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Pharmaceutical sciences in 2020

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By 2020, current scientific, business and social challenges and developments — such as R&D productivity, increased regulatory stringency and ageing populations — are likely to substantially affect many aspects of the pharmaceutical sciences. Here, we present four potential future scenarios based on discussions with experts in the pharmaceutical sciences, industry, regulation and society to identify the most crucial driving forces that might affect the evolution of the pharmaceutical sciences (see [Supplementary information S1](#) (box) for details of the methodology).

The scenario drivers

Using a deductive approach to identify key scenario drivers, we determined that potential high-impact uncertainties could be best captured in a matrix that differentiated between contrasting possibilities in two dimensions: societal attitudes towards the treatment of diseases (and the role of drugs therein); and the dominant scientific culture within pharmaceutical sciences. As shown on the horizontal axis of the matrix in FIG. 1, we identified two contrasting societal attitudes towards the treatment and prevention of diseases: ‘non-pharmacological’ and ‘pharmacological’. The non-pharmacological attitude considers drugs to be only one (and potentially a minor one) of the components used, in addition to other interventions such as health promotion, lifestyle change and exercise. It therefore focuses more on combining approaches and optimizing all aspects of health care. The pharmacological attitude is based on a strong societal belief

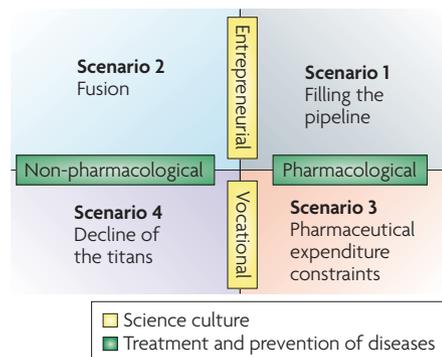


Figure 1 | A matrix of four scenarios for the pharmaceutical sciences in 2020.

that diseases are best treated by studying the underlying biological pathways and intervening through pharmacological means. Drugs are viewed as the primary approach for the prevention and treatment of diseases, with less focus on integrated care.

The vertical axis in FIG. 1 contrasts the potential ways in which science and scientists are organized and rewarded in society. We distinguished two possible dominant scientific cultures: ‘entrepreneurial science’ and ‘vocational science’. In the entrepreneurial culture, the key reason for (and the criteria for the evaluation of) the pharmaceutical sciences is the provision of knowledge to develop and market new drugs. By contrast, in the vocational culture, science is seen mainly as a civic virtue, independent and curiosity-driven, with the goal of elucidating scientific questions.

Four potential scenarios

Based on the 2 x 2 scenario matrix formed by the two dimensions described above, we developed four potential scenarios for the future of the pharmaceutical sciences (FIG. 1), some of the key aspects of which are outlined below. TABLE 1 shows selected features of the pharmaceutical landscape in each scenario to facilitate comparison.

Scenario 1: Filling the pipeline. In the next decade, breakthrough drugs in the fields of immunology and oncology — for example, based on RNA interference — enter the market and completely change the treatment of some major diseases. Drugs are viewed as precision tools that provide the best way to treat diseases, and society is willing to spend considerable resources to fill the pharmacological ‘toolbox’. Furthermore, advances in delivery technology blur the distinctions between drugs and devices.

The major pharmaceutical companies remain dominant, as only they have the resources and expertise needed to develop drugs and navigate the increasingly complex regulatory process. However, Chinese and Indian pharmaceutical companies slowly enter the group of large, leading innovative firms.

Academic institutions are responsible for training scientists who can seamlessly move into entrepreneurial research and technical

positions that require both expertise in cutting-edge science and knowledge of the many facets of drug R&D. Public–private partnerships (PPPs) further facilitate the interaction between basic sciences and industry, and academic institutions are encouraged to spin off companies.

Scenario 2: Fusion. With few major therapeutic breakthroughs between 2010 and 2015, recognition grows that the greatest short-term health-care gains can be achieved by optimizing the use of existing drugs and alignment among health-care providers, rather than spending large sums of money on new drugs that have uncertain benefits. Society shows less trust in pharmacological dominance than previously, and drugs are perceived as just one element — and not necessarily the key one — of treatment.

Traditional large pharmaceutical companies become less dominant. Health-care payers take the initiative to organize health-care delivery more effectively, and pay-for-performance schemes become more popular. Reflecting this, innovative firms, including companies spun off from universities, focus on new care models for many diseases. Diagnosis with appropriate biomarkers, improving compliance, optimizing dosages and formulations, and preventing adverse effects become leading issues in pharmaceutical research, practice and education. Systems approaches are also prioritized in research, both at the cellular and whole-patient level, aided by computational advances to harness vast volumes of associated data.

