



Innovation Snapshot

Diabetes Management 2.0: The Promise of Artificial Pancreas Systems

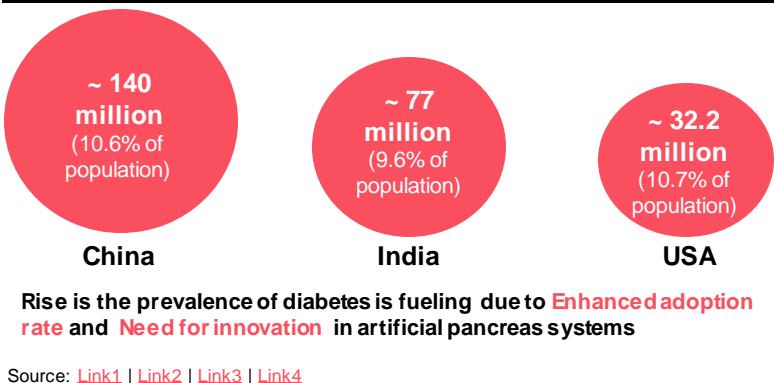
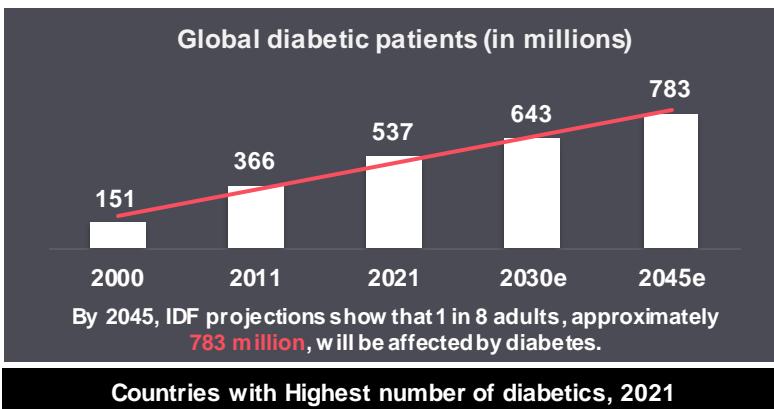
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FutureBridge

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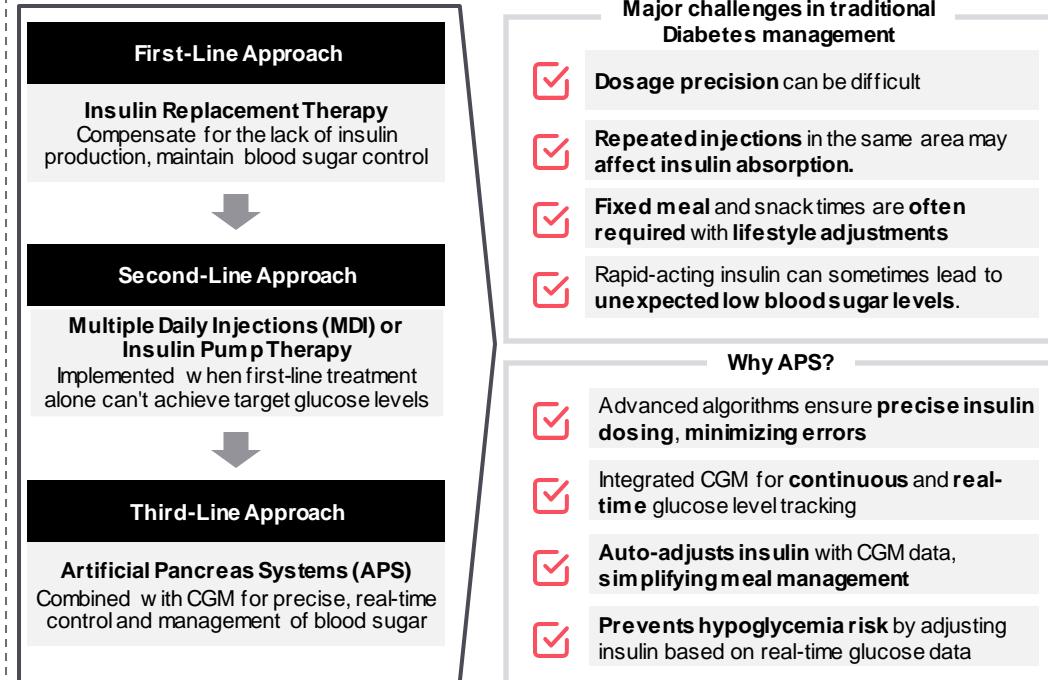
Overview: Prevalence of Diabetes across the globe and Management of Type 1 Diabetes

Diabetes, a global health challenge, exerts a profound impact on individuals, families, and communities. Embracing Advanced Patient Support (APS) and continuous innovation paves the way for a healthier future, enriching lives and strengthening societies worldwide.



