harvard.edu/gmc/award.html	Hangzhou		Genome editing & cell therapies

Consulting	HLTHventures	https://www.hlth.com/	London UK
Consulting	Intel	https://conferences.oreilly.com/artificial-intelligence/ai-ny-2018/public/schedule/speaker/305331.html	.
Consulting	Le Laboratoire	http://www.lelaboratoirecambridge.com/	Cambridge MA
Consulting	Merck	http://www.merck.com/index.html	.
Consulting	Microsoft	https://www.microsoft.com/en-us/research/	.
Consulting	Millennium Pharmaceuticals [then Takeda Oncology]	https://en.wikipedia.org/wiki/Millennium_Pharmaceuticals	.
Consulting	MPM Capital	http://www.mpmcapital.com/	.

Consulting	Novartis	https://www.nibr.com/	.	
Consulting	Open philanthropy	https://www.openphilanthropy.org/focus/global-catastrophic-risks/biosecurity/altruistic-technology-labs-biological-risk-prevention	.	global risk diagnostics
Consulting	OrchidHealth	https://www.orchidhealth.com/	.	
Consulting	Pfizer	http://www.pfizer.com/	.	

Consulting	R2M Rejuvenation Annual Meeting	https://regmedfoundation.org/2023/05/18/historic-first-regenerative-rejuvenative-medicine-industry-annual-congress-and-scientific-trade-show-announced/	Winston-Salem NC		
Consulting	Roche	https://www.roche.com/media/releases/med-cor-2014-06-02.htm	.		
Consulting	Sadtler [Biorad]	http://www.ir-spectra.com/sadtler/sadtler.htm	Philadelphia PA		DNA sequencing software
Consulting	Seven Bridges [Velsera]	https://www.sevenbridges.com/	.		

Consulting	SpaceX	https://www.edge.org/events/the-edge-master-class-2008-a-short-course-on-synthetic-genomics	Los Angeles CA				
Consulting	Takeda	https://www.takeda.com/en-us/	.				
Consulting	Takeda Oncology	https://www.takedaoncology.com/	.				
Consulting	Vertex Pharmaceuticals	http://www.vrtx.com/	.				
Donor	Roman Oliynyk	https://issuu.com/harvardmedicalschool/docs/benefactor_spring2018	Boston MA	2018	2018	2019	Genome Project Write
Donor	Lipper Family Charitable Foundation	https://fconline.foundationcenter.org/fdo-grantmaker-profile/?key=LIPP026	Foundation NJ	1996	1996	2018	computational biology, organoids and neurobiology
Donor	Life Sciences Research Foundation	https://lsrf.org/	San_Francisco CA	1984	1985	1986	Embryonic stem cells

Donor	Life Sciences Research Foundation	http://www.lsrf.org/	.				postdoc stem cells
Founder	64-x	http://64-x.com	Boston MA	2017	2017	present	Virus resistant cells
Founder	7-TM Protocol	https://opencorporates.com/companies/us_ma/001358911	Boston MA	2018	2019	present	digital registry/investment
Founder	AdoraPet BioSciences	https://headtopics.com/us/genomics-pioneer-george-church-former-kindred-bio-execs-launch-crispr-designed-pets-company-adorape-33535868	Alameda CA	2022	2022	present	non-allergenic pets
Founder	Alacris Pharmaceuticals	http://www.alacris.de/team/	Berlin Germany	2008	2008	present	Cancer genomics & systems biology
Founder	Arrived-AI	https://www.arrivedai.com/	Cambridge MA	2019	2019	present	Brand virality; AI augmentated

Founder	Breaking [Samri]	https://wyss.harvard.edu/technology/plastivores-plastic-degrading-super-microbes-and-enzymes/	Boston MA	2023	2023	present	Microplastic metabolism
Founder	Cache DNA LLC	https://opencorporates.com/companies/us_ma/001429539	Boston MA	2020	2020	present	DNA storage
Founder	Cellgorithmics, [then Syntax-Bio]	http://www.cellgorithm.com/	Chicago IL	2019	2019	present	CRISPR bio-coding
Founder	Colossal Bio	https://colossal.com/	Dallas Tx	2021	2021	present	Molecular biology for endangered species
Founder	Connectomes Inc	https://connectomes.net	Berkeley CA	2024	2024	present	synthetic neuro-connectomes
Founder	Cytosurge	https://www.cytosurge.com/press-release-harvards-wyss-institute-joins-forces-with-cytosurge-english	Zurich Switzerland	2016	2020	present	Fluid Force Microscopy

Founder	Digid8 [Arrived-AI]	http://digid8.com	Cambridge MA	2019	2019	present	Dating app for couples, wellness, infectious & inherited diseases
Founder	Dyno Tx	https://www.dynotx.com/	Cambrige MA	2018	2018	present	AAV engineering.
Founder	Editas	http://editasmedicine.com/	Cambridge MA	2013	2013	present	Cas9 gene therapy
Founder	Egenesis Bio	https://web.archive.org/web/20160317111036/http://www.egenesisbio.com/founding-team.html	Boston MA	2013	2013	present	Cas9 non-human applications
Founder	EnEvolv [Zymergen, Ginkgo]	http://enevolv.com/about/	Cambridge MA	2011	2011	present	genome engineering
Founder	Eugit Therapeutics	https://www.ycombinator.com/companies/eugit-therapeutics	Cambridge MA	2022	2022	present	gamma-delta T-cells
Founder	ExteRNA [AminoX]	https://www.externa.bio/	Boston MA	2023	2023	present	Novel amino acids
Founder	Fitbiomics	https://opencorporates.com/companies/us_ma/001157683	Boston MA	2015	2015	present	Wellness & probiotics

Founder	FormBio	https://www.genengnews.com/topics/artificial-intelligence/form-bios-ai-ensures-gene-therapies-pass-muster-with-ginkgos-help/	Austin TX	2022	2022	present	Computational SynBio
Founder	GenexGen	https://www.genexgen.com/	Los_Altos CA	2021	2022	present	Novel immunosuppressives, inflammation, GeneTx
Founder	GhostFire	,Ä¶	Boston MA	2024	2024	present	plants
Founder	GROBiosciences	https://www.grobio.com/team	Cambridge, MA	2016	2016	present	expanded genetic code
Founder	Inari	https://www.massbio.org/member/vl40-122966	Medford MA	2016	2016	present	agriculture
Founder	JuraBio	https://www.jurabio.com	Boston MA	2017	2017	present	CAR-T for autoimmunity
Founder	Kern	http://www.kernsystems.com	Boston MA	2017	2017	present	previously Glotta, DNA synthesis
Founder	ManifoldBio	https://manifold.bio/	Cambridge MA	2020	2020	present	peptide barcodes for drug design/testing

Founder	Qihan Biotech	https://synbiobeta.com/egenesis-announces-global-collaboration-xenotransplantation/	Hangzhou, China	2018	2018	present	pig genome engineering
Founder	Station for Natural Studies	http://www.connecticutcorps.com/corp/41461.html	Boston MA	1986	1986	present	genetics
Founder	Tenza	https://www.tenza.bio/	Cambridge MA	2020	2020	present	Biologics delivery
Founder	Tierra Biosciences [Synvitrobio]	https://tierrabiosciences.com/	San_Francisco CA	2015	2015	present	In vitro proten synthesis
Founder	Acuity	https://www.genomeweb.com/business-news/bruker-invests-startup-acuity-spatial-genomics	Newton MA	2021	2021	2022	spatial genomics, chromosomes
Founder	Veritas Genetics [then LetsGetChecked]	http://www.veritasgenetics.com/company.html	Danvers MA	2015	2015	2022	Clinical Genomics

Founder	Nebula Genomics [then ProPhase Labs]	https://www.nebulagenomics.io/	Boston MA	2018	2018	2021	Blockchain, Homomorphic Encryption, Genome Sequencing
Founder	Ally Tx	https://www.massbio.org/member/ally-therapeutics-147938	Cambridge MA	2019	2019	2020	AAV & innate immunity.
Founder	AbVitro [then Juno-Celgene]	https://web.archive.org/web/20160116233249/http://abvitro.com/about-us/scientific-advisory-board/	Boston MA	2010	2010	2018	Immunomes
Founder	Warp Drive Biosynthetics	https://www.biospace.com/article/ginkgo-bioworks-buys-warp-drive-bio-s-genome-mining-platform/	Boston MA	2011	2011	2018	now Revolution Medicines, Natural product therapeutics

Founder	Gen9	https://www.genengnews.com/news/ginkgo-bioworks-acquires-gen9/	Cambridge MA	2009	2009	2017	Ginkgo Bioworks, Synthetic Biology
Founder	Joule Unlimited [then Redrock]	http://www.xconomy.com/boston/2015/11/16/flagship-merges-biofuel-maker-red-rock-with-rd-focused-joule/#	Cambridge MA	2007	2007	2015	SolarFuels
Founder	Knome, Inc. [Tute, then PierianDx]	http://venturebeat.com/2016/10/12/pieriandx-acquires-tute-genomics/	Cambridge MA	2007	2007	2015	Human Genome Sequencing
Founder	LS9	https://web.archive.org/web/20140116182952/http://ls9.com/about/founders	San_Francisco CA	2005	2006	2014	then REG Inc., Biologically engineered fuels
Founder	Pathogenica [then BioInnovation Solutions]	http://pathogenica.com/sab.php	Cambridge MA	2010	2010	2014	Pathogencity and Drug resistance diagnostics

Founder	Telome	https://web.archive.org/web/20160318180904/http://telome.com/people.php	Boston MA	2010	2010	2014	Telomeres and aging
Founder	BioWeatherMap.org	http://www.bioweathermap.org/about.html	Boston MA	2009	2009	2010	DIYbio
Founder	Codon Devices [then Gen9]	http://www.bio-itworld.com/newsitems/2005/05/06-02-05-news-codon-devices	Cambridge MA	2005	2005	2009	Constructive Biology
Founder	Warpdrive Bio	https://ir.revmed.com/news-releases/news-release-details/revolution-medicines-acquires-warp-drive-bio-expand-drug	.				drug discovery
Founder .org	MindFirst Foundation	https://experiment.com/users/Foundation	Boston MA	2014	2014	present	mental illnesses

Founder .org	PersonalGenomes.org Boston	http://personalgenomes.org	Boston MA	2004	2004	present		open-access genome & trait data
Founder .org	PersonalGenomes.org London	http://personalgenomes.org	London UK	2013	2013	present		open-access genome & trait data
Founder .org	PersonalGenomes.org Toronto	http://personalgenomes.org	Toronto Canada	2012	2012	present		open-access genome & trait data
Founder .org	PersonalGenomes.org Uslan Korea	http://www.bio-itworld.com/Press-Release/Genome-Korea-in-Ulsan-Launched/	Uslan Korea	2015	2014	present		open-access genome & trait data
Founder .org	PersonalGenomes.org Vienna	http://personalgenomes.org	Vienna Austria	2014	2014	present		open-access genome & trait data
Founder .org	PersonalGenomes.org Shanghai	http://personalgenomes.org	Shanghai, China	2019	2019		2019	personal genomes
Founder .org	pgEd.org	https://web.archive.org/web/20190113053234/http://pged.org/advisory-board/	Boston MA	2006	2013		2019	personal genetics education
Founder .org	Open Humans	http://openhumansfoundation.org/	Boston MA	2016	2016		2018	open-access human bio-data
Founder .org	OpenHumans.org	http://openhumans.org	Boston MA	2016	2016		2018	open-access human bio-data

