

---

## 5b – Database Design

---

### **a – Technical Specifications**

**1. Patient and Donor:**

The Patient, Donor, and Donor Underlying Condition tables were created to store the medical profile (first name, last name, blood group, and underlying condition) of patients and donors, respectively. The underlying condition applies to donors only.

**2. Transfusion:**

Donor Blood Bag, Patient Blood Bag and Transfusion tables were created to track the transfusion of blood from a donor to a patient. Additionally, the data that is stored include the component of blood, the receipt and transfer date of the blood bags, and their corresponding branches. The Blood Inventory table is related to the tables mentioned above. The table stores the status of the blood bag as it is processed.

**3. Inventory & Expense:**

The tables - Incubators, Storage Equipments, Lab Equipments, Donation Equipments - were created to store the number of equipment in each branch. The Price table was created to store the monthly expense of a branch and the unit price of the components of blood each month for that branch.

**4. Branches & Employees:**

Branch was created to store the location of the branches, and their respective managers. Multiple tables are related to the branch table as a foreign key. The table provides the organization with the information as to which branch the data is related to. The Employees table records each employee's data (first name, last name, and SSN) and their respective branch and manager they work under.

### **b – Assumptions List**

**1. The database is HIPAA compliant.**

**2. The branches are identified by their street address & city names when being spoken of. For instance, Boston Post Rd, West Haven Branch or Campbell Ave, New Haven Branch.**

3. The donor can have an underlying condition that resolves in the future allowing them to donate blood again. However, it is considered that a patient does not have any underlying condition that would prevent them from **receiving** blood.
4. Blood bags cannot travel between branches. The donor donates blood in a particular branch where the blood bag will be stored and processed. However, a patient can receive a blood bag from any branch.
5. There is no limit on the number of days blood bags can be stored. It is assumed that blood does not expire. Therefore, the blood bags can be received by a patient at any date **after** it is donated and processed in the laboratory.
6. The unit price of a particular component of blood may change once in a month. It is assumed that the price would not change more than once in a month. The *Branch Expense* would be null until the end of month, when the particular tuple for the corresponding month would be updated to store the monthly expense.
7. It is not necessary to store historical record of the number of equipment stored in inventory. This is because the total number of equipment in a particular branch is of value and record keeping would not add further value.
8. One employee can work in one branch and under a single manager only.
9. If an employee is working under a particular manager, then the branch ID of the manager and the employee must be the same.
10. The Patient Blood Bag and Transfusion table are required for easier queries. The transfusion table uniquely identifies each transfusion (donor blood bag ID → patient) using the transfusion ID. The Patient Blood Bag table provides additional information including the branch and date on which a patient receives that particular blood bag.
11. A branch may not have a manager assigned. For instance, if a new branch is being formed it may not have a manager. There is only manager in a branch.
12. An employee may not have either a branch or manager or both. For instance, if the employee is a manager, then the employee may not have another manager supervising them. An employee may be new and may not have a branch or manager or both assigned.
13. There is no limit on the number of blood bags a donor can donate.
14. The blood group of the donor matches the blood group of the patient. The date of the donation does not have to be in order. Moreover, the date on which the patient and donor

profile is created does not necessarily have to be the date on which the blood bag is transferred or received. The profile may have been made beforehand.

**15.** Each blood bag can only contain one component of blood (red blood cell, plasma, platelets). A donor may donate different components of blood, but they would be stored in different blood bags with unique ID.

**16.** The time between which the underlying condition of a donor is declared, and blood is donated must be within 5 days. Dates are inclusive.

### **c - Tables Description**

To the best of my knowledge, I have achieved 3<sup>rd</sup> Normal Form for the blood\_bank\_db database. Details about the 3<sup>rd</sup> Normal Form criteria can be found in Document 3 - Assessment of Project Section d.



