1. What are the most critical impediments to scientific innovation and indigenisation in India? Examine.

Approach:
As the directive here is examine, it is necessary to establish a cause effect relationship besides covering various angles of the topic. In the introduction you can talk about the culture of scientific innovation and indigenisation in India. In the first half of main body part you need to explain about the challenges to scientific innovation and indigenisation in India. In the next half you need to suggest solutions. Giving government initiatives to promote innovation and indigenisation culture will fetch you more marks.

Introduction:
India has an impressive scientific heritage in terms of innovation-in fields such as mathematics, astronomy, medicine and material science which has been carried out in the Indian sub-continent since ancient times. However, in today's time a remarkable gap exist between this scientific knowledge and the 'common' man and woman, until recently, few efforts have been made by the government to bridge this gap.

Body:
Critical Impediments to Scientific innovation and indigenisation in India:

- Institutional problems: Our educational institutions are heavily exam oriented and thus lack in focusing on creativity, critical thinking, and open-mindedness. Which hampers the innovative and indigenisation spirit.
- Poor university-industry linkage: This leads to limited application oriented R&D. For instance, as per 'Quacquarelli Symonds (QS) world ranking of institutes, 2019' only three Indian institutes were placed in the top 200 universities of the world. The curriculums are outdated and they lack focus on skill development and employability potential.
- Administrative bottlenecks: Dominance of bureaucratic administrative structure in Indian research units and political interference in day to day activities of research institutions by government is in conflict with intellectual sum. Public access to science and scientists is limited.
- No cordial interaction between interaction of the scientific community with administrators and lawmakers for public engagement and societal support for science and the scientific activity.
- Funding Issues: India (Public and Private) spends only 0.82% of GDP on R&D, Private sector spends less than 0.2% of GDP on R&D, India attracts only 2.7% of global spending in R&D whereas China attracts 17.5%.
- Lack of curiosity-driven research and role of indigenous knowledge or "folk science" in a diverse bio and geo sphere has pushed India backwards. There is no proper networking between practitioners and experts from diverse field into a national platform and share the same with scientific community and students.
- Weak IPR regime of patents and trademarks reduces incentives for entrepreneurs to invest in innovation and research.

- Reducing Fiscal Deficit: For instance, India is the second largest arms importer in the world (after Saudi Arabia). Higher import dependency leads to increase in the fiscal deficit. Despite having the fifth largest defence budget in the world, India procures 60% of its weapon systems from foreign markets.
- World Economic Forum survey says that only 17% of Indian respondents stated that the so-called "cultural support pillar" was available in the country. Thus it hinders people from taking up research and other activities which have uncertain outcomes. It has created a cultural affinity for stability and job security over risk-taking.
- Large country, Diverse issues: While literacy levels are increasing, scientific literacy is still drastically low. Given India's large population, limited resources and multitude of languages, mass science education faces particularly great challenges. Without more attention on local languages, much of the population will miss out on science communication efforts.

India's innovation policy has to shift beyond a mere focus on R&D spending to transforming the ecosystem. Our innovation policy has to shift beyond a focus on increasing R&D spending to inculcating a mindset of "out-of-the-box" thinking in our universities, start-ups and corporate.

Steps needed to be taken up:
- Elimination of rote learning: India's educational policies need to be redesigned, with a focus on building cognitive abilities, beyond rote learning and focus on quantitative subjects. For instance, recent New Education Policy is a step in such a direction.
- Need to use Data analytics boom: Need to focus on taking advantage of the data analytics boom, improving educational qualities beyond our existing islands of excellence to the whole university system
- Greater access to public data to build innovative applications: A supporting ecosystem for this will require providing greater access to public data, through the Right to Information Act and a push to providing public data (for example, on train punctuality, water scarcity, air pollution metrics) for building innovative applications on a real-time basis.
- The Economic Survey 2017-18 recommends doubling national expenditures on R&D with most of the increase coming from the private sector and universities.
- There is a need to encourage investor-led research. In this direction, the Science and Engineering Research Board (SERB) has already been established. It is a promising start that needs to expand with more resources and creative governance structures.
- Impetus to various indigenous start-ups under Make in India. Stand-up India is the need of the hour.