Founder .org	GET Conference 2010	https://web.archive.org/web/20100221063543/http://www.getconference.org/GET2010/sponsors.html	.	Genomes, Environments & Traits meeting
Founder .org	GET Conference 2011	https://web.archive.org/web/20110812143911/http://www.getconference.org/GET2011/sponsors.html	.	Genomes, Environments & Traits meeting
Founder .org	GET Conference 2012	https://web.archive.org/web/20120619011412/http://www.getconference.org/GET2012/sponsors.html	.	Genomes, Environments & Traits meeting

Founder .org	GET Conference 2013	https://web.archive.org/web/20130302185902/http://www.getconference.org/	.		Genomes, Environments & Traits meeting
Founder .org	GET Conference 2014	https://web.archive.org/web/20150602022548/http://www.getconference.org/get2014/sponsors.html	.		Genomes, Environments & Traits meeting
Founder .org	GET Conference 2015	https://web.archive.org/web/20150924233040/http://www.getconference.org/	.		Genomes, Environments & Traits meeting
Founder .org	GET Conference 2017	https://web.archive.org/web/20170714095140/http://www.getconference.org/	.		Genomes, Environments & Traits meeting
Grant	CP Foods grant		Bangkok Thailand	1976	virus resistant animals

Investor	10x Genomics (NAS: TXG)	https://www.genengnews.com/topics/omics/as-10x-launches-visium-hd-will-single-cell-resolution-draw-new-customers/	.	Centrillion Technologies
Investor	81 Collection	https://www.81collection.com/#Collection	.	?
Investor	A&E Investments	https://www.aeinvestments.com/	.	?
Investor	Access Biotechnology	https://www.crunchbase.com/organization/access-biotechnology/recent_investments/investments	.	GRObio
Investor	Acequia Capital	https://www.acecap.com/portfolio	.	7Bridges
Investor	Acre Venture Partners	https://acre.vc/	.	Inari
Investor	Activate Global		.	

Investor	Agilent		.	Gen9
Investor	Alexandria Venture Investments	https://www.crunchbase.com/organization/alexandria-venture#/entity	.	Editas, EGenesis, Seres
Investor	Alpha Square Group		.	
Investor	Alta Partners		.	Egenesis
Investor	Altium Capital		.	
Investor	Alumni Ventures		.	
Investor	Amar Hussain		.	Colossal.com
Investor	Andreessen Horowitz [a16z]	https://www.crunchbase.com/organization/dyno-therapeutics/company_financials	.	DynoTx, GCTx
Investor	Animal Capital	https://colossal.com/company/	.	Colossal.com
Investor	Animoca Brands	https://colossal.com/company/	.	Colossal.com
Investor	Anne Wojcicki		.	
Investor	Apoletto Asia		.	

Investor	ARCH Venture Partners	https://www.crunchbase.com/organization/arch-venture-partners/investments	.	Arivale, EGenesis, Juno, Twist, Nebula
Investor	Ares Capital (NAS: ARCC)		.	
Investor	Astralabs		.	
Investor	At One Ventures	https://colossal.com/company/	.	Colossal.com
Investor	ATEL Capital Group		.	
Investor	Atlas Venture		.	GRObio
Investor	b2venture		.	
Investor	Bank of North Dakota		.	Colossal.com
Investor	BARD Worldwide		.	
Investor	Beresford Ventures		.	
Investor	Bill & Melinda Gates Foundation		.	
Investor	Bio-Rad Laboratories (NYS: BIO)		.	
Investor	Biomatics Capital [Boris Nikolic]	https://www.biomaticscapital.com/#portfolio	.	Editas, EGenesis, Twist
Investor	BioM√©rieux (Diagnostic Equipment) (PAR: BIM)		.	

Investor	BlackRock Private Equity Partners		.	
Investor	Blindspot Ventures		.	
Investor	bng0		.	Editas Medicine
Investor	BOLD Capital Partners	https://colossal.com/company/	.	Colossal.com
Investor	Boom Capital Ventures		.	
Investor	Boost VC	https://colossal.com/company/	.	Colossal.com
Investor	Boris Nikolic	https://www.crunchbase.com/person/boris-nikolic#/entity	.	Twist Bio, Editas
Investor	Boston Global Ventures		.	
Investor	BoxGroup		.	
Investor	Brandon Fugal	https://pulse2.com/colossal-200-million-series-c-raised-at-10-2-billion-valuation-for-de-extinction-technology/	.	Colossal.com
Investor	Breakout Ventures		.	
Investor	Breton Capital Ventures		.	

Investor	Breyer Capital	https://colossal.com/company/	.	Colossal.com
Investor	Bridge Capital Holding		.	
Investor	Builders VC		.	Colossal.com
Investor	Burch Creative Capital		.	
Investor	California Institute for Regenerative Medicine		.	Rejuvenate Bio
Investor	Calm Ventures		.	
Investor	Cantos Ventures		.	
Investor	Capital Factory		.	
Investor	Carnrite Ventures		.	
Investor	Casdin Capital	https://www.crunchbase.com/organization/casdin-capital#/entity	.	23andme, DynoTx, Editas
Investor	Catalio Capital Management	https://www.cataliocapital.com/portfolio	.	EGenesis
Investor	Chan Zuckerberg Initiative		.	
Investor	Charles Hoskinson		.	Colossal.com
Investor	Cherubic Ventures		.	
Investor	Chevron Renewable Energy Group		.	
Investor	Chevron Technology Ventures		.	
Investor	Chris Hemsworth		.	Colossal.com

Investor	Climate Capital	https://colossal.com/company/	.	Colossal.com
Investor	Coatue Management		.	
Investor	Codon Capital		.	
Investor	Companion Fund	https://www.crunchbase.com/organization/companion-fund/investments	.	RejuvenateBio
Investor	CONNECT (Accelerator)		.	
Investor	Converge Venture Partners		.	
Investor	Corey Nobile		.	Colossal.com
Investor	Cowen Healthcare Investments		.	
Investor	CPP Investments		.	
Investor	Creative Ventures		.	
Investor	CRV	https://www.crunchbase.com/organization/crvvc#section-overview	.	DynoTx

Investor	Cultivian Sandbox Ventures	https://www.crunchbase.com/organization/cultivian-sandbox-ventures/investments	.	EnEvolv
Investor	CureDuchenne Ventures		.	
Investor	Dana Sniezko		.	Colossal.com
Investor	DaVita (NYS: DVA)		.	Egenesis
Investor	Decheng Capital	https://www.crunchbase.com/organization/decheng-capital	.	ReadCoor
Investor	Deerfield Management	https://www.crunchbase.com/organization/deerfield#/entity	.	Editas, Pacbio
Investor	Defense Advanced Research Projects Agency		.	
Investor	Diamond Biofund (TAI: 6901)		.	Rejuvenate Bio

Investor	Digitalis Ventures	https://www.crunchbase.com/organization/digitalis-ventures	.	GRObio, Rejuvenate
Investor	Draper Associates	https://colossal.com/company/	.	Colossal.com
Investor	Draper Fisher Jurvetson [DFJ]	https://craft.co/dfj	.	Gen9
Investor	Dreamers VC		.	
Investor	E Squared Capital Management		.	
Investor	E14 Fund		.	
Investor	EcoR1 Capital		.	Editas, Intellia
Investor	EDBI	https://www.crunchbase.com/organization/ecor1-capital/investments	.	
Investor	Eisai Innovation		.	Egenesis
Investor	Elia Montanari		.	Colossal.com
Investor	Endless Frontier Labs		.	
Investor	EXOR Seeds		.	

Investor	F-Prime Capital Partners	https://www.crunchbase.com/search/funding_rounds/field/organizations/num_investments/f-prime-capital-partners	.	Nebula
Investor	Fan Ventures		.	Egenesis
Investor	Farallon Capital Management		.	
Investor	Fenbushi Capital	https://www.crunchbase.com/search/funding_rounds/field/organizations/num_investments/fenbushi-capital	.	Nebula
Investor	Fidelity Management and Research Company	https://www.crunchbase.com/organization/fidelity-management-and-research-company/investments	.	Editas, Intellia, Twist

Investor	Fifty Years	https://www.fifty.vc/	.	HelixNano, Memphis Meats, TierraBio, 64-x
Investor	First Light Capital Group		.	
Investor	First Round Capital		.	
Investor	Fjord Capital Partners		.	
Investor	Flagship Pioneering [Newcogen, AGCT]	http://flagshippioneering.com/portfolio/	.	Axcella, BGMedicine, CodonDevices, Editas, EngeneOS, Essentient, Helicos, Inari, Joule, LS9, Pronutria, Seres
Investor	Florida Opportunity Fund		.	
Investor	Fontus Capital		.	JURA Bio
Investor	Foresite Capital		.	
Investor	Founders Fund	http://foundersfund.com/	.	
Investor	FPV Ventures		.	
Investor	Fran Walsh		.	Colossal.com
Investor	Fran Walsh	https://pulse2.com/colossal-200-million-series-c-raised-at-10-2-billion-valuation-for-de-extinction-technology/	.	Colossal.com
Investor	Freeflow Ventures		.	

Investor	Fresenius Medical Care Ventures		.	Egenesis
Investor	Fundomo		.	
Investor	G Squared		.	
Investor	G Ventures (VC)		.	
Investor	Gaingels		.	
Investor	George Church		.	Orchid Health, Curii
Investor	GETTYLAB		.	
Investor	GG 1978		.	Colossal.com
Investor	Giammaria Giuliani	https://pulse2.com/colossal-200-million-series-c-raised-at-10-2-billion-valuation-for-de-extinction-technology/	.	Colossal.com
Investor	Global Space Ventures [GSV]	https://colossal.com/company/	.	Colossal.com
Investor	GoAhead Ventures	https://www.crunchbase.com/organization/google-ventures/investments	.	Colossal.com
Investor	Google Ventures		.	23andme, DynoTx, Editas

Investor	Great Point Ventures	https://www.crunchbase.com/organization/great-point-partners	.	Nebula
Investor	Green Sands Equity		.	
Investor	Greylock Partners	https://www.crunchbase.com/organization/greylock#/entity	.	WarpDriveBio
Investor	GRIDS Capital		.	
Investor	GV		.	
Investor	Habib Haddad		.	
Investor	HamiltonClark		.	enEvolv
Investor	Hansj√∂rg Wyss	https://www.crunchbase.com/person/hansj%C3%B6rg-wyss#/entity	.	ReadCoor
Investor	Hanwha Impact		.	Inari Agriculture
Investor	Harvard i-lab		.	
Investor	Harvard Innovation Launch Lab		.	
Investor	Hatteras Venture Partners		.	
Investor	HBM Healthcare Investments (SWX: HBMNE)		.	