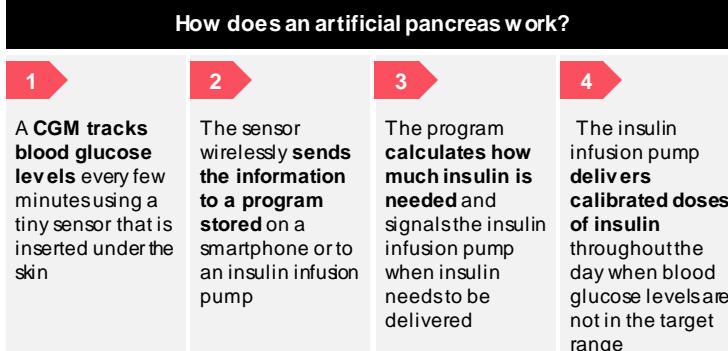
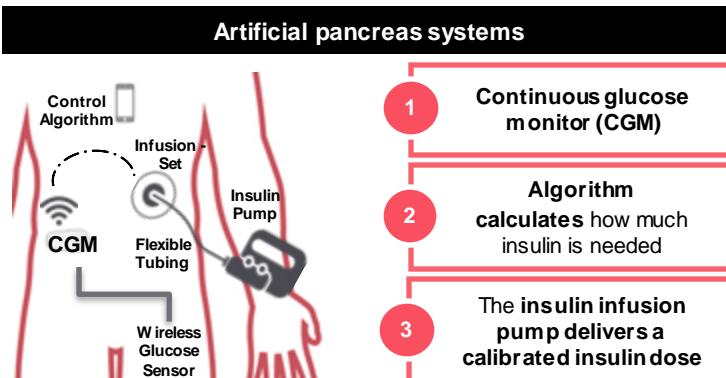
Source: [Link1](#) | [Link2](#) | [Link3](#) | [Link4](#)

Type 1 diabetes, often diagnosed in childhood or adolescence, is a chronic condition that demands relentless attention to blood sugar control. For individuals with Type 1 diabetes, maintaining optimal blood glucose levels is not just a medical task; it's a daily life challenge.