[illegible]

## Tables

**Please Note:** If an attribute description is not provided it is because the name is self-explanatory.

### 1. Employees:

The Employees table stores the profile information of all employees in each branch (Fig 1). There are 5 columns: Employee SSN, Employee First Name, Employee Last Name, Manager SSN, and Branch ID. The Employee SSN is the primary key. The Branch ID is a unique ID that is given to each branch to identify them. For instance, a branch in West Haven has an ID of 1, and a branch in New Haven has an ID of 2. Two branches may exist in the same city, but they would have different addresses and consequently different branch IDs. Each employee is allocated to work in a particular branch. A new employee may not have been assigned a branch and therefore would be null. The Branch ID is a foreign key that references ID in the Branch table.

The manager is an employee of the organization; hence their first name, last name and SSN exist in the Employee SSN, Employee First Name and Employee Last Name columns. The Manager SSN column provides us the SSN of the manager of a particular employee. An employee may be a manager herself and may not have a manager, therefore Manager SSN would be null. Additionally, an employee may be working independently at a particular branch and may not have a manager. If an employee is working under a particular manager, then the branch ID of the manager and that employee must be the same. The Manager SSN is a foreign key that references Employee SSN in the Employees table.

The table should have approximately 10,000 records or more. The number of records depend on the total number of employees in the organization.

### 2. Branch:

The branch table stores the information about all the branches in the organization (Fig 1). There are 7 columns: ID, Manager SSN, Street Address, City, State, Zip Code, Country. The address is divided into separate columns to ensure first normal form (data domain is atomic). The Manager SSN tells us the SSN of the manager who is supervising a particular branch. Each branch may or may not have a manager and therefore can be null. ID is the primary key. The Manager SSN is a foreign key that references Manager SSN in the Employees table.

The table should have approximately 20 records or more. The number of records depend

on the number of branches in the organization.

### **3. Patient:**

The patient table stores the medical profile of a patient including Patient First Name, Patient Last Name, Blood Group, and ID (Fig 1). The ID is the primary key.

The table should have approximately 100,000 records or more. The number of records depend on the number of patients who require blood donation and have created a profile in our organization.

### **4. Patient Blood Bag:**

The Patient Blood Bag table contains data for transfusion from the Donor Blood Bag ID → Patient ID on a particular date and in a particular branch (Fig 1). The table has the following columns: Patient ID, Donor Blood Bag ID, Transfer Datetime, and Branch ID. The Donor Blood Bag ID is the primary key. Patient ID is a foreign key referencing ID in the Patient table; Branch ID is a foreign key referencing ID in the Branch table; Donor Blood Bag ID is a foreign key referencing Blood Bag ID in the Donor Blood Bag table.

The table should have approximately 80,000 records or more. The number of records depend on the number of blood bags donated to patients.

### **5. Donor:**

The donor table stores the medical profile of a donor including Donor First Name, Donor Last Name, Blood Group, and ID (Fig 1). The ID is the primary key.

The table should have approximately 30,000 records or more. The number of records depend on the number of donors who have created a profile in our organization.

### **6. Donor Underlying Condition:**

The table is related to the Donor table and is part of the medical profile of the donor (Fig 1). The Donor ID and Stamp Date form a composite primary key. The table is separated to ensure 3rd Normal Form. The table contains a list of medical diseases that a donor would be tested for and would have to declare if they have it. A donor cannot donate blood if she has any of the diseases. A check is present to prevent the blood bank

from inputting further information in the blood bank. The table has the following columns: Donor ID, Stamp Date, HIV 1, HIV 2, HTLV I, HTLV II, Hepatitis C, Hepatitis B, West Nile Virus, and T Pallidum.

The composite primary key ensures that if a donor is positive for any of the diseases on a particular date and then recovers on a later date, the donor can become eligible for blood donation. The latest date will be seen to determine the eligibility of a donor. The past history of the donor should be kept for record keeping. For certain diseases it is considered hazardous to donate blood even if the person has recovered. To prevent such cases a record of the donor's history would make certain that a donor with such a disease cannot donate blood. The Donor ID is a foreign key that references ID in the Donor table.

The table should have approximately 90,000 records or more. The number of records depend on the number of donors and their blood donation frequency.