Investor	HBM Partners		.	
Investor	Heartbeat Labs	https://www.crunchbase.com/organization/heartbeat-labs	.	Nebula
Investor	Heisenberg Capital		.	
Investor	Hemi Ventures	https://www.crunchbase.com/organization/hemi-vc	.	Nebula
Investor	Hemsworth brothers	https://www.pedestrian.tv/news/hemsworth-fund-thylacine-research/	.	Colossal.com
Investor	Heritage Medical Systems	https://www.crunchbase.com/organization/heritage-provider-network	.	
Investor	Heritage Provider Network		.	GRObio
Investor	Highbury Group		.	
Investor	Hikma Ventures	https://www.crunchbase.com/organization/hikma-ventures	.	Nebula

Investor	Hillspire		.	
Investor	HOF Capital		.	
Investor	Horizons Ventures		.	
Investor	Humboldt Fund		.	Tierra Bio
Investor	Hyperplane Venture Capital		.	
Investor	IBCC		.	
Investor	In-Q-Tel [IQT]	https://colossal.com/company/	.	Colossal.com
Investor	Innovation Endeavors	https://www.crunchbase.com/organization/innovation-endeavors	.	GRObio
Investor	Investment Corporation of Dubai		.	
Investor	IPV Capital		.	
Investor	Irving Investors		.	
Investor	James Michaelis		.	Colossal.com
Investor	JAZZ Venture Partners	https://colossal.com/company/	.	Colossal.com
Investor	Jeffrey Wilke		.	Colossal.com

Investor	Jennison Associates	https://www.crunchbase.com/organization/jennison-associates/investments	.	Editas
Investor	Jiangsu Simcere Pharmaceutical		.	Veritas (Laboratory Services)
Investor	John Ballantyne		.	
Investor	John Stuelpnagel		.	
Investor	John Woyton		.	Colossal.com
Investor	Johnson & Johnson Innovation - JLABS		.	
Investor	Joshua Elkington		.	JURA Bio
Investor	K2 HealthVentures		.	
Investor	Katherine High		.	Rejuvenate Bio
Investor	KDT Ventures	https://www.kdtvc.com/home/dyno-2/	.	DynoTx, RejuvenateBio
Investor	Kendall Capital Partners		.	RejuvenateBio
Investor	Keswick Ventures		.	
Investor	Khosla Ventures	https://www.crunchbase.com/organization/khosla-ventures/investments	.	CodonDevices, EGenesis, LS9, Nebula
Investor	Kingsley Advani		.	
Investor	KittyHawk Ventures		.	

Investor	Kohlberg Kravis Roberts (NYS: KKR)		.	
Investor	LabCentral		.	
Investor	Laura Fingal-Surma		.	Colossal.com
Investor	Leader Ventures		.	
Investor	Leaps by Bayer	https://leaps.bayer.com/companies/health	.	Cellino, Egenesis, GRObio
Investor	lee tachman	https://pitchbook.com/profiles/investor/493399-36	.	Colossal.com
Investor	LetsGetChecked		.	
Investor	LifeSci Venture Partners		.	
Investor	LifeSpan Vision Ventures		.	
Investor	Lightspeed Venture Partners		.	
Investor	Lilly Asia Ventures	https://www.crunchbase.com/organization/lilly-asia-ventures	.	ReadCoor, VeritasGenetics
Investor	Liquid 2 Ventures		.	

Investor	Lux Capital	https://www.crunchbase.com/organization/dyno-therapeutics/company_financials	.	DynoTx
Investor	Lux Research		.	
Investor	Mana Ventures		.	
Investor	Mancora Ventures		.	Colossal.com
Investor	MarketX		.	Colossal.com
Investor	Maryke Appel		.	?
Investor	Mass General Brigham Ventures	https://www.massgeneralbrigham.org/en/research-and-innovation/innovation/ventures/portfolio	.	Editas
Investor	Massachusetts Biomedical Initiatives	https://mbi.bio/graduate-companies/	.	Beckmann Coulter
Investor	MassCONNECT		.	

Investor	MassVentures	https://www.crunchbase.com/search/organization.companies/57e30460d91cbbb6b768ff5338dc3ffd	.	Inari, Acuity, Egenesis, Cellino, nference, GCTx, Manifold, GroBio, Dyno, Nabla, HelixNano, NuProbe, Thymmune, AOBiome, Humanity, Xgenomes, Holobiome, EnEvolv, Fitbiomics, Plex, Tenza, Gen9, Eugit, Abvitro
Investor	Material Impact Fund	https://www.materialimpact.com/companies/	.	TierraBio
Investor	Matrix		.	
Investor	Matrix Capital Management	https://www.crunchbase.com/organization/matrix-capital-management/recent_investments/investments	.	Solve, nference
Investor	Matthew De Silva		.	
Investor	Maverick Ventures		.	

Investor	Mayfield Fund	https://www.crunchbase.com/organization/mayfield-fund	.		Nebula
Investor	Mayo Clinic Ventures		.		
Investor	Merck (ETR: MRK)		.		
Investor	Metaplanet Holdings	https://metaplanet.com/portfolio	.		HelixNano, Kern
Investor	Michael Chambers		.		
Investor	Milad Alucozai		.		
Investor	Mirae Asset Global Investments	https://www.crunchbase.com/organization/mirae-asset-financial-group	.		Nebula
Investor	Mission BioCapital		.		
Investor	Monashee Investment Management		.		
Investor	Natco Pharma (BOM: 524816)		.		Egenesis
Investor	National Institutes of Health		.		
Investor	National Science Foundation		.		
Investor	Neman Ventures		.		
Investor	New Enterprise Associates		.		

Investor	Nextplay Ventures (Los Angeles)		.	
Investor	NHRGI		.	
Investor	Non-Government Schools Superannuation Fund		.	Inari Agriculture
Investor	Northpond Ventures		.	64xbio, Enplusone
Investor	NTTVC	https://nttvc.com/portfolio/	.	nference
Investor	Nucleate	https://nucleate.org/companies/	.	Manifold
Investor	Obvious Ventures	https://obvious.com/portfolio/	.	Dyno, Zymergen
Investor	Omega Funds	https://www.crunchbase.com/organization/omega-funds#/entity	.	Editas
Investor	OS Fund	https://www.crunchbase.com/organization/os-fund	.	GRObio
Investor	Osage University Partners	https://oup.vc/portfolio/	.	Egenesis
Investor	Page One Ventures	https://pageone.vc/our-companies/	.	GRObio

Investor	Pagliuca Harvard Life Lab		.	
Investor	Paris Hilton	https://colossal.com/woolly-mammoth-revival-raises-75-million-from-vc-firms-paris-hilton/	.	Colossal.com
Investor	Parkwood		.	Egenesis
Investor	Partners Innovation Fund	https://www.crunchbase.com/organization/partners-innovation-fund/investments	.	Editas
Investor	Paul McEwan		.	
Investor	Paul Tudor Jones	https://pulse2.com/colossal-200-million-series-c-raised-at-10-2-billion-valuation-for-de-extinction-technology/	.	Colossal.com
Investor	Pavilion Capital Partners		.	
Investor	PBM Capital		.	

Investor	Peak6 Strategic Capital	https://colossal.com/company/	.	Colossal.com
Investor	Peter Jackson		.	Colossal.com
Investor	Petri		.	
Investor	PharmStars		.	
Investor	Philab Holdings		.	
Investor	Pictet		.	
Investor	Pillar VC	https://www.crunchbase.com/organization/pillar-companies-2	.	GRObio
Investor	PJC.vc	https://www.pjc.vc/team	.	?
Investor	Platform Capital Management		.	Colossal.com
Investor	Playground Global	https://playground.global/portfolio	.	Manifold
Investor	Plug and Play Tech Center		.	
Investor	Polaris Partners	http://www.polarispartners.com/portfolio/	.	Arivale, Editas, DynoTx
Investor	Power Angels	https://www.crunchbase.com/organization/tenza-aac3	.	Tenza Bio

Investor	Preston Estep		.	Telome
Investor	PROOF.vc	https://www.proof.vc/portfolio	.	Colossal.com
Investor	Prophase Labs (NAS: PRPH)		.	Nebula
Investor	Prosus Ventures		.	
Investor	QB3		.	
Investor	Qiagen (NYS: QGEN)		.	IBS
Investor	Radical Ventures	https://radical.vc/why-we-led-nabla-bios-series-a/	.	Nabla
Investor	Rajeev Surati		.	
Investor	Red Bear Angels		.	?
Investor	Redmile Group		.	
Investor	Refactor Capital	https://refactor.com/portfolio/	.	64xBio, ShapeTx, Orchid
Investor	Ric Edelman	https://pulse2.com/colossal-200-million-series-c-raised-at-10-2-billion-valuation-for-de-extinction-technology/	.	Colossal.com

Investor	Richard Garriott	https://pulse2.com/colossal-200-million-series-c-raised-at-10-2-billion-valuation-for-de-extinction-technology/	.	Colossal.com
Investor	Rising Tide Fund	https://www.crunchbase.com/organization/rising-tide-fund	.	GRObio
Investor	Rivas Capital		.	Inari Agriculture
Investor	Robert Nelsen [not ARCH]	https://colossal.com/company/	.	Colossal.com
Investor	Roche (SWX: ROG)		.	
Investor	Rokos Capital Management		.	Inari Agriculture
Investor	Rusnano		.	
Investor	S32	https://www.s32.com/	.	Manifold, Patch
Investor	Sage Hill Capital		.	Inari Agriculture

Investor	Sahsen Ventures	https://www.crunchbase.com/organization/dyno-therapeutics/company_financials	.	DynoTx
Investor	Samsara BioCapital		.	
Investor	Samuel Smith		.	Tierra Bio
Investor	Sandbox Industries		.	
Investor	Sanofi Genzyme		.	
Investor	SBIR, STTR		.	
Investor	Shake and Bake		.	GhostFire
Investor	Silicon Valley Community Foundation		.	
Investor	Social Capital		.	
Investor	Soleus Capital		.	
Investor	Soma Capital		.	
Investor	Sports Tech Tokyo		.	FitBiomics
Investor	StartX (US)		.	
Investor	State of Michigan Retirement Systems		.	Inari Agriculture
Investor	Stex25		.	
Investor	SV Angel		.	