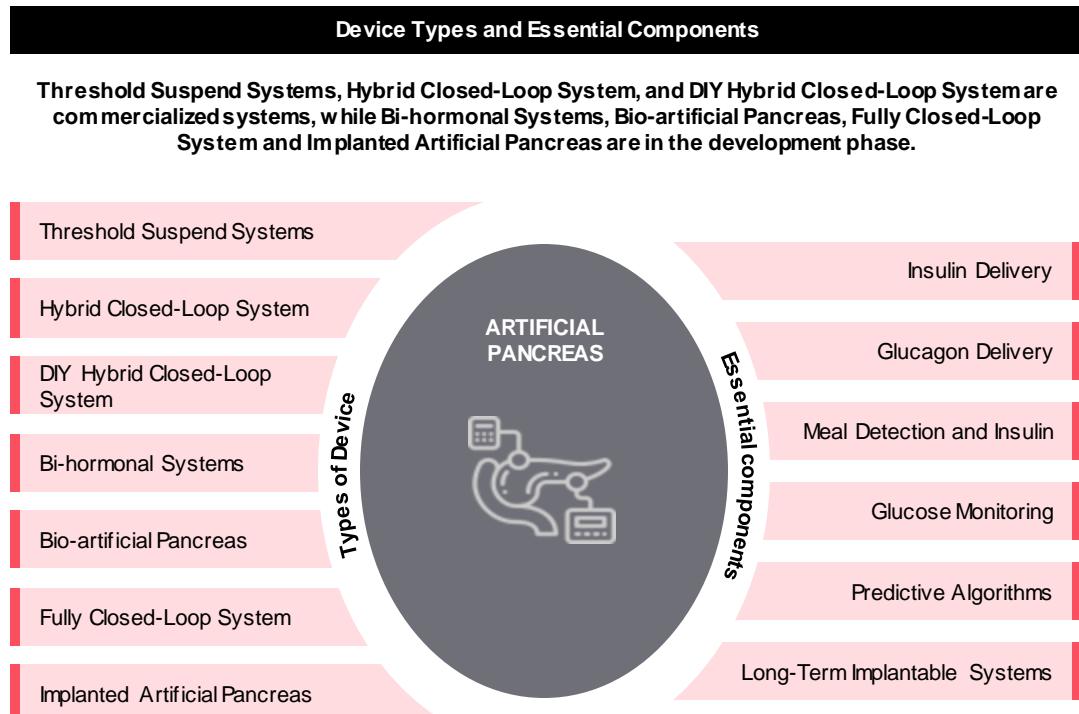


Overview of Artificial Pancreas System (APS)

Artificial pancreas is a system made of three parts working together to mimic how healthy pancreas controls blood glucose also called blood sugar, in the body. An artificial pancreas is mainly used to help people with type 1 diabetes.



Source: [Link1](#) [Link2](#)



Current limitations in Artificial Pancreas System

The Artificial Pancreas System (APS) technology has evolved rapidly, providing effective management of diabetes but still there are few instances of unmet needs and challenges to be addressed.



No-prick or completely non-invasive still unavailable



Highly accurate algorithms for predicting glucose levels in real-time



Dealing with the variability in insulin absorption rates



Adapting to changes in physical activity levels and their impact on glucose dynamics



Integrating with other diabetes management tools and technologies



Addressing the influence of hormonal fluctuations on glucose regulation.



High cost of insulin pump



Risk of hypoglycemia and hyperglycemia



Intuitive and user-friendly interfaces

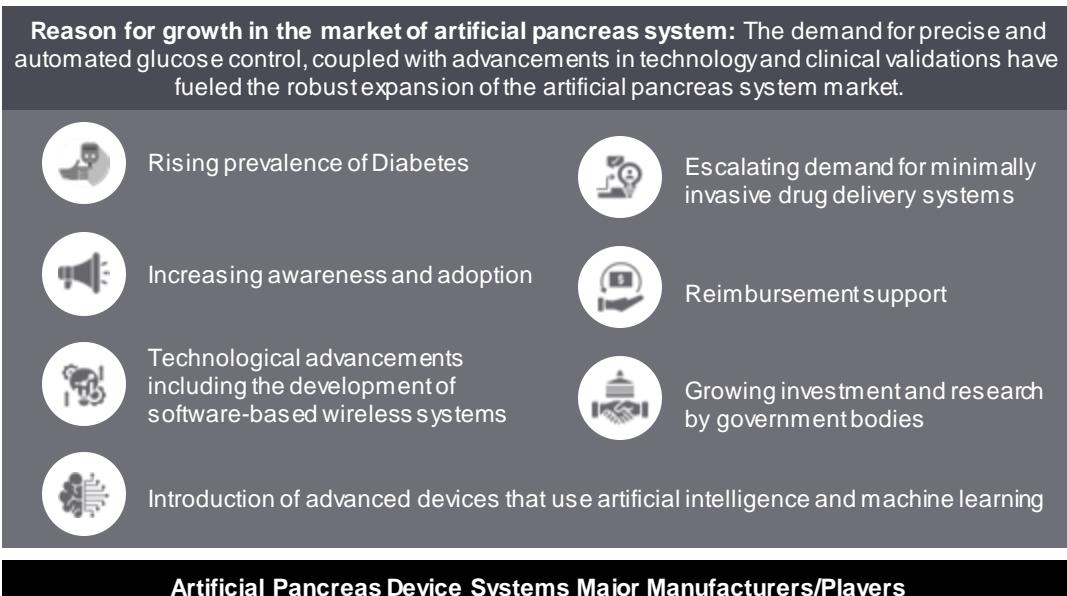


Consistent performance and durability over extended periods of use

Approaches used by digital health tech companies to transform APS

Digital health tech companies are using various approaches for revolutionizing the APS by integrating blood glucose readings into the pump's control software, adjusting insulin on the fly, and improving the day-to-day lives of people.

