Name: _____

Question:	1	2	3	4	5	6	Total
Points:	20	15	15	15	15	20	100
Score:							

Answer the questions in the spaces provided. If you run out of room for an answer, continue on the back of the page.

1. Fill in the following algebraic datatype definitions

(a) (5 points)

$\mathbb{B}$ ::= _____
| _____

(b) (5 points)

$\mathbb{N}$ ::=_____
| Succ _____

(c) (5 points)

List a ::= Empty
| Cons _____

(d) (5 points)

Maybe a ::= _____
| _____ a

2. (15 points) Is the following function tail-recursive?

$$\begin{aligned}&\text{foo} : \mathbb{B} \to \mathbb{N} \to \mathbb{N}\\&\text{foo } acc\ (\text{Succ } n) = \text{Succ } (\text{foo } acc\ n)\\&\text{foo True Zero} = \text{Zero}\\&\text{foo False Zero} = \text{Succ Zero}\end{aligned}$$

3. (15 points) What is the type of the following function?

$$\begin{aligned}&\text{bar } f\ x\ y\ = y \text{ match}\\&\quad \text{True} \to f\ x\\&\quad \text{False} \to (\text{Succ } (\text{Succ x}))\end{aligned}$$

4. (15 points) What is the type of the following list?

$$\text{let } xs = \text{Cons } 5 \text{ (Cons } 4 \text{ (Cons True (Cons “Hello, World!” Empty)))}$$

A. xs : List A
B. xs : List $\mathbb{N}$
C. xs : List Expr
D. It doesn't have a type because xs is not well-typed

4. _____

5. (15 points) There is a problem with the following function, what is it?

$$\text{baz (Succ (Succ } x)) \; y = \text{baz } x \; y$$
$$\text{baz (Succ } x) \text{ True} = \text{baz (Succ } x) \text{ False}$$
$$\text{baz } x \; y = \text{baz } x \text{ True}$$

A. there is nothing wrong with it
B. it is not total, meaning it is missing cases
C. it is not well-typed
D. it never terminates

5. _____

6. (20 points) Write the filter function for Lists. Recall that it takes a predicate(A function from some type to the Booleans) and a list of whatever that type was and returns the list of items for which the predicate is true. Remember that you may need to use internal case/pattern matching to write this. Remember to write the type signature/declaration!