## **7. Donor Blood Bag:**

The donor blood bag contains data about each blood bag that is created (Fig 1). It holds data about the donor, date of creation of the blood bag, and the branch where the blood bag is stored and processed. The Blood Bag ID is the primary key. The table has 7 columns: Receival Datetime, Donor ID, Red Blood Cells, Platelets, Plasma, Blood Bag ID, and Branch ID. The Red Blood Cells, Platelets, and Plasma contain boolean values which tell us the component of blood in the blood bag. Donor ID is a foreign key referencing ID in the Donor table; Branch ID is a foreign key referencing ID in the Branch table.

The table should have approximately 90,000 records or more. The number of records depend on the number of donors and their blood donation frequency.

## **8. Price**

The price table holds data for the unit price of each component of blood - red blood cells, platelets, plasma (Fig 2). The unit price is recorded for each month, year, and location/branch. Moreover, the monthly expense of the branch is recorded at the end of the month. The table has 7 columns: Month ID, Year ID, Unit Price Plat (Platelets), Unit Price Rb (Red Blood Cells), Unit Price Plas (Plasma), Branch Expense, and Branch ID. Month ID, Year ID, and Branch ID form a composite primary key. Branch ID is a foreign key referencing ID in the Branch table.

The table should have approximately 1000 records or more. The number of records depend on the number of branches and their establishment (start) date.



## 9. Transfusion:

The transfusion table uniquely records and identifies each transfusion from Donor Blood Bag ID → Patient ID using the Transfusion ID. The Transfusion ID is the primary key. The Donor Blood Bag ID is a foreign key referencing Blood Bag ID in the Donor Blood Bag table. The Patient ID is a foreign key referencing ID in the Patient table. The columns in the table include: Donor Blood Bag ID, Patient ID, and Transfusion ID.

The table should have approximately 80,000 records or more. The number of records depend on the number of blood bags donated to patients.

## 10. Blood Inventory:

The Blood Inventory records the status of the blood bag as it is processed through the laboratory and consequently the branch. The Donor Blood Bag ID and Stamp Datetime form a composite primary key. The columns include Donor Blood bag ID, Stamp Datetime, and Blood Bag Status. The Donor Blood Bag ID is a foreign key referencing Blood Bag ID in the Donor Blood Bag table. The composite primary key allows the database to uniquely identify the same blood bag with different status, due to the distinct stamp times.

The table should have approximately 90,000 records or more. The number of records depend on the number of blood bags donated.

**Please Note:** The following tables contain a list of equipment available in each branch for each category/attribute (Fig 2). The Branch ID is the primary key. Each attribute is updated when there is a change. No record data is kept since there may be multiple changes in equipment. Only the total count of equipment is required. Below the column names are provided for each table. The attribute values are not null because it is the count of the number of equipment of that type available. The count may be 0.

The tables should have approximately 20 records or more. The number of records depend on the number of branches in the organization.

## 11. Lab Equipments:

Column Names - Microscope, Microscope Slide Cover Slip, Balance, Thermometer, Plasma Extractor, Cyrofuge, Centrifuge, Funnel, Wash Bottle, Pipettes, Dropper Bottle,

Test Tube Racks, PPE, Branch ID.

**12. Incubators:**

Column Names – Platelet Incubator, Water Bath, Incubator, Branch ID.

**13. Storage Equipments:**

Column Names – Branch ID, Ultralow Freezer Plasma, Temperature Controlled Box, Blood Refrigerator.

**14. Donation Equipments:**

Column Names – Branch ID, Blood Bags, Blood Donation Chair, Blood Shaker, Blood Bag Tube Sealer, Scissor Forceps, Instrument Trays, Spirit Swab Bowl, Packing Label.

**List of ALL Tables:**

There are no **Many to Many** relationships in the ER diagram, therefore no intermediary table exists. There are **1 to 1** and **1 to Many** Relationships in the ER diagram hence there are several referenced tables.