Investor	Sven-Olof Lindblad	https://pulse2.com/colossal-200-million-series-c-raised-at-10-2-billion-valuation-for-de-extinction-technology/	.	Colossal.com
Investor	SymBiosis Capital Management		.	
Investor	T. Rowe Price	https://www.crunchbase.com/organization/t-rowe-price/investments	.	Editas, PacBio
Investor	T1D Fund		.	
Investor	Tectonic Capital		.	
Investor	Tencent Holdings		.	
Investor	The Invus Group		.	
Investor	The World Economic Forum		.	
Investor	Third Rock Ventures	http://www.thirdrockventures.com/portfolio	.	WarpDrive, Editas
Investor	Thomas Tull [Tulco]	https://colossal.com/company/	.	Colossal.com

Investor	TiE-Boston		.	
Investor	Tom Brady		.	Colossal.com
Investor	Tony Robbins		.	
Investor	Triatomic Capital		.	
Investor	Trustbridge Partners	https://www.crunchbase.com/organization/trustbridge-partners/investments	.	VeritasGenetics
Investor	Tudor Investment		.	Colossal.com
Investor	Tute Genomics		.	Knome
Investor	U.S. Department of Energy		.	
Investor	U.S. Department of Health and Human Services		.	
Investor	United States Department of Defense		.	
Investor	Untamed Planet	https://colossal.com/company/	.	Colossal.com
Investor	Uprising	https://www.crunchbase.com/organization/uprising#/entity	.	EGenesis
Investor	Uprising Ventures		.	

Investor	US Innovative Technology Fund [USIT]		.	Colossal.com
Investor	Vcapital	https://www.crunchbase.com/organization/vcapital/investments	.	RejuvenateBio
Investor	Veritas (Laboratory Services)		.	Curoverse
Investor	Victor Vescovo		.	Colossal.com
Investor	Victor Vescovo	https://pulse2.com/colossal-200-million-series-c-raised-at-10-2-billion-valuation-for-de-extinction-technology/	.	Colossal.com
Investor	Viking Global Investors	https://www.crunchbase.com/organization/viking-global-investors/investments	.	Editas, Ginkgo
Investor	Village Global		.	

Investor	Vivo Capital	https://www.crunchbase.com/organization/vivo-capital/investments	.	ReadCoor
Investor	Wave Digital Assets		.	Colossal.com
Investor	Waveland Group		.	Tenza (Drug Delivery)
Investor	Wealthing VC Club		.	
Investor	Wellington Partners		.	
Investor	WestRiver Group		.	Viome Life Sciences
Investor	Will Ventures		.	
Investor	Willett Advisors		.	
Investor	Willett Advisors			
Investor	William Gates		.	
Investor	William Gates			
Investor	Wilson Sonsini Goodrich & Rosati	https://www.crunchbase.com/organization/wilson-sonsini-goodrich-rosati	.	GRObio

Investor	Wilson Sonsini Goodrich & Rosati	https://www.crunchbase.com/organization/wilson-sonsini-goodrich-rosati		GRObio
Investor	Windham Venture Partners	https://www.crunchbase.com/organization/windham-venture-partners	.	Nebula
Investor	Windham Venture Partners	https://www.crunchbase.com/organization/windham-venture-partners		Nebula
Investor	Winklevoss Capital	https://colossal.com/company/	.	Colossal.com
Investor	Winklevoss Capital	https://colossal.com/company/		Colossal.com
Investor	Wyss Institute at Harvard University		.	Fitbiomics, GCTx
Investor	Wyss Institute at Harvard University			Fitbiomics, GCTx

Investor	Xfund		.				
Investor	Xfund						
Investor	Y-combinator	https://www.crunchbase.com/organization/y-combinator	.				64-x, Xgenomes
Investor	Y-combinator	https://www.crunchbase.com/organization/y-combinator					64-x, Xgenomes
Investor	Yijing Capital		.				
Investor	Yijing Capital						
Investor	Zetta Venture Partners		.				
Investor	Zetta Venture Partners						
Investor	Zymergen		.				EnEvolv
Investor	Zymergen						EnEvolv
M&A	Future of Life Institute [FLI]	http://thefutureoflife.org/who	Cambridge MA	2014	2014	present	technology risk management

M&A	Ginkgo [Gen9, Zymergen, WarpdriveBio, Joule, Patch, FormBio]	https://www.prnewswire.com/news-releases/ginkgo-bioworks-acquires-warp-drive-bios-genome-mining-platform-for-discovery-and-development-of-novel-classes-of-antibiotics-300850312.html	Boston MA	2008	2017	present	Synthetic Biology.
M&A	Thermo Fisher [IonTorrent, ABI]	https://en.wikipedia.org/wiki/Life_Technologies_(Thermo_Fisher_Scientific)	.			present	Molecular Bio tools
M&A	Beckmann Coulter [Danaher, Agencourt]		.				Next-gen sequencing

M&A	Juno [Abvitro, Celgene]	http://www.businesswire.com/news/home/20160111005419/en/Juno-Therapeutics-Adds-Next-Generation-Single-Cell-Sequencing	.		Immunotherapies
M&A	Kollmorgen [Danaher]	https://www.kollmorgen.com/en-us			Precision motors
M&A	Oscient [GTC]	https://www.bioworld.com/articles/574890-genome-therapeutics-changes-name-to-oscient-pharmaceuticals?v=preview	Waltham MA	2004	Therapeutics

M&A	Revolution Medicines	https://endpts.com/six-years-after-a-spectacular-debut-warp-drive-bio-is-powering-down-and-handing-its-undruggable-ambitions-over-to-revolution/	.				Antibiotic discovery
M&A	Tute [Knome, PierianDX]	https://tutegenomics.com/	.				Genome Dx
M&A	Twist Bioscience	https://www.twistbioscience.com/	.				DNA synthesis
SAB	10X genomics	https://www.10xgenomics.com/	Pleasanton CA	2012	2020	present	spatial omics
SAB	23andme	https://web.archive.org/web/20131017160634/https://www.23andme.com/about/advisors/	Mountain _View CA	2006	2006	present	personal genomics

SAB	4baseCare	https://4basecare.com/	Karnataka India	2017	2019	present	Cancer genomics
SAB	4Bionics-Homodeus	https://www.4catalyzer.com/	Guilford CT	2019	2019	present	integrase engineering & Covid diagnostics
SAB	AanikaBio	https://www.aanikabio.com/about#our-advisors	Brooklyn NY	2019	2019	present	formerly Carverr, supply chain tracking
SAB	Adaptive Phage Therapeutics	http://www.aphage.com/about-adaptive-phage-therapeutics/#team	Gaithersburg, MD	2016	2018	present	phage therapies
SAB	Advancement Initiative for Medicine and Science [AIMS]	http://theaims.org/en/board/	Boston MA	2006	2018	present	medical education
SAB	Ageless Sciences Inc [NovosLabs]	https://www.crunchbase.com/organization/novos-701e	New_York NY	2021	2021	present	nutrional supplements
SAB	AgeMeter	https://www.agemeter.com	Las_Vegas NV	2010	2010	present	physiological metrics
SAB	Agilent Technologies	http://www.agilent.com	Palo_Alto CA	1999	2001	present	nucleic acid nanopore sensors
SAB	Aikium	https://www.aikium.com	Berkeley CA	2022	2023	present	targeting GPCRs

SAB	Alphazyme	https://www.alpha-zyme.com/	Jupiter, FL	2019	2019	present	Enzymes
SAB	Altruistic Technology Labs	https://altlabs.tech/about/	Berkeley, CA	2019	2019	present	global risk diagnostics, synbio attribution
SAB	Alveo Technologies	https://alveotechnologies.com/science.php	Alameda CA	2018	2019	present	Infectious disease diagnostics
SAB	Androcyte LLC	https://www.cryonicsarchive.org/docs/cryonics-magazine-2016-05.pdf	Aventura FL	2013	2013	present	Aging Reversal
SAB	AOBiome	http://web.archive.org/web/20160531232344/http://aobiome.com/directors-advisors	Cambridge MA	2013	2013	present	Skin Microbes
SAB	Applied Biotech Lab	https://www.appliedbiotechlab.com/advisors	London UK	2020	2020	present	Biotech
SAB	Aptah Bio Inc	https://aptah-bio.com	San_Carlos CA	2024	2024	present	RNA splicing drugs
SAB	Arc	http://arcprograms.net/about/arc-advisory-board/	Boston MA	2014	2014	present	Biomed + IT fusion

SAB	ArcherDx [InVitae]	https://ir.invitae.com/news-and-events/press-releases/press-release-details/2020/Invitae-and-ArcherDX-to-create-a-global-leader-in-comprehensive-cancer-genetics-and-precision-oncology/default.aspx	Cambridge MA	2013	2019	present	precision oncology
SAB	ArgenTAG	https://www.argentag.com/	Rosario Argentina	2021	2021	present	Long-read sequencing
SAB	Artemys	https://artemysfoods.com/	San_Leandro CA	2019	2019	present	Lab cultivated meat
SAB	Astrego Dx	https://astrego.se/	Uppsala, Sweden	2017	2017	present	Dx drug susceptibility
SAB	Attivare Tx	https://crunchbase.com/organization/attivare-therapeutics	Natick MA	2021	2021	present	biomaterial vaccines

SAB	AuraVax Therapeutics Inc	https://www.prnewswire.com/news-releases/auravax-therapeutics-announces-formation-of-scientific-advisory-board-chaired-by-george-m-church-phd-301297565.html	Houston TX	2021	2021	present	intranasal vaccination
SAB	Avammune	https://www.avammune.com/	Philadelphia PA	2017	2019	present	ENPP1 inhibitors, STING pathway
SAB	Axcella	https://www.flagshippioneering.com/stories/q-a-with-george-church	Littleton MA	2008	2008	present	metabolic modulators

SAB	Berggruen Institute	http://berggruen.org/work/the-transformations-of-the-human/bio-tech-the-human-collective/	Los_Angeles CA	2014	2017	present	Global dialog
SAB	BetterHumans	https://betterhumans.org/projects.html	Gainesville FL	2011	2011	present	aka Androcyte, 501(c)(3), Supercentenarians
SAB	Bifrost	https://bifrostbio.com/	Boston MA	2022	2022	present	monitoring growing cells
SAB	BioLoomics	https://www.bioloomics.com/about-us	Boulder CO	2023	2023	present	Targeted antibody Tx
SAB	Bione Ventures Limited	https://www.bione.in/about-us	Karnataka, India	2021	2021	present	genome + microbiome
SAB	Biophysical Therapeutics	https://www.biophysicaltherapeutics.com/	Wilmington DE	2022	2022	present	Aging and reducing metabolic heat
SAB	BioViva	http://www.bioviva-science.com/advisory-board/	Seattle WA	2015	2015	present	anti-aging gene therapies