- 1 Addressing a global health challenge
- 2 Innovative collaborations
- 3 Patient-centric approach
- 4 Rapid prototyping and open-source sharing
- 5 Continuous glucose monitoring (CGM) integration
- 6 Remote monitoring and telehealth
- 7 User-friendly interfaces
- 8 Advocacy and patient empowerment



Artificial Pancreas Device Systems Major Manufacturers/Players



Johnson & Johnson



TANDEM[®]
DIABETES CARE

Medtronic

Insulet Corporation



INREDIA[®]



bigfoot[™]
BIOMEDICAL

Source: [Link1](#)

Innovative Technologies – Inreda Diabetic AP

Artificial pancreas contain sensors and continuously measure the blood glucose levels and control them with two essential hormones: insulin and glucagon. Adjustments are done without any intervention on the part of the patient



Bi-hormonal fully closed loop system



This is a bihormonal AP in the form of a fully closed loop system. It supports the patients in making treatment decisions, carbohydrate counting, and adapting their behavior to achieve good glycemic control

Source: [Link1](#)

About



Expected to hit market with mass production in 2024



Obtained CE marking in 2020

Features and Benefits

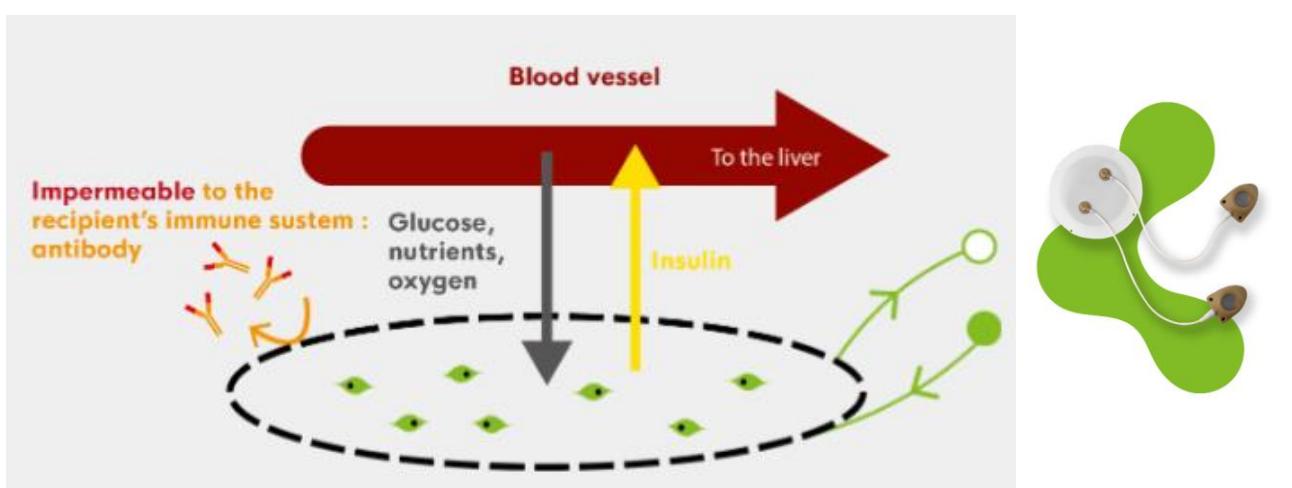
- 1 Bi-hormonal
- 2 Integrated device
- 3 Reactive glucose control algorithm
- 4 Fully automated; no manual announcements

Innovative Technologies – Defymed

A medical device comprising of non-biodegradable, biocompatible membranes with selective permeability for the encapsulation of insulin-secreting cells is under development. Glucose and insulin pass freely through the membrane while antibodies are restricted from passing in.



Mail Pan ®- Bioartificial Pancreas (BAP)



Features and Benefits

- 1 Immune-protective membranes
- 2 Unlimited access to insulin-secreting cells
- 3 Autonomous and physiological regulation of blood glucose
- 4 Possibility of replacing the cells without any need for surgery
- 5 Adaptable with other cell therapies

About



Patented technology

Source: [Link1](#)

Innovative Technologies – Pancreum

Currently users are required to wear multiple devices all over their bodies. Pancreum has developed an all-in-one integrated platform that is managed by a single hand-held controller.