1. Employees
2. Branch
3. Patient
4. Patient Blood Bag
5. Donor
6. Donor Underlying Condition
7. Donor Blood Bag
8. Price
9. Transfusion
10. Blood Inventory
11. Lab Equipments
12. Incubators
13. Storage Equipments
14. Donation Equipments

**List of Main Tables:**

1. Branch
2. Employees
3. Patient
4. Patient Blood Bag
5. Donor
6. Donor Underlying Condition
7. Donor Blood Bag
8. Transfusion
9. Blood Inventory

**List of Additional Tables (Expense & Equipment Inventory):**

The remaining tables are monthly expense and equipment inventory for each branch.

1. Price
2. Lab Equipments
3. Incubators
4. Storage Equipments
5. Donation Equipments

The diagram is an Entity-Relationship (ER) model for a blood bank system. It consists of the following entities, attributes, and relationships:

- search** (Entity): Attributes include ID, Country, Street\_address, City, State, ZIP\_code, Manager\_info, and a 1:1 relationship with **employee** (Manages).
- employee** (Entity): Attributes include Manager\_SSN, Employee\_SSN, Employee\_firstname, Employee\_lastname, and Search\_ID. It has a 1:N relationship with **search** (Works\_in) and a 1:N relationship with **patient** (Supervises).
- patient** (Entity): Attributes include ID, Patient\_firstname, Patient\_lastname, Blood\_group, Patient\_ID, Transfuse\_date, Transf\_ID, Patient\_blood\_bank\_ID, and a 1:N relationship with **transfusion** (Transfuses).
- transfusion** (Entity): Attributes include Transfusion\_ID, Patient\_ID, and Donor\_blood\_bank\_ID. It has a 1:N relationship with **patient** (Transfuses) and a 1:N relationship with **donor** (Donates).
- donor** (Entity): Attributes include Blood\_group, Donor\_firstname, Donor\_lastname, ID, and a 1:N relationship with **transfusion** (Donates).
- donor\_underlying\_condition** (Entity): Attributes include HIV\_1, HIV\_2, HIV\_3, HIV\_4, HIV\_5, HIV\_6, HIV\_7, HIV\_8, HIV\_9, HIV\_10, HIV\_11, HIV\_12, HIV\_13, HIV\_14, HIV\_15, HIV\_16, HIV\_17, HIV\_18, HIV\_19, HIV\_20, HIV\_21, HIV\_22, HIV\_23, HIV\_24, HIV\_25, HIV\_26, HIV\_27, HIV\_28, HIV\_29, HIV\_30, HIV\_31, HIV\_32, HIV\_33, HIV\_34, HIV\_35, HIV\_36, HIV\_37, HIV\_38, HIV\_39, HIV\_40, HIV\_41, HIV\_42, HIV\_43, HIV\_44, HIV\_45, HIV\_46, HIV\_47, HIV\_48, HIV\_49, HIV\_50, HIV\_51, HIV\_52, HIV\_53, HIV\_54, HIV\_55, HIV\_56, HIV\_57, HIV\_58, HIV\_59, HIV\_60, HIV\_61, HIV\_62, HIV\_63, HIV\_64, HIV\_65, HIV\_66, HIV\_67, HIV\_68, HIV\_69, HIV\_70, HIV\_71, HIV\_72, HIV\_73, HIV\_74, HIV\_75, HIV\_76, HIV\_77, HIV\_78, HIV\_79, HIV\_80, HIV\_81, HIV\_82, HIV\_83, HIV\_84, HIV\_85, HIV\_86, HIV\_87, HIV\_88, HIV\_89, HIV\_90, HIV\_91, HIV\_92, HIV\_93, HIV\_94, HIV\_95, HIV\_96, HIV\_97, HIV\_98, HIV\_99, HIV\_100, HIV\_101, HIV\_102, HIV\_103, HIV\_104, HIV\_105, HIV\_106, HIV\_107, HIV\_108, HIV\_109, HIV\_110, HIV\_111, HIV\_112, HIV\_113, HIV\_114, HIV\_115, HIV\_116, HIV\_117, HIV\_118, HIV\_119, HIV\_120, HIV\_121, HIV\_122, HIV\_123, HIV\_124, HIV\_125, HIV\_126, HIV\_127, HIV\_128, HIV\_129, HIV\_130, HIV\_131, HIV\_132, HIV\_133, HIV\_134, HIV\_135, HIV\_136, HIV\_137, HIV\_138, HIV\_139, HIV\_140, HIV\_141, HIV\_142, HIV\_143, HIV\_144, HIV\_145, HIV\_146, HIV\_147, HIV\_148, HIV\_149, HIV\_150, HIV\_151, HIV\_152, HIV\_153, HIV\_154, HIV\_155, HIV\_156, HIV\_157, HIV\_158, HIV\_159, HIV\_160, HIV\_161, HIV\_162, HIV\_163, HIV\_164, HIV\_165, HIV\_166, HIV\_167, HIV\_168, HIV\_169, HIV\_170, HIV\_171, HIV\_172, HIV\_173, HIV\_174, HIV\_175, HIV\_176, HIV\_177, HIV\_178, HIV\_179, HIV\_180, HIV\_181, HIV\_182, HIV\_183, HIV\_184, HIV\_185, HIV\_186, HIV\_187, HIV\_188, HIV\_189, HIV\_190, HIV\_191, HIV\_192, HIV\_193, HIV\_194, HIV\_195, HIV\_196, HIV\_197, HIV\_198, HIV\_199, HIV\_200, HIV\_201, HIV\_202, HIV\_203, HIV\_204, HIV\_205, HIV\_206, HIV\_207, HIV\_208, HIV\_209, HIV\_210, HIV\_211, HIV\_212, HIV\_213, HIV\_214, HIV\_215, HIV\_216, HIV\_217, HIV\_218, HIV\_219, HIV\_220, HIV\_221, HIV\_222, HIV\_223, HIV\_224, HIV\_225, HIV\_226, HIV\_227, HIV\_228, HIV\_229, HIV\_230, HIV\_231, HIV\_232, HIV\_233, HIV\_234, HIV\_235, HIV\_236, HIV\_237, HIV\_238, HIV\_239, HIV\_240, HIV\_241, HIV\_242, HIV\_243, HIV\_244, HIV\_245, HIV\_246, HIV\_247, HIV\_248, HIV\_249, HIV\_250, HIV\_251, HIV\_252, HIV\_253, HIV\_254, HIV\_255, HIV\_256, HIV\_257, HIV\_258, HIV\_259, HIV\_260, HIV\_261, HIV\_262, HIV\_263, HIV\_264, HIV\_265, HIV\_266, HIV\_267, HIV\_268, HIV\_269, HIV\_270, HIV\_271, HIV\_272, HIV\_273, HIV\_274, HIV\_275, HIV\_276, HIV\_277, HIV\_278, HIV\_279, HIV\_280, HIV\_281, HIV\_282, HIV\_283, HIV\_284, HIV\_285, HIV\_286, HIV\_287, HIV\_288, HIV\_289, HIV\_290, HIV\_291, HIV\_292, HIV\_293, HIV\_294, HIV\_295, HIV\_296, HIV\_297, HIV\_298, HIV\_299, HIV\_300, HIV\_301, HIV\_302, HIV\_303, HIV\_304, HIV\_305, HIV\_306, HIV\_307, HIV\_308, HIV\_309, HIV\_310, HIV\_311, HIV\_312, HIV\_313, HIV\_314, HIV\_315, HIV\_316, HIV\_317, HIV\_318, HIV\_319, HIV\_320, HIV\_321, HIV\_322, HIV\_323, HIV\_324, HIV\_325, HIV\_326, HIV\_327, HIV\_328, HIV\_329, HIV\_330, HIV\_331, HIV\_332, HIV\_333, HIV\_334, HIV\_335, HIV\_336, HIV\_337, HIV\_338, HIV\_339, HIV\_340, HIV\_341, HIV\_342, HIV\_343, HIV\_344, HIV\_345, HIV\_346, HIV\_347, HIV\_348, HIV\_349, HIV\_350, HIV\_351, HIV\_352, HIV\_353, HIV\_354, HIV\_355, HIV\_356, HIV\_357, HIV\_358, HIV\_359, HIV\_360, HIV\_361, HIV\_362, HIV\_363, HIV\_364, HIV\_365, HIV\_366, HIV\_367, HIV\_368, HIV\_369, HIV\_370, HIV\_371, HIV\_372, HIV\_373, HIV\_374, HIV\_375, HIV\_376, HIV\_377, HIV\_378, HIV\_379, HIV\_380, HIV\_381, HIV\_382, HIV\_383, HIV\_384, HIV\_385, HIV\_386, HIV\_387, HIV\_388, HIV\_389, HIV\_390, HIV\_391, HIV\_392, HIV\_393, HIV\_394, HIV\_395, HIV\_396, HIV\_397, HIV\_398, HIV\_399, HIV\_400, HIV\_401, HIV\_402, HIV\_403, HIV\_404, HIV\_405, HIV\_406, HIV\_407, HIV\_408, HIV\_409, HIV\_410, HIV\_411, HIV\_412, HIV\_413, HIV\_414, HIV\_415, HIV\_416, HIV\_417, HIV\_418, HIV\_419, HIV\_420, HIV\_421, HIV\_422, HIV\_423, HIV\_424, HIV\_425, HIV\_426, HIV\_427, HIV\_428, HIV\_429, HIV\_430, HIV\_431, HIV\_432, HIV\_433, HIV\_434, HIV\_435, HIV\_436, HIV\_437, HIV\_438, HIV\_439, HIV\_440, HIV\_441, HIV\_442, HIV\_443, HIV\_444, HIV\_445, HIV\_446, HIV\_447, HIV\_448, HIV\_449, HIV\_450, HIV\_451, HIV\_452, HIV\_453, HIV\_454, HIV\_455, HIV\_456, HIV\_457, HIV\_458, HIV\_459, HIV\_460, HIV\_461, HIV\_462, HIV\_463, HIV\_464, HIV\_465, HIV\_466, HIV\_467, HIV\_468, HIV\_469, HIV\_470, HIV\_471, HIV\_472, HIV\_473, HIV\_474, HIV\_475, HIV\_476, HIV\_477, HIV\_478, HIV\_479, HIV\_480, HIV\_481, HIV\_482, HIV\_483, HIV\_484, HIV\_485, HIV\_486, HIV\_487, HIV\_488, HIV\_489, HIV\_490, HIV\_491, HIV\_492, HIV\_493, HIV\_494, HIV\_495, HIV\_496, HIV\_497, HIV\_498, HIV\_499, HIV\_500, HIV\_501, HIV\_502, HIV\_503, HIV\_504, HIV\_505, HIV\_506, HIV\_507, HIV\_508, HIV\_509, HIV\_510, HIV\_511, HIV\_512, HIV\_513, HIV\_514, HIV\_515, HIV\_516, HIV\_517, HIV\_518, HIV\_519, HIV\_520, HIV\_521, HIV\_522, HIV\_523, HIV\_524, HIV\_525, HIV\_526, HIV\_527, HIV\_528, HIV\_529, HIV\_530, HIV\_531, HIV\_532, HIV\_533, HIV\_534, HIV\_535, HIV\_536, HIV\_537, HIV\_538, HIV\_539, HIV\_540, HIV\_541, HIV\_542, HIV\_543, HIV\_544, HIV\_545, HIV\_546, HIV\_547, HIV\_548, HIV\_549, HIV\_550, HIV\_551, HIV\_552, HIV\_553, HIV\_554, HIV\_555, HIV\_556, HIV\_557, HIV\_558, HIV\_559, HIV\_560, HIV\_561, HIV\_562, HIV\_563, HIV\_564, HIV\_565, HIV\_566, HIV\_567, HIV\_568, HIV\_569, HIV\_570, HIV\_571, HIV\_572, HIV\_573, HIV\_574, HIV\_575, HIV\_576, HIV\_577, HIV\_578, HIV\_579, HIV\_580, HIV\_581, HIV\_582, HIV\_583, HIV\_584, HIV\_585, HIV\_586, HIV\_587, HIV\_588, HIV\_589, HIV\_590, HIV\_591, HIV\_592, HIV\_593, HIV\_594, HIV\_595, HIV\_596, HIV\_597, HIV\_598, HIV\_599, HIV\_600, HIV\_601, HIV\_602, HIV\_603, HIV\_604, HIV\_605, HIV\_606, HIV\_607, HIV\_608, HIV\_609, HIV\_610, HIV\_611, HIV\_612, HIV\_613, HIV\_614, HIV\_615, HIV\_616, HIV\_617, HIV\_618, HIV\_619, HIV\_620, HIV\_621, HIV\_622, HIV\_623