SAB	Boutique Venture Partners	https://www.boutiquevc.com/team/prof-george-church	Palo_Alto CA	2020	2022	present	Life science investments
SAB	Bronic	https://www.bronic.co/	London UK	2023	2023	present	Everyday biotech
SAB	Brotman Baty Institute	https://brotmanbaty.org/about	Seattle WA	2017	2019	present	Genomics tech
SAB	Camden Nexus	http://www.camdenpartners.com/nexus/	Baltimore, MD	2019	2019	present	Biomedical Technologies
SAB	Camden Partners	https://www.camdenpartners.com/	Owings_Mills MD	1995	2023	present	biotech
SAB	Caribou Biosciences	http://cariboubio.com	Berkeley CA	2012	2013	present	Cas9 tools) & Intellia 201
SAB	Catalio Capital Management	https://www.cataliocapital.com/team	New_York NY	2023	2023	present	Biotecnology
SAB	Celemics	http://www.celemics.com	Seoul Korea	2011	2011	present	Genome engineering.
SAB	Celestial Tx	https://www.celestialtherapeutics.com/news	Irvine CA	2021	2021	present	lipid, mRNA Tx, vaccines
SAB	CellinoBiotech	https://www.cellinobio.com/	Cambridge MA	2017	2017	present	ex vivo protein therapeutic delivery

SAB	CellOrigin	https://www.prnewswire.com/news-releases/cellorigin-secured-a-new-round-of-investment-for-developing-its-globally-proprietary-ipsc-car-macrophage-technology-platform-301401007.html	Hangzhou China	2021	2021	present	CAR-Macrophage
SAB	Cellular Technology Limited [CTL]	https://immunospot.eu/our-company	Cleveland OH	1998	2019	present	cellular immune assays
SAB	Centrillion Genomics Technologies	http://www.centrilliontech.com/advisor/	Palo_Alto CA	2009	2017	present	DNA synthesis
SAB	Clinomics	http://clinomics.com/en/coreWorkforce	Ulsan Korea	2015	2015	present	Cinical multiomics

SAB	CloudHealth Genomics	http://www.marketwired.com/press-release/george-church-world-renowned-scientist-joins-scientific-advisory-board-cloudhealth-medical-2238710.htm	Shanghai	2017	2017	present	pan-omics
SAB	Cobalt Biomedicine VL39	https://www.massbio.org/member/vl39-126150	Boston MA	2018	2018	present	Sana therapeutics
SAB	Convergent Research_E11	https://www.convergentresearch.org/	Cambridge MA	2021	2021	present	Focused Research Orgs (FRO)
SAB	Crestwood Advisors LLC	http://www.crestwoodadvisors.com/	Boston MA	2003	2009	present	Investing
SAB	Cultivarium	https://www.cultivarium.org/#team	Watertown MA	2020	2020	present	accessing novel microbes
SAB	Curii	https://www.curii.com/#team	Somerville MA	2020	2020	present	Computational genomics, cloud, AI

SAB	Dart Biosciences	https://crunchbase.com/organization/dart-biosciences	London UK	2024	2024	present	T-cell gene Tx
SAB	DeSci Foundation	https://www.descifoundation.org/about	New_York, NY	2014	2022	present	Decentralized Science
SAB	Detect.com	https://www.detect.com	Guilford, CT	2024	2024	present	diagnostics
SAB	Dior Science	https://www.linkedin.com/posts/parfums-christian-dior_reverse-aging-dior-science-activity-7047085052043665408-w0CL/	Paris France	2000	2019	present	Aging reversal
SAB	DNA-Romance	https://www.dnaromance.com/	Vancouver BC	2014	2024	present	Dating app for couples, HLA & other DNA analyses
SAB	E11.bio	https://e11.bio/	Alameda CA	2022	2022	present	Scalable single-cell brain circuit mapping
SAB	Edge Foundation	http://edge.org/memberbio/george_church	New_York, NY	1988	2005	present	science communication

SAB	EngineeringBiologyCenter.org	https://engineeringbiologycenter.org/	New_York, NY	2018	2018	present	genome-scale editing/synthesis/recoding
SAB	Enhanced Games Ltd	https://enhanced.org/science-is-real/	Kensington UK	2023	2023	present	safer sports
SAB	EnPlus One	https://www.enplusonebio.com/team/	Watertown MA	2020	2020	present	RNA modification chemistry
SAB	Epinoma Inc	https://www.vcnewsdaily.com/Epinoma/venture-funding.php	San_Carlos CA	2021	2021	present	epigenetic early-stage cancer detection
SAB	Episteme Research	https://opencorporates.com/companies/us_ca/4779454	New_York NY	2023	2023	present	Young Researchers
SAB	EternaDNA	https://www.eternadna.com/	Singapore Singapore	2021	2021	present	DTC epigenetic testing
SAB	Flagship Ventures	http://www.flagshipventures.com/venturelabs/working-with-venturelabs	Cambridge MA	2000	2000	present	genomics & informatics

SAB	Frontera Therapeutics	https://opencorporates.com/companies/us_ma/001446271	Boston MA	2020	2020	present	AAV
SAB	FrontierBio	https://www.frontierbio.com/	San_Francisco CA	2018	2018	present	3D bioprinting
SAB	G42	https://en.mgi-tech.com/news/160/	Abu_Dhabi UAE	2021	2021	present	Human genomics
SAB	Gametogen	https://www.gametogen.com/company	New_York, NY	2020	2020	present	in vitro ovarian cells
SAB	GC-Tx	https://www.gc-tx.com/	Cambridge MA	2020	2020	present	Cell therapies, testing Tx
SAB	Genapsys	http://web.archive.org/web/20190822210825/http://www.genapsys.com/team/	Redwood_City CA	2010	2010	present	Label-free nanosensor array sequencing.
SAB	GenEdit	http://www.genedit.com/	Berkeley CA	2015	2016	present	CRISPR delivery
SAB	Genera.Bio [Replay.Bio]	https://replay.bio/team	San Diego	2023	2023	present	Large DNA Synthesis
SAB	GenerationLab	https://www.generationlab.com/	San Francisco	2024	2024	present	Aging

SAB	Genome Compiler Corp [Twist]	http://genomecompiler.com/about-genome-compiler	San_Francisco CA	2011	2011	present	Twist, Genome CAD
SAB	Genorasis	https://www.genorasis.com/	Seattle WA	2023	2023	present	Eye gene therapies
SAB	Genscript	https://www.genscript.com/advisory_board.html	Piscataway, NJ	2020	2018	present	genome-scale editing/synthesis/recoding
SAB	Ginkgo Bioworks	http://www.bizjournals.com/boston/news/2017/01/20/boston-based-ginkgo-snaps-up-george-church-founded.html	Boston MA	2008	2017	present	Synthetic Biology. See: Gen9, Zymergen, WarpdriveBio, Joule, Patch, FormBio
SAB	Gnubiotics Sciences SA	https://gnubiotics.com	Monthey Switzerland	2024	2024	present	glycans
SAB	Harton Tx	https://www.hartontherapeutics.com/our-team	Cambridge MA	2021	2021	present	immune medicine

SAB	HelixNano	https://www.helixnano.com/advisory-board	Cambridge MA	2013	2016	present	non-viral gene delivery
SAB	Hera Testing Laboratories	https://www.herabiolabs.com/	Lexington KY	2014	2014	present	Gene editing cells & animals
SAB	HLTH.network	https://hlth.network/	London UK	2021	2021	present	health data
SAB	Holobiome	http://holobiome.org	Boston MA	2016	2017	present	Brain-gut microbiome therapies
SAB	Homeworld Bio	https://homeworld.bio/about/	San_Francisco CA	2023	2023	present	climate solutions
SAB	Humanity.com Inc	https://www.businesscloud.co.uk/news/new-healthtech-app-launches-with-1-9m-funding-to-reverse-aging/	Boston MA	2020	2020	present	watch-based age-related apps
SAB	Humanity.health	https://www.humanity.health/	New_York NY	2019	2019	present	Wellness
SAB	Identifeye.health	https://www.identifeye.health/	Guilford, CT	2015	2024	present	AI retinal diagnostics

SAB	INanoBio	http://www.inanobio.com/scientific-advisory-board.php	Tempe AZ	2007	2017	present	Sensors & sequencing
SAB	Inst for Protein Design [IPD]	https://www.ipd.uw.edu/people/advisory-board/	Seattle WA	2012	2015	present	De novo proteins
SAB	Institute for Protein Innovation [IPI]	https://proteininnovation.org/team#sab-banner	Boston MA	2017	2018	present	antibodies
SAB	Integra-Tx	https://integra-tx.com/	Barcelona Spain	2021	2021	present	gene writing
SAB	Inzen Tx	https://www.inzentx.com/	Cambridge MA	2021	2021	present	Thanokines
SAB	Iridia	http://iridia.com/data-storage-solution-may-be-in-the-dna/	San_Diego CA	2017	2018	present	DNA data storage
SAB	Ivy Natal	https://www.ivynatal.com	San_Francisco CA	2019	2020	present	skin derived gametes
SAB	Ixbio	https://www.nature.com/articles/s41587-019-0369-7/tables/1	Boston MA	2018	2018	present	bio tools

SAB	JethroPharma	https://jethropharma.com/	Boston MA	2019	2019	present	Clinical translation
SAB	JumbleTx	https://www.bizapedia.com/ma/jumble-therapeutics-inc.html	Boston MA	2023	2023	present	Tx
SAB	Kanvas Biosciences Inc	https://www.kanvasbio.com/	Princeton NJ	2021	2021	present	multiplexed microbial imaging
SAB	Kendall Capital Partners	https://www.sec.gov/Archives/edgar/data/1856977/000110465921050279/xslFormDX01/primary_doc.xml	Boston MA	2020	2020	present	Biotech investment
SAB	Latch-Bio	https://latch.bio/about	San_Francisco CA	2023	2023	present	comp-Bio pipelines
SAB	Life Extension Advocacy Foundation [LEAF]	https://www.lifespan.io/advisory-board-2/	Seaford, NY	2015	2015	present	aging
SAB	Logic.Ink	http://www.logic.ink/	San_Francisco CA	2015	2015	present	Data collecting temporary tattoos
SAB	Longevity Vision Fund	https://lvf.vc/academic/	New_York, NY	2019	2020	present	aging reversal

SAB	Lynx [Solexa, Illumina]	http://web.archive.org/web/20120908062001/http://www.thefreelibrary.com/Lynx+Augments+Its+Intellectual+Property+Portfolio.-a058723058	Hayward CA	1992	2000	present	multiplex tags
SAB	Marble Therapeutics [MRBL]	https://www.linkedin.com/company/marbletx/	Cambridge MA	2020	2020	present	skin gene delivery
SAB	Matter Bio	https://matterbio.com/	New_York NY	2021	2021	present	Aging & somatic mutation based diseases
SAB	Memphis Meats [now Upside]	http://www.memphismeats.com/	New_York NY	2015	2016	present	tissue culture foods
SAB	Menlo Ventures Management	https://menlovc.com/team/	Menlo_Park CA	1976	2023	present	Biotechnology
SAB	Micromole.xyz	https://micromole.xyz	Berkeley CA	2024	2024	present	Long DNA sequencing reads
SAB	Nabla Bio	https://www.nabla.bio/company	Cambridge MA	2020	2020	present	protein design via machine learning