All-in-one Integrated System



Features and Benefits

- 1 Smarter, flexible, convenient, safer and affordable
- 2 Modular design and semi-disposable concept
- 3 Customizable to individual needs
- 4 CoreMD is rechargeable and reusable thus eliminates costs associated with it
- 5 Easily adapts to incorporate newer technologies

About



Patented technology

Source: [Link1](#)

Innovative Technologies – De Montfort University | MIT

This implantable insulin delivery device features a gel that responds to changes in blood glucose levels. When blood glucose levels are elevated, the gel enables a higher rate of insulin to be released; during lower sugar levels, the gel decreases the amount of insulin release.



Implantable Artificial Pancreas



Benefits

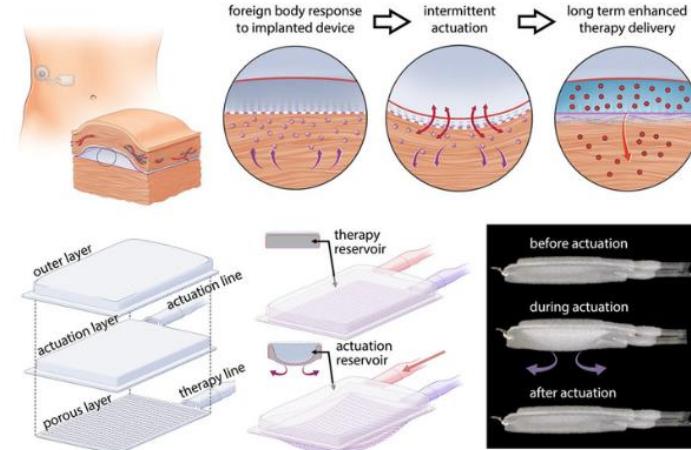
- 1 Continuous supply of insulin that adapts with changing blood levels
- 2 Totally implantable, nothing is visible from the outside.
- 3 Refillable with insulin

Source: [Link1](#) | [Link2](#)



Massachusetts
Institute of
Technology

Mechanically actuated soft robotics modifying body's response



- A two chambered device made of polyurethane and with elasticity similar to an extracellular matrix.
- One chamber acts as drug reservoir while other as an inflatable actuator.
- On stimulation actuator inflates and deflates, thus driving away immune cells and preventing formation of scar tissue.

Innovative Technologies – Ideal Medical Technologies

FUSION works with Dexcom G6 CGM system which provides updated glucose values every 5 minutes to AI- based FUSION software. FUSION systems controls, adjusts the infusion rates of insulin and/or dextrose (glucose) to bring safe and effective glucose control.



FUSION- Artificially intelligent, hospital based fully automated closed loop system



Source: [Link1](#)

Benefits

- 1 **Lowers Mortality Rate:** Automation reduces human error and leads to safer and more effective glucose control, which results in better clinical outcomes.
- 2 **Decreases nursing time:** Using the FUSION system will reduce this to about 20 mins, allowing nurses to focus on providing stellar care and support.
- 3 **Reduces costs:** By decreasing the complication rate, the FUSION system has the potential to decrease the hospital length of stay by at least 2 days, which will lead to significant cost savings.
- 4 Future of patient care

Features



Closed loop system



Artificial Intelligence



Easy to use



Analyze results

Role of Big Data and AI in the development of APS

Development of APS is a promising application of Big Data and AI; it automatically measures and regulates the blood glucose levels and can improve the quality of life and health outcomes of diabetic patients by reducing the burden of self-management and preventing complications.

How big data and AI are used in APS?



Bluetooth



Artificial Neural Networks



Machine Learning



Deep Learning

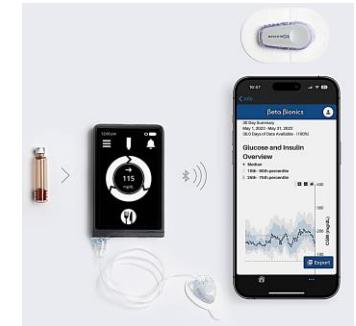


Bioinspired Reinforcement Learning Algorithm

Many players leverage Big Data and Artificial Intelligence (AI) to enhance product design and performance. This integration allows them to create highly personalized, adaptive, and user-friendly systems that cater to individual patient needs.