As a supplement to these steps following government initiatives also need to be implemented in their letter and spirit to inculcate culture of scientific innovation and indigenisation.
- Atal Innovation Mission: It was launched by the NITI Ayog as an innovation promotion platform involving academics, entrepreneurs, and researchers

utilizing national and international experience to promote the culture of innovation, R&D in India particularly in technology-oriented areas.

- India Innovation Growth programme (IIGP) 2.0: The programme provides funding, capacity building, mentoring, incubation and business development support to the innovators.
- Defence Procurement Policy: Based on the recommendations of the Dhirendra Singh committee, Defence Procurement Procedure 2016 (replaced DPP 2013) added an additional category "Buy (Indian-IDDM)" i.e. Indigenously Designed, Developed and Manufactured, as the most preferred way of defence goods acquisition.

Conclusion:

With globalisation, it is easier to notice the growing contrast between the designs for promoting innovation and indigenisation in the western world and in India. Having a young population and a strong Diaspora that is more affluent than any other country, India has the potential pioneering high-tech innovation and indigenisation. If necessary steps are implemented in letter and spirit will definitely India to be a 'Vishwaguru' in modern technological developments and their indigenisation.
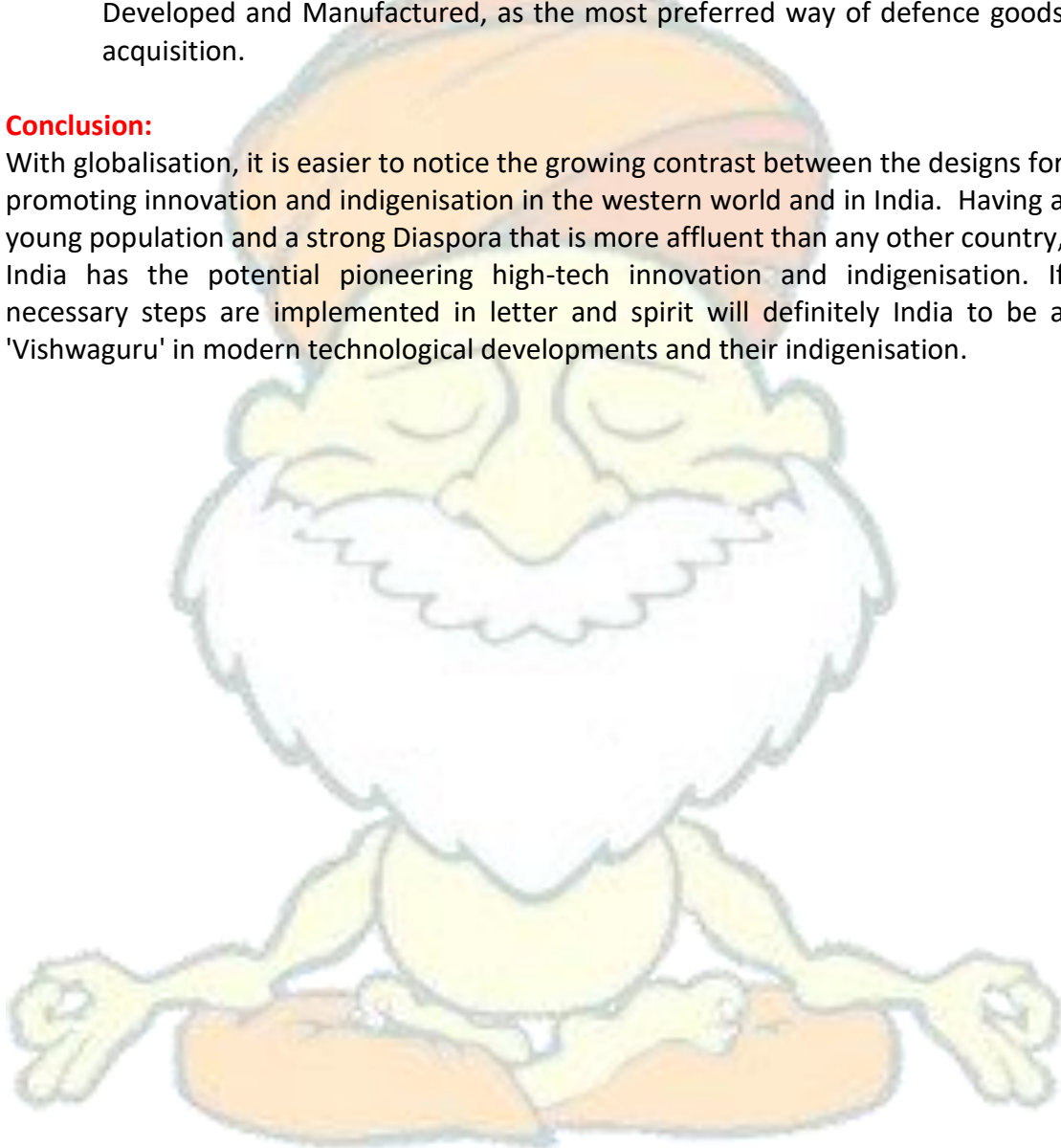
2. What do you understand by intelligent transportation system? What role can they play at a time of rising population and congestion? Illustrate.