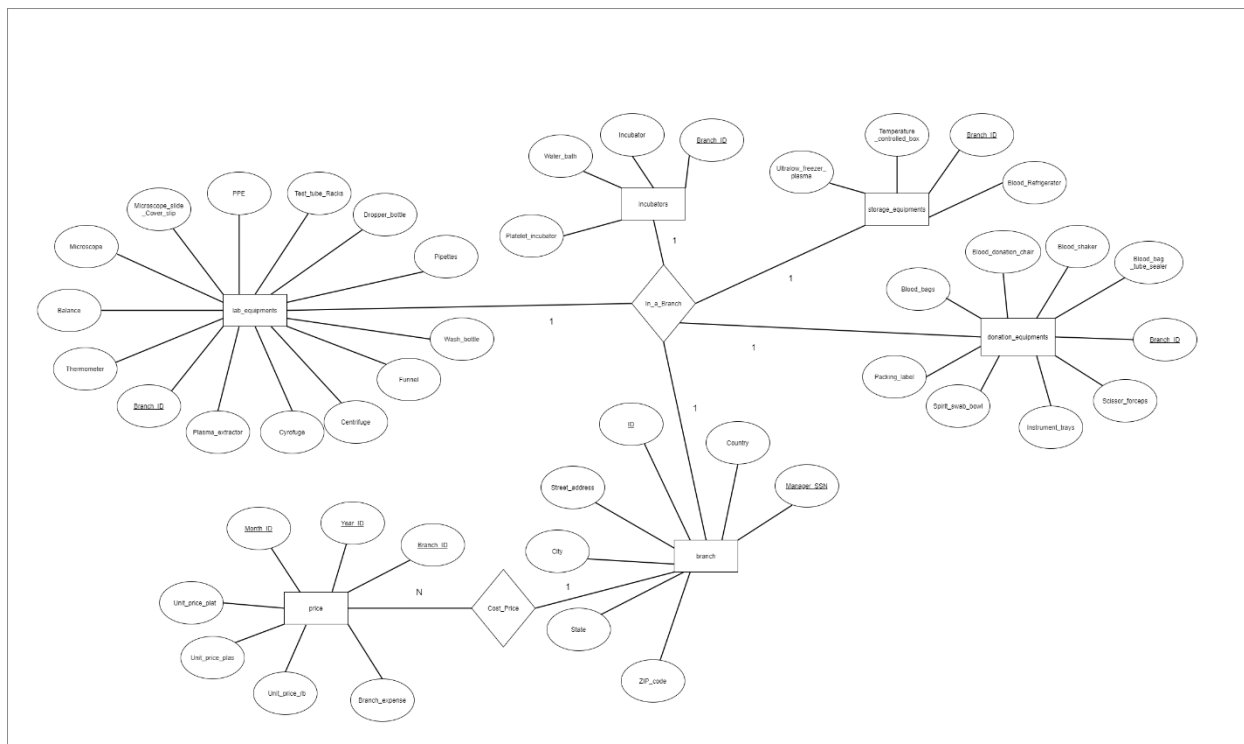


Fig 2. Additional Tables