1. Exercise

We have the following property:
X is closed if and only if $|D[Y]| < |D[X]|$ for every $Y \supsetneq X$
and this means that $D[Y] \subsetneq D[X]$.
If $|D[X \cup i]| \geq \ |D[X]||$ then X is not closed because it contradicts with the property.
So all proper supersets of X must have support count less that the support count of X $D[X \cup i] \subsetneq D[X]$ must hold for all $i \in I \setminus X$ in order for X to be closed.
And if X is closed then $D[X \cup i] \subsetneq D[X]$ for all $i \in I \setminus X$ and the statment holds.

2. Exercise

Let X be an itemset and D[X] be the support count of X
If we perform a closure operation c(X) then we can have either X (X is closed) or a superset containing X.
Now we know that : $C(x) = ti(it(X))$
By definition $it(X)$ returns all the lines containing all elments of X.
In other words : $it(X) = it(X1) \cap it(X2)... \cap (Xn); X1, X2, ..Xn \in X$.
So the output of $it(X)$ will be all transactions that have the subset X in them, and from definition : $ti(Y) = ti(Y1) \cap ti(Y2)... \cap (Yn); Y1, Y2, ..Yn \in Y$
So the output of $ti(Y)$ will be all common items in the itemsets presented in $Y1, Y2, ...Yn$, but we know that the output of $it(X)$ contains all transactions having X in them, and so by performing ti to result of $it(X)$ we will have an itemset containing X, and perhaps some other items, and this itemset must apper in all lines of the database (because of the definition), which means that result will always have a support count equal to $D[X]$.
In other words $D[X] = D[c(X)]$