Approach - It expects students to write about intelligent transport system. And highlight on role of intelligent transportation system in the time of rising population and congestion with various examples and analysis.

Introduction

With the conception of smart city transmuting cities into digital societies, making the life of its citizens easy in every facet, Intelligent Transport System becomes the indispensable component among all. In any city mobility is a key concern be it going to school, college and office or for any other purpose citizens use transport system to travel within the city in the time of rising population and congestion.

Body

Intelligent transportation system - An intelligent transportation system is an advanced application which aims to provide innovative services relating to different modes of transport and traffic management and enable users to be better informed and make safer, more coordinated, and 'smarter' use of transport networks.

How Intelligent Transport System works?
Traffic Management Centre (TMC) is the vital unit of ITS. It is mainly a technical system administered by the transportation authority. Here all data is collected and analysed for further operations and control management of the traffic in real time or information about local transportation vehicle. Well-organised and proficient operations of Traffic Management Centre depends on automatised data collection with precise location information than analysis of that data to generate accurate information and then transmitting it back to travellers.

Role of the Intelligent transportation system at a time of rising population and congestion in transport -
- **Data collection**: Strategic planning needs precise, extensive and prompt data collection with real-time observation. So the data here is collected via varied hardware devices that lay the base of further ITS functions. These devices are Automatic Vehicle Identifiers, GPS based automatic vehicle locators, sensors, camera etc. The hardware mainly records the data like traffic count, surveillance, travel speed and travel time, location, vehicle weight, delays etc.
- **Data Transmission**: Rapid and real-time information communication is the Key to proficiency in ITS implementation so this aspect of ITS consists of the transmission of collected data from the field to TMC and then sending back that analysed information from TMC to travellers. Traffic-related announcements congestion, accidents and any work of construction are communicated to the traveler through internet, SMS or onboard units of Vehicle and infra-red links.

- **Data Analysis**: The data that has been collected and received at TMC is processed further in various steps. These steps are error rectification, data cleaning, data synthesis, and adaptive logical analysis. Inconsistencies in data are identified with specialised software and rectified. After that data is further altered and pooled for analysis. This mended collective data is analysed further to predict traffic scenario which is available to deliver appropriate information to users.
- **Traveler Information**: Travel Advisory Systems (TAS) is used to inform transportation updates to the traveling user. The system delivers real-time information like travel time, travel speed, delay, accidents on roads, change in route, diversions, work zone conditions etc. This information is delivered by a wide range of electronic devices like variable message signs, highway advisory radio, internet, SMS, automated cell.

Why Intelligent transport system is need in congestion areas and high populations areas:
- Improve attractiveness of public transport system.
- Tackling rising congestion which increases industry cost, travel time and life style problems.
- Low speed and increased accident can be tackled.
- Reduce environment impact of transport.
- For Capacity and security management.
- Incident management.

Advantage of the Intelligent transport system:
- Make transportation more efficient, secure, safe, affordable and reduce traffic related stress in life.
- Travel time improvement
- Speed control and improvement.
- Reduction in stops and delays at intersections.

Conclusion

With urbanisation expanding with speedy stride, number of vehicles on road is also increasing. Combination of both in return puts enormous pressure on cities to maintain a better traffic system so that the city keeps on moving without any hassle. For the purpose application of Intelligent Transport System is the only solution. ITS a win-win situation for both citizens and city administrators where it provides safety and comfort to citizens and easy maintenance and surveillance to city administrators.