SAB	Nasadiya Bio Inc.	https://app.g2xchange.com/companies/ZUBWR6ZJVZS1	San Diego, CA	2024	2024	present	Multi-Cancer Early Detection
SAB	Nature Publishing Group [NPG]	https://en.wikipedia.org/wiki/Molecular_Systems_Biology	London UK	1869	2005	present	senior editor, MSB
SAB	Nephrogen	https://www.nephrogenbiotech.com/#Team	Beverly MA	2020	2020	present	Tx for kidney dieases
SAB	NerdBio [CellarisBio]	https://opencorporates.com/companies/us_ca/201816310746	San_Diego CA	2018	2022	present	cell target engagement
SAB	NeubaseTx	https://www.neubasetherapeutics.com/about/	Pittsburgh PA	2019	2019	present	PNA Antisense Therapeutics
SAB	Neurona Health	https://www.neuronahealth.com/	Roseville CA	2021	2021	present	Autism Dx PRS

SAB	NextGenJane	https://pulse.embs.org/november-2016/womens-health-is-personal/	Oakland CA	2016	2018	present	endometrial diagnostics
SAB	nference.ai	http://nference.ai/	Cambridge MA	2017	2017	present	Machine Learning
SAB	NovosLabs	https://novoslabs.com/	.			present	Age-related metabolism
SAB	Nuclera Nucleics	http://www.nuclera.com/	Cambridge UK	2014	2017	present	DNA synthesis
SAB	NuProbe	http://nuprobe.com/	Cambridge MA	2018	2017	present	Toehold tech
SAB	Nurfy	https://www.nurfy.care	Brooklyn, NY	2024	2024	present	home microbiology
SAB	Nurture Genomics	https://nurturegenomics.com/about-us/	Cambridge, MA	2022	2023	present	Rare disease Genomic screening
SAB	Omega Therapeutics	https://omegatherapeutics.com/about-us/	Cambridge MA	2016	2018	present	epigenetic medicine
SAB	Ontera Inc. [Twoporeguys]	http://twoporeguys.com/about.html	Santa_Cruz CA	2016	2016	present	nanopore diagnostics
SAB	Optra Health	https://www.optrahealth.com/about/company	San_Jose CA	2015	2018	present	Digital HealthCare

SAB	Opus Therapeutics	https://opusgtx.com/	Durham NC	2021	2022	present	prenatal gene editing
SAB	Orbit Genomics	http://www.orbitgenomics.com/scientific-advisory-board/	Boulder CO	2016	2017	present	precision medicine and DNA repeats
SAB	Outsized Ventures	https://www.outsized.vc/team	London UK	2021	2021	present	Biotech Investments
SAB	Ovelle Bio	https://ovelle.bio/	Cambridge MA	2025	2025	present	human meiosis
SAB	Oxford Cryotechnology	https://oxfordcryotech.com/about-us/	Oxford UK	2023	2023	present	Cryo-preservation

SAB	Patch.bio [then Ginkgo]	https://www.prnewswire.com/news-releases/ginkgo-bioworks-acquires-patch-biosciences-expanding-suite-of-genetic-medicine-capabilities-available-to-customers-302073671.html	New_York NY	2021	2021 present	machine-designed DNA for gene therapy
SAB	Pathway Genomics	http://www.businesswire.com/news/home/20140227005427/en/World-Renowned-Geneticist-George-Church-Joins-Pathway-Genomics	San_Diego CA	2008	2013 present	Personal Genomics

SAB	Pattern Computer	https://www.patterncomputer.com/about-us/	Friday_Harbor, WA	2021	2021	present	advanced AI
SAB	Peak6	https://peak6.com/	Chicago, IL	1997	2021	present	technology investment
SAB	PearlBio	https://www.pearlbio.com/about-us/	Cambridge MA	2021	2022	present	Novel amino acids
SAB	Peptilogics	https://www.peptilogics.com/	Pittsburgh, PA	2019	2019	present	Engineered Cationic Antibiotic Peptides
SAB	Pershing Square Foundation	https://medicine.yale.edu/news-article/the-pershing-square-foundation-is-accepting-applications-for-its-2024-mind-prize/	New_York, NY	2006	2023	present	support for early career scientists
SAB	Petri Bio	http://petri.bio	Cambridge MA	2019	2019	present	Biotech accelerator

SAB	Pleistocene Park [Northeast Science Station]	https://medium.com/@eriona.hysolli/an-american-russian-collaboration-to-repopulate-siberia-with-woolly-mammoths-or-something-similar-9cbac4e985cb	Chersky Russia	1996	2018	present	Arctic Ecosystems
SAB	Plex Research	https://angel.co/company/plex-research	Cambridge MA	2018	2018	present	Search engines for drug discovery)
SAB	Poseida Therapeutics	https://poseida.com/about-us/#sab	San Diego	2014	2014	present	Cell & gene therapies
SAB	Prime Discoveries	https://www.primediscoveries.com/	New_York NY	2019	2019	present	Rapid COVID-19 Panels for Laboratories

SAB	ProPhase Labs [Nebula]	https://genomeweb.com/sequencing/prophase-labs-acquires-personal-genome-sequencing-firm-nebula-genomics-146m	Garden_City, NY	2021	2021	present	DTC genomics
SAB	Protein Evolution	https://www.protein-evolution.com/about-us	Guilford, CT	2024	2024	present	decarbonizing plastic production
SAB	Pupil Bio	https://www.pupil.bio/	Houston TX	2022	2023	present	autoimmune T1 diabetes
SAB	Radvac.org	https://radvac.org/	Boston MA	2020	2020	present	nasal vaccines
SAB	Regenerative Bio	http://regen-bio.com/	Boston MA	2021	2021	present	anti-aging, AI, cloud computing
SAB	Regula Bio	https://www.bizapedia.com/ma/regula-bio-inc.html	Boston MA	2023	2023	present	Age reversal
SAB	Rejuvenatebio	http://www.rejuvenatebio.com/	Boston MA	2015	2015	present	aging-reversal gene therapies

SAB	Roswell Biotechnologies	https://www.prnewswire.com/news-releases/roswell-biotechnologies-forms-scientific-advisory-board-301410793.html	San_Diego CA	2016	2016	present	Biomolecular sensors
SAB	S'more [Tawkify]	https://techcrunch.com/2023/02/13/tawkify-matchmaking-acquistion-smore-dating-app/	New_York NY	2019	2019	present	anti-superficial Dating / matchmaking
SAB	Scientific American	http://www.nature.com/press_releases/scientificamerican_advisors.html	New_York, NY	1845	2008	present	editorial advisor
SAB	Seed.com	https://seed.com/we/	Venice, CA	2018	2018	present	microbiome

SAB	SENS Research Foundation	https://www.sens.org/about-us/leadership/research-advisory-board/	Mountain_View, CA	2009	2013	present	aging
SAB	Seven Therapeutics	https://www.crunchbase.com/organization/seven-therapeutics	Singapore			present	immune-stealth AAV/Cas
SAB	Shape Therapeutics	https://www.shapetx.com/our-team	Tumwater WA	2018	2018	present	RNA therapies
SAB	Shield Dx	https://shielddx.com/about	San_Jose, CA	2018	2018	present	Infectious disease diagnostics
SAB	Shivom	https://www.the-scientist.com/bio-business/startups-plan-the-health-data-gold-rush-64840	London UK	2019	2019	present	medical data sharing
SAB	Signet Therapeutics Inc.	https://www.linkedin.com/company/signet-therapeutics/	Boston MA	2020		present	cancer therapies using organoids and AI.

SAB	Single Cell Technology	http://www.single-cell-technology.com/scientific-advisory-board/	San_Jose CA	2013	2013	present	Therapeutic antibodies
SAB	Singlera Genomics	http://www.singleragenomics.com>Singlera Genomics La Jolla, CA 2015 (2017-present; Genetic diagnostics)	La_Jolla, CA	2015	2017	present	Genetic diagnostics
SAB	Skinome	http://skinome.com/aboutus	Santa_Clara CA	2016	2016	present	personalized skin care
SAB	SmartSkinBiome	https://www.facebook.com/p/Smart-Skin-Biome-100068488472744/?_rdr	San_Francisco, CA	2018	2018	present	skin microbes
SAB	SNIPR Biome LTD	https://www.sniprbiome.com/team	Cambridge UK	2017	2017	present	CRISPR + phage

SAB	SolveBio	https://www.solvebio.com/about	New_York NY	2012	2016	present	Computational genomics
SAB	Spatial Temporal Omics Consortium [STOC]	https://www.sto-consortium.org/	Singapore Singapore	2022	2023	present	STOC
SAB	Syenex	https://pitchbook.com/profiles/company/507164-50#overview	Evanston IL	2022	2022	present	extracellular vesicle terapeutics
SAB	Symphogen [Receptor BioLogix]	http://www.fiercebiotech.com/press-releases/symphogen-s-acquires-receptor-biologix-inc-technology	.			present	recombinant polyclonal Ab,
SAB	Syntax-Bio [was Cellgorithmics]	https://www.syntax-bio.com/	.			present	stem cell-derived therapies
SAB	Synthego	http://www.synthego.com/	Redwood _City CA	2016	2017	present	RNA synthesis

SAB	Technicolor SA	http://www.globalpost.com/article/6628554/2015/08/09/harvard-scientist-coding-entire-movie-dna	Issy-les-Moulineaux, France	1914	2012	present	Nucleic Acid Memory
SAB	Terrain Life Science	https://www.terrainlifescience.com/about-us	Boston MA	2025	2025	present	spatial proteomics for cancer Dx
SAB	Tessera Therapeutics	https://www.tesseratherapeutics.com/team	Cambridge MA	2020	2020	present	gene writing
SAB	The CRISPR Journal	https://home.liebertpub.com/publications/the-crispr-journal/642/editorial-board	New_Rochelle NY	2018	2018	present	editorial advisor
SAB	The ODIN	http://www.the-odin.com/about-us/	Castro_Valley CA	2013	2016	present	Consumer SynBio

SAB	Thymmune Therapeutics	https://www.bizapedia.com/ma/thymmune-therapeutics-inc.html	Cambridge MA	2020	2020	present	immune system
SAB	Tomorrow.Life	https://www.tomorrow.life/	Pittsburgh PA	2020	2020	present	Filmmaking
SAB	Transposagen	http://biotech-365.com/transposagen-piggybac-transposon-system/	Lexington KY	2003	2014	present	Poseida Therapeutics, Hera Testing; Mammalian genome engineering
SAB	TransposonRx	https://transposonrx.com	San_Diego CA	2024	2024	present	Inhibiting human transposons
SAB	Treatus	https://www.treatus-inc.com/	Boston MA	2023	2023	present	Healthcare delivery
SAB	Unravel Biosciences	https://www.unravel.bio/about	Boston MA	2023	2023	present	rapid prototyping Tx for complex disorders
SAB	Verge	http://www.vergegenomics.com/about-us-1#team	San_Francisco CA	2015	2015	present	Neurotherapeutics
SAB	Viome	https://www.viome.com/company	Bellevue, WA	2021	2021	present	pro- + pre- biotics
SAB	Volta Labs	https://www.voltalabs.com	Cambridge MA	2018	2018	present	bio-automation

