**Understanding the Real-World Supply Chain**

In the pharmaceutical industry, a **supply chain** refers to the process in which medicines are produced, transported, and delivered to end users. Typically, this chain consists of the following main stages:

1. **Pharmaceutical Company (Manufacturer):** Produces medicine batches.
2. **Distributor / Supplier:** Transports and stores the medicines.
3. **Retailer / Medical Store:** Sells the medicines to consumers.
4. **Customer / Patient:** The final consumer who uses the medicine.

At each stage, medicine changes hands. If this movement is not properly tracked, counterfeit or fake medicines can easily enter the supply chain. This can result in health risks and financial losses.

**Supply Chain Implementation in Our Project (PharmaSentinel)**

In our proposed system, **PharmaSentinel**, we are developing a secure and digital supply chain model. Our application will track each stage of the medicine's journey from production to the hands of the user. The implementation will follow the sequence below:

1. **Pharmaceutical Company:**  
   The company enters new medicine batch details (batch number, expiry date, etc.) into the system. A unique QR code is generated and attached to each batch. This data is recorded on the blockchain as a new block.
2. **Supplier / Distributor:**  
   The supplier receives the batch and confirms it in the system by scanning or entering the batch ID. This transfer is stored as a new block in the blockchain, showing the movement from the company to the supplier.
3. **Medical Store:**  
   The retailer receives the medicines and confirms the delivery. This is also recorded in the blockchain as the next block.
4. **User / Customer:**  
   The customer scans the QR code through the PharmaSentinel mobile app. The app checks the blockchain to verify the medicine's complete history. If all stages are valid, the app displays that the medicine is original. If any stage is missing or invalid, it shows a warning that the medicine may be fake.

**Role of Blockchain in PharmaSentinel**

**Blockchain** is a secure and tamper-proof system that stores information in the form of blocks. Each block is connected to the previous one using a unique hash, creating a chain of records. In PharmaSentinel, blockchain is used to:

* Record each transfer of medicine (company → supplier → store)
* Ensure that the data cannot be edited or deleted
* Provide full transparency and traceability

Because each block is linked, if anyone tries to change the data, the chain becomes invalid. This prevents manipulation and helps detect counterfeit medicines.

**Blockchain Implementation Plan**

Each block in our blockchain will include:

* Batch information (ID, name, expiry)
* Sender and receiver details
* Timestamp

When a new stage is completed (e.g., supplier confirms receipt), a new block is added to the chain. The chain is stored securely and accessed during verification.

**Functional Requirements (FRs) – *What the system should do***

1. **User Registration and Authentication**  
   The system should allow different types of users to register and log in. These users include pharmaceutical companies, suppliers, medical stores, and customers. Each user should be able to securely create an account and log in using valid credentials.
2. **Medicine Information Entry by Company**  
   Pharmaceutical companies should be able to add new medicines to the system. They will enter details like the medicine name, manufacturing date, expiry date, batch number, and other relevant data. This information will then be stored on the blockchain.
3. **Blockchain Data Recording**  
   Every medicine entry should be saved as a block on the blockchain. This ensures the data is secure, transparent, and cannot be changed once recorded. Each block represents a transaction or transfer in the supply chain.
4. **QR Code Generation**  
   After adding a medicine, the system should generate a unique QR code for that batch. This code can later be scanned by any user (like the customer) to check whether the medicine is original or fake.
5. **Supply Chain Movement Recording**  
   As the medicine moves from the company to the supplier, then to the store, and finally to the customer, each handover should be recorded in the blockchain. This allows complete traceability of the medicine.
6. **Medicine Verification by Users**  
   Customers should be able to scan the QR code of the medicine using the mobile app. If the data exists in the blockchain and is valid, the app will confirm the medicine is original. If not, it will warn the user about a potential fake medicine.
7. **Role-Based Dashboard Access**  
   Each user will have access to their own dashboard. For example, companies can see batches they created, suppliers can view what they received and passed on, and customers can track the source of their medicines.

**Non-Functional Requirements (NFRs) – *How the system should behave***

1. **Security**  
   The system must be secure, especially since sensitive data like medicine records and user credentials are involved. User authentication, blockchain immutability, and QR code encryption will protect data integrity.
2. **Reliability**  
   The app should work correctly in all scenarios. Whether scanning a QR code or viewing supply chain records, the system should not crash or give wrong information.
3. **Performance and Speed**  
   The application should be fast. It should open quickly (in a few seconds), and QR codes should be scanned and verified instantly to ensure a smooth experience for users.
4. **User-Friendliness (Usability)**  
   The user interface should be clean, easy to navigate, and understandable by all types of users—even those with no technical background. Icons, buttons, and options should be clear and simple.
5. **Scalability**  
   As more users (and more medicines) are added to the system, the app and backend should be able to handle this growth without slowing down or failing.
6. **Maintainability**  
   The backend code (developed in Node.js and C#) should be written in a modular way, making it easier to debug, update, or add new features in the future without rewriting everything.
7. **High Availability**  
   The app should be accessible anytime, without frequent crashes or downtime. Users should be able to verify medicine at any time of the day.
8. **Cross-Platform Compatibility**  
   The app, developed using React Native, should run on both Android and iOS smoothly, giving a consistent user experience across different devices.