3. What are the current issues related to GM crops in India? What are your views on adoption of GM technologies? Substantiate.

Approach:

Students are expected to write about the current issues of GM crops in India in first part, substantiate the views on adoption of GM technologies in second part.

Introduction:

GM crops are those crops whose DNA has been modified by introducing alien genes in the seeds to get desired effects such as resistance to pest attacks. Genes from any living organism, be it plants, or animals, is used to arrive at the desired traits. GM technology is often called "modern biotechnology" or "genetic engineering". It allows selected individual genes to be transferred from one organism into another, also between nonrelated species.

Body:

Recently farmers in Maharashtra were protesting the central government's move which bans the cultivation of GM crops and they would undertake mass sowing of GM seeds for maize, soyabean, mustard, brinjal and herbicide tolerant (Ht) cotton, although these are not approved.

Issues related to GM crops:
- Cost effective variety of Cotton: Bt cot is the only GM crop that is allowed in India. currently farmers cite the high cost of weeding of it, which goes down considerably if they grow Ht Bt cotton and use glyphosate against weeds.
- New variety of Brinjal: Brinjal growers in Haryana have rooted for Bt brinjal as it reduces the cost of production by cutting down on the use of pesticides.
- To challenge Government for change its regulations: This action of defying government regulations by growing unapproved Bt varieties will draw attention of authorities to the need for introduction of the latest technology in the fields as the approval process of GM seeds is lengthy, opaque and often excludes farmers. This is opposed by farmers who want access to better technology.
- Huge benefits of GM crops: Because of the modification in genes, GM crops has huge benefits like Increased crop yields, Reduced costs for food or drug production, Reduced need for pesticides, Enhanced nutrient composition, Resistance to pests and disease, Increased shelf life etc. hence its attracts farmers to enhance their revenue.

In 2002 Genetic Engineering Appraisal Committee (GEAC) allowed Bt cotton, since then 95 per cent of the country's cotton area has under Bt cotton.

Concerns over the use of genetically modified (GM) technology:

- Ecological Balance: The capability of the GMO to escape and potentially introduce the engineered genes into wild populations thus disturbing the fragile ecological balance.
- Danger of Permanence: The persistence of the gene after the GMO has been harvested. The susceptibility of non-target organisms (e.g. insects which are not pests) to the gene product will be in danger. Also, the stability of the gene is another cause of worry which will Increase use of chemicals in agriculture.
- Health: Genetic modification brings about changes that can be harmful to humans in the long run.
- Awareness and Labelling issues: Manufacturers do not mention on the label that foods are developed by genetic manipulation considering it may affect their business. However, this is harmful practice.
- Religious issues: Many religious and cultural communities are against such foods because they see it as an unnatural way of producing foods.

Views on adoption of GM technologies:
- Medicinal Benefits of GM technologies: GM technologies have emerged as one of the mainstays of biomedical research since the 1980. Pharmaceutical products such as hepatitis B vaccine, injectable insulin produced through GM technology.
- Genetic modification of insects: GM mosquitoes have been developed that express a small protein called SM1, which blocks entry of the malaria parasite, Plasmodium, into the mosquito's gut. Introduction of these GM mosquitoes into the wild could help reduce transmission of the malaria parasite. Also, male Aedes aegypti mosquitoes engineered so it transmits a gene to their offspring that causes the offspring to die before becoming sexually mature.
- Genetic modification of humans is becoming a treatment option: Genetic modification via gene therapy is becoming a treatment option for diseases ranging from rare metabolic disorders to cancer. Coupling stem cell technology with recombinant DNA methods allows stem cells derived from a patient to be modified in the laboratory to introduce a desired gene. introduction of these GM cells into the patient could cure the disease without the need for a matched donor.
- No Harm from GM Food recorded: There is a scientific consensus that currently available food derived from GM crops poses no greater risk to human health than conventional food, but that each GM food needs to be tested on a case-by-case basis before introduction.

Considering all modern medicinal benefits of GM technology, introduction and responsible use of it is necessary for mankind.