SAB	Xgenomes	https://www.xgenomes.com/	Cambridge MA	2014	2014	present	Analytical optical instruments
SAB	Xpose Therapeutics	https://www.xposetx.com/team	San_Francisco CA	2019	2023	present	DNA damage response Tx
SAB	Copernicus Space Corp	https://avi-loeb.medium.com/the-next-copernican-revolution-9110709b7320	Boston MA	2023	2023	2024	gram-scale space probes
SAB	RegmedFoundation.org Trade Show	https://www.linkedin.com/company/r2mtradeshow/	Wellington, FL	2023	2023	2024	Meetings
SAB	Elysium Health	http://www.elysiumhealth.com/team	New_York, NY	2014	2015	2023	Aging & genomic nutritional supplements
SAB	LalTal	https://davidbieber.com/snippets/2022-01-18-snippets-lessons-for-laltal/	Lafayette CA	2020	2022	2023	communication
SAB	Onconetics	http://onconetics.com/	Mill_Valley CA	2016	2019	2023	Gene Therapies

SAB	SIAT genome engineering and therapy	http://english.siat.cas.cn/News2017/SN2017/201910/t20191029_221819.html	Shenzhen China	2019	2019	2023	mammalian genome recoding
SAB	Complete Genomics [CGI/BGI/MGI]	https://www.seqanswers.com/forum/sequencing-technologies-companies/service-providers/19582-bgi-shenzhen-acquires-complete-genomics	Sunnyvale CA	2006	2006	2022	fluorescent NGS
SAB	Regenesis Institute	https://research.genomics.cn/jointLaboratory	Shenzhen China	2017	2017	2022	recoding and DNA-storage
SAB	Alibaba DAMO	http://www.chinadaily.com.cn/bizchina/tech/2017-10/12/content_33145000.htm	Academy Hangzhou	2017	2017	2020	DAMO

SAB	Centre for Study of Existential Risk [CSER]	http://cser.org/people	Cambridge UK	2013	2013	2020	Risk
SAB	GPBio	https://web.archive.org/web/20180320015756/http://gpbio.com/	Shanghai China	2017	2017	2020	DNA chip diagnostics
SAB	ReadCoor [10X Genomics]	https://genomeweb.com/sequencing/10x-genomics-acquire-readcoor-350m-cartana-412m	Boston MA	2014	2014	2020	In situ Sequencing
SAB	Zhejiang University	https://www.zju.edu.cn/english/2017/1106/c19573a811233/page.htm	Hangzhou China	1897	2017	2020	Cell therapies
SAB	7Tx	https://www.seventherapeutics.com/	Boston MA	2019	2019	2019	deimmunizing
SAB	Amrita GP LLC	https://files.brokercheck.finra.org/individual/individual_1996617.pdf	New_York NY	2016	2016	2019	biomedical investment

SAB	Arivale	https://web.archive.org/web/20190122204017/https://www.arivale.com/about-us/	Seattle, WA	2015	2015	2019	Omics and wellness
SAB	Rady Children's Institute for Genomic Medicine	https://www.radygenomics.org/	San_Diego CA	2017	2017	2019	Precision pediatrics
SAB	Recombinetics	http://www.businesswire.com/news/home/20170110005835/en/Recombinetics-Expands-Scientific-Advisory-Board	St_Paul, MN	2008	2016	2019	animal genome engineering
SAB	Searna	http://www.searna.com/	Boston MA	2015	2015	2019	DNA enrichment diagnostics
SAB	uBiome	https://ubiome.com/science/	San_Francisco CA	2012	2016	2019	microbiome measures
SAB	United Therapeutics	https://www.unither.com/about-us/leadership	Silver_Spring MD	1996	2018	2019	Lung biology and organoids

SAB	GenePeeks	https://www.genepeeks.com/about/advisory-boards/	New_York NY	2014	2014	2018	pre-conception human genetics
SAB	Genia	https://web.archive.org/web/20160603203157/http://www.geniachip.com/about/advisory	Mountain_View, CA	2009	2011	2018	then Roche; nanopores
SAB	Med Data Quest [MDQ]	http://meddataquest.com/	San_Diego CA	2015	2015	2018	Clinical genomics
SAB	Autodesk	https://www.fiercebiotech.com/it/george-church-autodesk-embark-project-to-synthesize-human-genome	Mill_Valley CA	1982	2012	2017	caDNano & personal genomics
SAB	Genos	https://www.genosresearch.com/team.html	San_Francisco, CA	2016	2016	2017	Personal Genomics

SAB	Genspace	http://www.genspace.org/blog/2011/11/11/new-advisory-board-members/	Brooklyn NY	2009	2011	2017	DIY Bio
SAB	Yizhen Biological Technology	https://www.yicaiglobal.com/news/genetics-pioneer-george-church-bgi-aim-to-develop-virus-resistant-organisms-at-newly-opened-genesis-institute-in-shenzhen	Hangzhou China	2017	2017	2017	Genetic disease risk
SAB	Cellular Dynamics International [CDI then Fuji]	http://www.cellulardynamics.com/news/medialib/	Madison WI	2006	2009	2016	Fujifilm, iPS stem cells
SAB	Ecoeos	http://nowlabsinc.com/ecoeos	San_Francisco CA	2013	2013	2016	Environmental chemicals and omics

SAB	Genomatica	https://web.archive.org/web/20161224064906/http://www.genomatica.com/about/advisors/	San_Diego CA	2001	2001	2016	microbial metabolic models
SAB	Pronutria	https://web.archive.org/web/20140319162858/http://www.pronutria.com/who-we-are/advisors/	Cambridge, MA	2011	2011	2016	Axcella, nutritional synbio
SAB	SeresHealth	https://web.archive.org/web/20161206151235/http://sereshealth.com/about/leadership/scientific-advisors	Cambridge MA	2012	2012	2016	microbiome therapeutics
SAB	Enzymatics	https://web.archive.org/web/20131121032304/http://www.enzymatics.com/board_of_directors.htm	Beverly MA	2006	2006	2015	Qiagen Large-scale, high quality enzymes

SAB	Georgarage LLC	https://www.delawarecompanies.org/georgarage-llc	Wilmington DE	2014	2014	2015	tech & biotech
SAB	NABsys	https://web.archive.org/web/20150729145756/http://www.nabsys.com/About-Us/Scientific-Advisors.aspx	Providence RI	2005	2010	2015	SbH with nanopores
SAB	Cambrian Genomics	https://angel.co/cambrian-genomics	San_Francisco CA	2011	2011	2014	nextgen DNA synthesis + synthesis
SAB	Genomera	https://www.crunchbase.com/organization/genomera#section-overview	San_Francisco CA	2010	2010	2014	Crowd-sourced Health Insight
SAB	Noblegen Biosciences	https://web.archive.org/web/20150218153814/http://noblegenbio.com/Advisors.html	Boston MA	2010	2010	2014	optipore sequencing

SAB	X-prize.org	http://genomics.xprize.org/news/blog/cancellation-of-archon-genomics-xprize-public-debate	Playa_Vista CA	1996	2005	2014	sequencing & energy
SAB	DeMatteo Monness LLC	http://www.bloomberg.com/research/stocks/private/snapshot.asp?privcapId=6959637	New_York, NY	1997	2011	2013	DNA Sequencing
SAB	Epitome [Millipore]	https://web.archive.org/web/20160306185437/http://www.sondergroup.com/2013/05/synthetic-biology-has-arrived/	Cambridge MA	2004	2004	2013	

SAB	Essentient	https://blogs.wsj.com/venturecapital/2011/08/22/flagships-david-berry-harkens-back-to-venture-capitals-roots/	Cambridge MA	2011	2011	2013	global nutrition
SAB	evalueSCIENCE	http://www.evaluescience.com	Zurich Switzerland	2011	2011	2013	Science and policy advising
SAB	Gerson Lehrman Group [GLG]	http://www.glgroup.com/	New_York, NY	1998	2007	2013	Genomics technologies
SAB	Guidepoint Global	http://guidepointglobaladvisors.com/	New_York, NY	2003	2009	2013	Genomics technologies
SAB	Ion Torrent	https://web.archive.org/web/20120114061324/http://www.iontorrent.com/scientific-advisory-board	Guilford, CT	2008	2009	2013	then LifeTech then Thermo Fisher ; electronic sequencing
SAB	Lawrence Ellison Foundation	https://www.ellisonfoundation.org/node/3961?page=2	Creek CA	1997	2008	2013	Aging reversal

SAB	Millipore	http://www.millipore.com/	Bedford, MA	1954	1989	2013	multiplex sequencing 1989; 2009-2013 EMD
SAB	Pacific Biosciences	http://www.pacificbiosciences.com	Menlo_Park CA	2004	2008	2013	real-time single-molecule sequencing
SAB	PharmoRx	https://web.archive.org/web/20110201223809/http://www.securingpharma.com/40/articles/132.php	Wellesley MA	2005	2005	2013	secure medication
SAB	Danaher-Dover-Polonator	http://www.polonator.org/	Salem NH	2007	2007	2012	fluorescent NGS instrument
SAB	Halcyon Molecular	https://web.archive.org/web/20120313115343/http://halcyonmolecular.com/team/advisors-and-collaborators/	Redwood_City CA	2009	2009	2012	Mbp read-length EM sequencing
SAB	Helicos Biosciences Corp	https://web.archive.org/web/20130519065115/http://ir.helicosbio.com/scientific_advisory.cfm	Cambridge MA	2004	2003	2012	Single-molecule DNA sequencing

SAB	IBM	http://www.nytimes.com/2009/10/06/science/06dna.html	Yorktown _Heights, NY	1911	2009	2012	DNA Sequencing
SAB	IntelligentBioSystems [IBS, Qiagen]	https://www.crunchbase.com/organization/intelligent-bio-systems#/entity	Waltham MA	2006	2006	2012	Sequencing by Polymerase on beads
SAB	Qteros [formerly SunEthanol]	https://web.archive.org/web/20110813113937/http://www.masshightech.com/stories/2008/11/17/daily20-SunEthanol-renames-as-Qteros-raises-25M-Series-B-fund.html	Amherst MA	2007	2007	2011	Biofuels

SAB	Azco Biotech	https://web.archive.org/web/20150303235508/http://www.azcobiotech.com/about-us.php	Oceanside CA	2003	2009	2010	sequencing system
SAB	Bionanomatrix	http://www.bionanomatrix.com/	Philadelphia PA	2008	2009	2010	Fluorescent mapping
SAB	DNAdirect MEDCO	https://web.archive.org/web/20110312003026/http://www.dnadirect.com/web/about-dna-direct/our-staff-and-advisors	San_Francisco CA	2004	2006	2010	DNA diagnostics

