1) $SCF \subset CF$:

$G = (\Sigma, P, \sigma) \longrightarrow G' = (N, T, P', S)$

$m1(abc) = ABC$

For $a \in \Sigma$: $A \in N$, $a \in T$

$\underline{A \to a} \in P'$

For $a \to x \in P$: $A \longrightarrow m1(x) \in P'$

$S \in N$: $S \longrightarrow m1(\sigma)$

$\{a, aa\} \in CF$

$\notin SCF$

2) SCF $\subset$ PCF:

$G=(\Sigma, P, S) \rightsquigarrow G'=(\Sigma, P', S)$

$P' = P \cup \{a \to a \mid a \in \Sigma\}$

$\{a^{2^n} \mid n \geq 0\} \in$ PCF $-$ SCF

$a \to aa \qquad a \underset{P}{\Rightarrow} aa \underset{P}{\Rightarrow} aaaa \underset{P}{\Rightarrow} \ldots$

3) $JSCF^{-\varepsilon} \subset JSCF$:

$\{a, ab\} \in JSCF$: $\omega = ab$, $P = \{b \to \varepsilon\}$

$\underline{ab} \underset{j}{\Rightarrow} \underline{a}$

$\{a, ab\} \notin JSCF^{-\varepsilon}$: $\omega = a$, $P = \{a \to ab, \dots\}$

$a \underset{j}{\Rightarrow} ab \underset{j}{\Rightarrow} \cancel{abb}$

$SCF^{-\varepsilon} \subset SCF$ $\underset{j}{\Rightarrow} bab$

$P = \{a \to ab\}$, $\omega = a$

$\underline{a} \underset{jp}{\Rightarrow} \underline{ab}$

$JPCF^{-\varepsilon} \subset JPCF$: $\{aa, aab\}$

$PCF^{\varepsilon} \subset PCF$

$L_A = \{a^{2^n} b^{2^n} \mid n \geq 0\} \notin JPCF$

Assume $L(G, {}_{jp}\Rightarrow) = L_A \in JPCF$.

$S = ab$, $a \to x$, $b \to y \in P$

1) $x = \varepsilon$, $y \in L(G)$ — $y = ab$: $\cancel{L(G, {}_{jp}\Rightarrow) = \{ab\}}$

— $y = \varepsilon / a / b \; \varepsilon \; \cancel{\in L(G, {}_{jp}\Rightarrow)}$

— $|y| > |ab|$:

$y = aabb$

$ab \; {}_{jp}\Rightarrow \underline{aa}\,\underline{bb} \; {}_{jp}\Rightarrow aabb\,\underline{aabb}$ ✗

2) $y = \varepsilon$, $X \in L(G)$ ...

3) $X \neq \varepsilon$, $y \neq \varepsilon$:

3a) $X = \underline{bx'}$ or $y = \underline{by'}$: $ab \; {}_{jp}\Rightarrow bz$ ✗

3b) $X = x'a$ or $y = y'a$: $ab \; {}_{jp}\Rightarrow za$ ✗

3c) $X = ax'b$ or $y = ay'b$: $ab \; {}_{jp}\Rightarrow ax'ba\,y'b$ ✗