Scenario 3: Pharmaceutical expenditure constraints. The debate about health-care issues in the next decade is dominated by finding strategies to contain steeply rising health-care costs due to economic constraints and a growing elderly population with chronic diseases. As an easily identifiable ‘silos’, pharmaceutical expenditures are subject to even closer scrutiny by payers than previously, and so the ‘fourth hurdle’ to commercial success — demonstrating comparative effectiveness and cost-effectiveness — becomes higher in many countries. Regulators and payers experiment with different risk-sharing

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► systems for allowing new drugs on the market; for example, by making the indications for which a drug is approved dependent on outcomes that are achieved with the drug in a real-life setting in the initial years after market introduction. The consequent pressure on pharmaceutical company revenues leads companies to focus increasingly on niches in which added value can be demonstrated more easily. Some of the traditional larger therapeutic areas, such as cardiovascular disease or diabetes, experience a marked decline in investments and new drugs.

Academia is seen by industry as a source of in-depth knowledge, but remains at arm's length, and universities mainly produce scientists who are trained in fundamental research. Publicly funded collaborations between academia and industry are not viewed as desirable by government and regulators.

Scenario 4: Decline of the titans. Early in the decade, large pharmaceutical companies move out of multiple therapeutic areas following major Phase III trial failures and growing concerns about company liability after costly product lawsuits. Society is faced with an enormous problem: how to get drugs to the market without substantial private investment in drug R&D? Governments struggle with the balance between the population health-care needs and the intrinsic high risk of investment in developing new medicines. Public

stakeholders try to create various incentive systems to bring drugs to the market as a replacement for the classical model but, with most of these efforts failing, their focus shifts to finding better care or disease management models (non-pharmacological interventions). This also becomes an important area for academic research, but partnerships between academia and industry are viewed with mistrust, and large PPPs no longer exist.

Chinese and Indian pharmaceutical firms remain global leaders in the production of generic medicines. Some traditional pharmaceutical companies survive by transforming into companies that use their expertise in confirmatory trials of therapeutic interventions developed elsewhere, building up towards large-scale production, distribution and regulatory approval and marketing.

Discussion

Given the limitations of the scenario analysis, we are not aiming to predict which of the scenarios presented here is most likely to occur or most preferable, and indeed some aspects of the different scenarios could coexist or blend. For example, for cardiovascular drugs, payers could be very critical of the added value of new drugs and require significant therapeutic benefits to be shown, including convincing favourable data on long-term, 'hard' outcomes such as mortality, before considering reimbursement. By contrast,

in oncology, reimbursement might be obtained more easily for new drugs that show marginal clinical benefits but have strong societal appeal. Another example is the way the pharmaceutical sciences are organized and funded — a controversial issue given the current societal mistrust of the way drugs are developed, marketed and used.

In addition, the scenarios are not based on quantitative data analyses in which past trends are extrapolated according to models with a limited, fixed set of parameters. Rather, we have chosen a qualitative approach that allows the incorporation of a number of driving forces, which differ in their type and extent of impact, and so are likely to be limited to some degree by arbitrariness. Nevertheless, we hope that attempting to provide a glimpse of the future might aid in preparing for the possibilities and challenges for the pharmaceutical sciences that it ultimately brings.

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Table 1 | The four scenarios and some key features

Features	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Industry	Pharmaceutical companies remain dominant in innovation, with SMEs as suppliers of early-stage developments; governments are partners through PPPs	Traditional pharmaceutical companies decline as the life sciences become more focused on devices and lifestyle technologies; new types of businesses emerge at interfaces	There is strong pressure to contain drug prices in major markets; companies focus on niche markets in which added value can be shown more easily	A large part of drug development takes place in publicly funded institutes, in parallel with SMEs; pharmaceutical companies exist for confirmatory trials, production and regulatory approval
Regulation	Strong drive for harmonization; regulators are faced with high-tech and complex technologies	Major challenges for regulators to globally integrate regulations on various combinations of technologies, leading to a strong drive for harmonization	Little global harmonization; payers focus on cost reduction; mechanisms are tested for 'gradual' market authorization for new drugs	Regulators are crucial administrators as society has become strongly risk averse; there is a limited drive for global harmonization
Funding	Basic and applied sciences are well funded, predominantly by public and industrial sources, respectively; a substantial part of funding is channelled through PPPs	Applied sciences and basic sciences are well funded within academia through public funding; research on new care concepts is funded by health-care payers	Public funding is the main driver of academic research; limited funding is available for PPPs; industry works through its own R&D organizations and CROs	Academic funding comes mainly from public sources and stakeholders such as insurance companies and charities; there is little private funding and few PPPs
Academia	Academia works closely with industry, with a seamless transition from basic to applied science; entrepreneurship is highly valued	Research focuses on care approaches; academia spins off companies focused on lifestyle niches and care approaches; PPPs flourish at this interface	Academia is viewed as an important source of fundamental knowledge, but publicly funded collaborations between academia and industry are not seen as desirable	Academic research is strongly focused on alternatives to drug treatment; partnerships between academia and pharmaceutical companies are viewed with mistrust, so academia has few links with industry

CRO, contract research organization; PPP, public-private partnership; SME, small-to-medium-sized enterprise.