Conclusion:

Though there is a ban on other GM crops, cases of cultivation of GM Crops not approved by the government indicate that there may be an illegal supply of GM seeds in the country. With growing agrarian distress there is a need for innovation in

agriculture that balances interests of humans and that of environment. Given the increased growth of global population and increased urbanisation, GM crops offer one of the promising solutions to meet the world's food security needs which ultimately meet the SDG zero hunger target by 2030. Hence the government must take steps carefully keeping in the mind of interests of farmers, national biosafety and biosecurity.

4. What are the potential applications of 5G technology? How can it contribute to the vision of Digital India? Discuss.

Approach:

It expects students to write - in first part write about potential application of 5G - in second part write how it can contribute to vision of digital India - in end write few challenges before it.

Introduction:

5G is next generation wireless network technology that's expected to change the way people live and work. It will be faster and able to handle more connected devices than the existing 4G LTE network, improvements that will enable a wave of new kinds of tech products.

Body:

Potential application of 5G:
- Workspaces: The first use cases based on 5G will pertain to company workspaces, whether they are physical or virtual. The capacities of 5G will enable a wider use of video and the manipulation of large files on the go (architectural plans for example), as well as a shift towards greater use of virtual, augmented or mixed reality.
- Industry 4.0: A majority of analysts believe that Industry 4.0 will emerge as one of the first concrete applications of 5G and specialized services. Customers have already shown high expectations in this sector. However, the goal is not simply to connect a factory to the web, it is also about transforming business models, production methods, processes, etc. The densification of connected objects and real-time data analysis will play an essential part in environments where autonomous machines, humans and robots will work side by side.
- Sales: 5G will also make it possible to manage orders in a very precise way. In the event of a problem on a production line, immediate feedback will recalculate the production plan right away and automatically inform the end customer of a possible delivery delay. It will also become possible to integrate connectivity into the product itself. In this way, it will communicate with artificial intelligence and offer predictive maintenance. It will also become possible to guide applications remotely via a hologram, showing the user exactly how to use the product and thus multiply the examples. In all these situations, it is truly a whole new field of possibility that opens up with 5G.
- Transport: The rising number of connected vehicles is another important issue pertaining to 5G. With communication between vehicles, as well as other road users (pedestrians, cyclists, etc.) and even infrastructure (roads, traffic signals and traffic lights, for example), new applications may be developed to reduce accident rates and journey times in order to improve the flow of traffic. 5G will also enhance operational efficiency for transport professionals. The ability to download a large amount of content in near real time will enable ships, trains

and aircraft to quickly retrieve navigation information and share refuelling and predictive maintenance data when docking, landing or arriving at stations.

- Critical communications: In the future, it will be possible to host a vast range of critical communications in order to secure processes, goods and people. 5G will help facilitate enterprise security applications by powering connected security teams capable of responding to emergencies in real time. 5G will also improve fixed network performance until fiber is rolled out everywhere. Why not also secure fiber in 5G? This is the type of hybrid installation we are now exploring.

It can contribute to vision of digital India as follows:

- Smart cities
  - Video surveillance and analytics
  - Intelligent transport and traffic management
  - Smart grids and metering systems with smart street light
  - Solid waste management
- Government
  - This revolution also provides an opportunity for the government to improve its connect with the citizens. Digitalisation could help improve delivery of government services to citizens and also lower transaction costs for citizens
- Public protection and disaster relief
  - National authorities or relevant operators use Public Protection and Disaster Relief (PPDR) radio communications for managing services with regards to public safety, security, defense and emergency. To further modernise and enable reliability over critical communications, the use of 5G network is expected to be supportive in addressing the requirements.
  - Sensors, cameras and other automated devices are significant sources of information to ensure public safety. Through building synergies across such source feeds, 5G networks could also support integrating information from diverse source feeds or devices into Public Safety operations, enabling it to become less reactive and more proactive.
- Manufacturing
  - Enhance efficiency through robotics
  - Automation through Internet of Things (IoT)
  - Effective operations through Augmented Reality (AR)
- Agriculture and allied industry
  - Soil and crop monitoring
  - Precision farming
  - Smart irrigation & climate change alignment
  - Livestock monitoring
  - Agricultural drones
- Energy and utilities
  - Distribution of energy within a smart-grid
  - Smart meters for the smart homes
  - Remote monitoring of energy sites
  - Energy efficiency and reducing the effects of climate change
  - Smart Power generation, Green energy and distribution automation
- Healthcare industry

