Q3:
Notice that we can rewrite $F(y) = \int_a^b f(x,y)dx = \int_a^b (\int_c^y D_2 f(x,y)dy + f(x,y)dx)$. We compute

$$\begin{aligned}
\frac{\partial}{\partial y} F(y) &= \frac{\partial}{\partial y} \int_a^b (\int_c^y D_2 f(x,y)dy + f(x,y)dx) \\
&= \frac{\partial}{\partial y} \left[\int_a^b \int_c^y D_2 f(x,y)dydx + \int_a^b f(x,c)dx \right] && \text{(by linearity)} \\
&= \frac{\partial}{\partial y} \int_c^y \int_a^b D_2 f(x,y)dxdy + \frac{\partial}{\partial y} \int_a^b f(x,y)dx && \text{(by Fubini's Theorem)} \\
&= \frac{\partial}{\partial y} \int_c^y \int_a^b D_2 f(x,y)dxdy \\
&= \int_a^b D_2 f(x,y)dx && \text{(by FTC)}
\end{aligned}$$