- FDA has cleared the **Beta Bionics iLet ACE Pump** and **iLet Dosing Decision Software** for type 1 diabetes patients **aged 6 and older**
- The **iLet** engages **ML-AI** to autonomously control the individual's blood-glucose levels, and to continuously adapt to the individual's ever-changing insulin needs



ILLINOIS TECH

ILLINOIS INSTITUTE OF TECHNOLOGY

- Developed a **Machine Learning (ML) System** that can be integrated into an APS to **enhance the accuracy** of the artificial pancreas.
- This system **received \$1.2 million** from the **NIH**



- Developed **Reinforcement Learning (RL)** based AI algorithm that **calculates the amount of insulin** needed for a diabetic patient and **injects it automatically**, without the **need to input the meal or exercise information**.

Future of Diabetes treatment with Artificial Pancreas Systems

Future systems are expected to show greater improvement in glycemic control, as new algorithms may include customizable glucose targets and optional meal announcements.

Improved Automation and Algorithms

Advanced algorithms for personalized glucose trend predictions and insulin delivery adjustment.

Higher time in range for optimal glucose levels

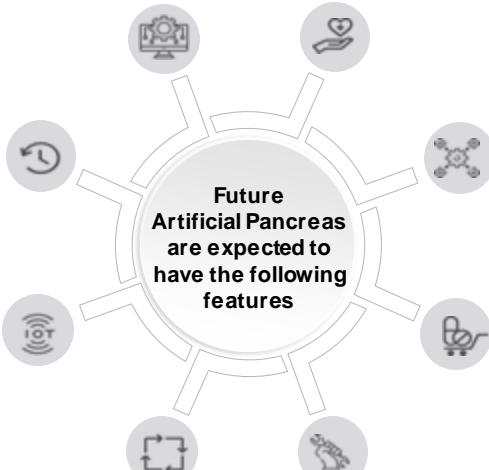
Future systems may be able to achieve this goal more **consistently** and for longer periods of time.

Closed-Loop for Type 2 Diabetes

Closed-loop systems could also be **tailored** for individuals with type 2 Diabetes in need of insulin therapy.

Incorporation of low power IOT technology

Incorporating compact and low power IOT into infusion pumps will **eliminate the need for smartphones** to deliver data securely and reliably to cloud.



Less input required by patients

Aim to **automate insulin delivery**, reducing the burden of managing diabetes, may even operate as fully closed-loop, **requiring no user inputs**

Integration with other devices

Integrating APS with **wearable devices** like smartwatches and smartphones for **convenient diabetes management**.

New route for insulin delivery

Intraperitoneal (IP) delivery is considered a viable alternative to conventional routes. IP insulin delivery has physiological advantages thus providing better insulin/glucagon balance.

Adjunctive therapies

Researchers are investigating the potential of adjunctive therapies, including hormones like **glucagon**, alongside APS to **enhance glycemic control**.

Features		
Automated insulin delivery without requiring user input for mealtime boluses	Improved Hypoglycemia	Improved time-in-target range

Current Challenges		
Capability to adapt with complex scenarios (exercise, sleep disruption, variable mealtime and sizes)	Postprandial hyperglycemia	Lack of stable liquid formulations of glucagon

Expected Technological Advancements		
Integration of biometric data:		
▪ Incorporating biometric data like heart rate, skin temperature, accelerometry, and energy expenditure into closed-loop systems boosts sophistication, as these parameters impact glucose levels.		
Chemically stable glucagon:		
▪ Dual hormone artificial pancreas containing insulin and a chemically stable synthetic glucagon analogue.		
Advanced algorithms:		
▪ Advanced algorithms that can address not only person-to-person variability but also day-to-day variability in glucose regulation.		

Note: Not an exhaustive list

Thank you

North America
55 Madison Ave, Suite 400
Morristow n, NJ 07960
USA
T: +1 973 891 9800

Europe
Stadsplateau 7
3521 AZ Utrecht
The Netherlands
T: +31 30 298 2108

United Kingdom
Holborn Gate, 330 High Holborn
London, WC1V 7QH
United Kingdom
T: +44 207 406 7548

Asia Pacific
Millennium Business Park
Sector 3, Building # 4, Mahape
Navi Mumbai 400 710
India
T: +91 22 6772 5700