- o Mobility
- o Monitor Health
- o Automation
- o Online consultations
- o Data Management
- Media and entertainment
  - o Immersive experiences
  - o Enriching gaming experience
  - o User/machine generated content from smart devices
- Retail
  - o In-store analytics
  - o Interactive storefront windows
  - o Handheld devices

However, it faces following challenges:

- Problem of network coverage
- Lack of 5G devices
- Lack of digital inclusion
- Lack of uniform policy framework
- Industry crippling under margin pressure
- Network modernisation and densification will be complex
- Strengthening the security apparatus with evolving technologies

Conclusion:

Regulatory support from the government providing the right ecosystem for research and development, regulatory framework for spectrum, data and information security, IoT, digital as well as inclusive business environment to encourage domestic and international players to invest in the technology would be key to technology implementation.

5. Innovation should be made public in exchange for a limited monopoly. Do you agree? Substantiate your views.

Approach:

Question is asked in context of COVID pandemic. It expects student to write about - in first part write about need for innovation to be made public - in second part write about how innovation could be made public in exchange for a limited monopoly - in end write way forward.

Introduction:

With the outbreak of COVID-19, there are several innovations. All these innovations may be the subject matter of patent applications around the world. It will be a few years before patents are even granted. However, friction already exists among various stakeholders. For instance, one country made attempts to obtain exclusive rights to a vaccine being developed. On the other hand, there are also collaborations taking place.

Body:

Need for innovation to be made public:

- Pandemics need disruptive solutions. Governments and international organisations need to arrive at a consensus in advance to ensure that the system is ready. Procrastination would be disastrous.
- Creating hindrances through exclusivity claims, in the wake of a pandemic, will result in dividing countries, corporations and international organisations.
- This will not benefit patients and the world as a whole. If patent owners create impediments on the strength of patent rights, the world will start despising patents and that is not a situation IP owner ought to be in.
- Under the TRIPS (Trade-Related Aspects of Intellectual Property Rights) regime, there are several tools such as compulsory licensing that are available to ensure access to medicines.
- However, beyond the laws, society needs to respect innovation. To protect the sanctity and integrity of patent systems, and in order to ensure that an anti-IP sentiment is not generated globally, answers need to be found within the existing regime.
- In exceptional circumstances such as these, there is a likelihood that societies may resort to extreme steps to protect themselves. Before such ideas are floated, solutions should be created.

Innovation could be made public in exchange for a limited monopoly by:

- One method by which aggregation and dissemination of innovative products can be ensured is by creating a patent pool.
- Patent pools are usually effective in aggregating, administering and licensing patents related to specific areas of technology.

- Such pools are usually managed by a central agency and the patents which become part of the pool are readily made available for licensing.
- Some pools even publish the royalty rates payable for such licences. Anyone who wishes to obtain a licence will be able to approach the pool, agree to the terms, and begin to manufacture and sell the products.
- Such pools are prevalent in, for instance, standard essential patents related to telecom and digital innovations.
- At the moment, individual efforts are being made by research organisations to create their own pools.
- A more fruitful endeavour would be to create a global pool of COVID-19-related innovations, or innovations related to rare pandemics, in respect of vaccines and medicines. This could be managed by a trustworthy international organisation.
- All countries ought to have the right to implement these innovations without further permission from the patent-holders and without resorting to provisions such as compulsory licensing, state acquisition, etc.
- Even if royalties are at a minimal level, the revenues would still be in billions of dollars owing to the large swathes of the population affected by the pandemic, who will need to be administered these products.

Way forward:

- The purpose of creating and recognising patent rights is for the common public good, i.e., innovation should be made public in exchange for a limited monopoly.
- Thus, patents need to be disclosed to the public in order to enable further research.
- Public-private partnerships (PPP) need to be scaled up. Creation of the 'PPP-pandemic patent pool' at a global level, to pool all innovations, is the way forward.
- Pooling of patent resources is also in line with the Doha Declaration on Public Health which is a part of the TRIPS agreement. This declaration recognises the need for taking measures to 'protect public health' and 'promote access to medicines'.

Conclusion:

Concerns relating to patents and profits to be earned therefrom should be put aside. The world has to come out of this crisis quickly and patents ought to accelerate rather than impede the path. Combating the crisis and earning collectively is the need of the hour.