SAB	Genizon Cantaloupe	http://www.genomeweb.com/sequencing/genizon%E2%80%99s-sbh-based-resequencing-tech-may-provide-cost-effective-analysis-option-0	Quebec Canada	2008	2008	2010	In situ sequencing
SAB	Good Start Genetics	http://www.xconomy.com/boston/2009/04/29/massachusetts-1b-life-sciences-plan-pumps-34m-in-loans-into-startups/	Cambridge MA	2009	2009	2010	Molecular Diagnostics
SAB	LightSpeed Genomics	http://www.lsgen.com/	Sunnyvale CA	2007	2007	2010	high-speed DNA sequencing
SAB	New England Biolabs [NEB]	https://www.neb.com/	Beverly MA	1975	2009	2010	protein synthesis

SAB	ACLU, Supreme Court, Association for Molecular Pathology v. Myriad Genetics	http://news.harvard.edu/gazette/story/2013/11/genes-without-patents/	Washington DC	2009	2009	2009	DNA diagnostics
SAB	Oxford NanoPore Technologies	https://nanoporetech.com/about-us/news/oxford-nanopore-and-harvard-university-agreement	Kidlington UK	2005	2008	2009	single-molecule sequencing
SAB	Epstein Foundation	http://www.jeffreyepstein.org/Jeffrey_Epstein.html	St_Thomas, VI	2000	2005	2007	cutting edge science & education
SAB	Receptor Biologix [Symphogen]	http://web.archive.org/web/20060509014355/http://www.receptorbiologix.com/sab.html	San_Francisco CA	2003	2004	2007	alternative splicing

SAB	Agencourt [then Beckman Coulter]	http://www.genomeweb.com/beckman-buys-agencourt-abi-under-pressure	Beverly MA	2000	2003	2006	Polony bead sequencing by ligation
SAB	Applied Biosystems	http://www.nytimes.com/2006/07/18/science/18dna.html?ex=1154232000&en=81ac02a0323e0b16&ei=5070	Foster_City CA	1981	2003	2006	via Agencourt, polony bead sequencing by ligation
SAB	GreenFuel Technologies Corp	http://en.wikipedia.org/wiki/GreenFuel_Technologies_Corporation	Cambridge MA	2004	2005	2006	Photosynthetic CO2 emissions capture
SAB	US Supreme Court: Ebay, Half.com vs MercExchange	http://patentlaw.typepad.com/eBay/MercIntVen.pdf	Washington DC	1997	2006	2006	Intellectual Property

SAB	EngeneOS [Epitome, CodonDevices, Gen9]	https://web.archive.org/web/20140116182952/http://ls9.com/about/founders	Cambridge MA	2001	2000	2005	Engineered Genetic Operating Systems
SAB	Longenity Inc	http://www.bioportfolio.com/corporate/company/27330/Longenity-Inc.html	Boston MA	2001	2001	2005	Boston MA 2001 (2001-2005; human aging
SAB	Pyrosequencing [Biotage, 454]	http://www.thecrimson.com/article/2002/10/3/hms-licenses-technology-to-swedish-biotech/	Stockholm Sweden	2000	2001	2005	modified dNTPs for array sequencing
SAB	BeyondGenomics [then BGMedicine]	http://www.thefreelibrary.com/Beyond+Genomics,+Inc.+to+Present+at+the+CHI+Genome+2001...-a071002294	Cambridge MA	2001	2000	2004	biomarkers & systems biology

SAB	Xeotron [then Invitrogen, Atactic]	http://www.thefreelibrary.com/Xeotron+Announces+Establishment+of+Illustrious+Scientific+Advisory...-a079569129	Houston TX	2000	2001	2004	Light-directed DNA/RNA-microarray synthesis
SAB	Affymetrix [Affymax]	http://www.affymetrix.com/	Palo_Alto CA	1993	1990	2003	Oligonucleotide arrays
SAB	CodonCode Corp	http://www.codoncode.com/	Dedham MA	1996	1996	2003	DNA sequencing software
SAB	Genome Pharmaceuticals [see GPC Biotech, Alacris]	http://www.evaluategroup.com/Universal/View.aspx?type=Story&id=24	Martinsried, Germany	1998	1998	2003	genomics for drug targets
SAB	Adeptient	https://www.ncbi.nlm.nih.gov/pubmed/12159981	Los Altos CA	2000	2001	2002	inkjet aerosols for drug delivery and array manufacture

SAB	Caliper Technologies [then PerkinElmer]	http://www.xconomy.com/san-diego/2016/07/11/a-homage-to-larry-bock-who-had-gods-hand-on-his-shoulder/#	Palo_Alto CA	1995	1994	2002	microfluidics
SAB	First Genetic Trust	http://www.firstgenetic.net/	Chicago, IL	2001	2001	2002	personal genetic information access
SAB	Sangamo [Gendaq]	http://www.sangamo.com/	Richmond CA	1995	2000	2002	Zn-finger engineering
SAB	Aventis [Rhone-Poulenc Rorer & Hoechst Marion Roussel Paris, Frankfurt]	https://www.harvardmagazine.com/sites/default/files/pdf/2004/01-pdfs/0104-44.pdf	Collegeville PA	1990	1998	2001	computational functional genomics
SAB	FamilyGenetix	http://www.familygenetix.com/	Oxford, UK	1990	2000	2001	Genetic patient history software & services
SAB	GenProfile AG	http://www.biospace.com/company_profile.aspx?CompanyId=150504	Berlin, Germany	1998	1997	2001	multiplex haplotyping

SAB	Mosaic Technologies [then Apogent, Illumina]	http://web.archive.org/web/20020524090618/http://www.mostek.com/	Boston MA	1994	1993	2001	DNA diagnostics
SAB	Gamera [then Tecan LabCD]	http://www.tecan.com/page/content/index.asp?MenuID=2185&ID=3737&ConID=3737&View=&Item=34.9.3	Medford MA	1995	1998	2000	microfluidics
SAB	Lilly	https://www.lilly.com/	Indianapolis IN	1876	1998	1998	bioinformatics
SAB	Bruker Daltonics	http://www.bruker.com/	Billerica MA	1960	1993	1997	Mass-tags
SAB	Intelligent Automation [Azenta]	https://pitchbook.com/profiles/company/124272-46#funding	Cambridge MA	1990	1992	1996	multipin array oligo synthesizer)
SAB	MJ Research Inc [Biorad]	https://pitchbook.com/profiles/company/162674-83#overview	Waltham MA	1987	1986	1995	Pulsed Electrophoresis & PCR

SAB	Genome Therapeutics [Oscient, Agencourt, Collaborative Research Inc.]	https://en.wikipedia.org/wiki/Genome_Therapeutics_Corporation	Waltham MA	1961	1984	1994	microbial genomes
SAB	HySeq	http://www.nature.com/nbt/journal/v21/n1/full/nbt0103-5.html	Chicago IL	1993	1993	1993	Sequencing by Hybridization
SAB	Hamilton Company		Reno NV	1957	1986	1990	multisample handing syringes)
SAB	Polytech Products		Somerville MA	1982	1982	1988	Sequencing electrotransfer devices
SAB	Biogen Inc.	http://www.biogen.com/	Cambridge MA	1978	1984	1985	genomic sequencing
SAB	New England Nuclear [then NEN, Dupont/PerkinElmer]	https://speciation.net/Database/Companies/PerkinElmer-Inc/NEN-New-England-Nuclear-;i21a163	Boston MA	1956	1982	1984	nylon membranes
SAB	Biorad-Sadtler	https://en.wikipedia.org/wiki/Bio-Rad_Laboratories	Philadelphia PA	1952	1979	1981	DNA sequencing software

SAB	4Catalyzer	https://www.4catalyzer.com/	.	
SAB	AminoX	https://wyss.harvard.edu/technology/aminox-making-biologics-safer-with-synthetic-biology-and-advanced-chemistry/	.	
SAB	Atactic Technologies [Xeotron]	https://www.sciencedaily.com/releases/2005/01/050111180347.htm	.	DNA chip synthesis
SAB	BGI	https://dealbook.nytimes.com/2012/09/17/chinese-company-to-acquire-dna-sequencing-firm	Shenzhen China	Sequencing & Synthesis
SAB	BGMedicine	http://www.bg-medicine.com/	Waltham MA	Genomic medicines

SAB	BioInnovation Solutions [Pathogenica]	https://www.genomeweb.com/sequencing/pathogenica-rebrands-bioinnovation-solutions-collaborates-usamriid-filovirus-pan	.	Pathogen Dx
SAB	Biotage [454]	https://web.archive.org/web/20070208213245/http://www.pyrosequencing.com/DynPage.aspx?id=8623&search=454	.	DNA sequencing by synthesis

SAB	Fujifilm	https://badgerherald.com/news/2016/02/09/madison-based-cellular-dynamics-international-performs-cutting-edge-stem-cell-research/	.
SAB	GPC Biotech [Agennix AG]	https://web.archive.org/web/20130430094905/http://alacrispharma.com/management.html	Berlin, Germany
SAB	Intellia	http://www.xconomy.com/boston/2014/11/18/with-atlas-cash-and-berkeley-tools-intellia-joins-the-crispr-fray/	.

SAB	Invitrogen	http://www.invitrogen.com/content.cfm?pageid=10619	
SAB	LetsGetChecked [Veritas Genetics]	https://www.businesswire.com/news/home/20220329005061/en/LetsGetChecked-to-Acquire-Veritas-Genetics-and-Veritas-Intercontinental-to-Unlock-the-Future-of-Personalized-At-Home-Healthcare	.
SAB	Life Technologies	http://www.lifetechnologies.com/us/en/home/brands/ion-torrent.html	.

SAB	Qiagen	https://web.archive.org/web/20160707002840/https://www.labiotech.eu/qiagen-new-giant-next-gen-sequencing-tools/	.			Next-gen sequencing
SAB	REG Life Sciences LLC	http://investing.businessweek.com/research/stocks/private/snapshot.asp?privcapId=30448372	San_Francisco CA			sustainable fuel
SAB	Sana Biotechnology	https://www.flagshippioneering.com/companies/sana-biotechnology	Cambridge MA	2018		Tx delivery

SAB	Zymergen [EnEvolv, Ginkgo]	https://www.prnewswire.com/news-releases/ginkgo-bioworks-completes-acquisition-of-zymergen-301653624.html	.	metabolic engineering
SAB	Zymergen [EnEvolv, Ginkgo]	https://www.prnewswire.com/news-releases/ginkgo-bioworks-completes-acquisition-of-zymergen-301653624.html		

SAB	Zymergen [EnEvolv, Ginkgo]	https://www.prnewswire.com/news-releases/ginkgo-bioworks-completes-acquisition-of-zymergen-301653624.html