Let $p : E \to B$ be a covering map. Then

a.) p is an open map

b.) E locally (path) connected iff B locally path connected.

Defn: A **separation** of X is a pair of nonempty open sets U, V, s.t. $U \cap V = \emptyset$ & $U \cup V = X$. X is **connected** if there does not exist a separation of X.

Lemma: X is connected if and only if the only subsets of X which are both open and closed in X are the $\emptyset$ and X.

Defn: Given points $x, y \in X$, a **path** in X from x to y is a continuous map $f : [a, b] \to X$ such that $f(a) = x$ and $f(b) = y$.

A space is **path connected** if every pair of points of X can be joined by a path in X.

Lemma: Path connected implies connected.

Lemma 23.2: If C, D form a separation of X and if Y is a (path) connected subspace of X, then $Y \subset C$ or $Y \subset D$

Theorem 23.5: If $f : X \to Y$ is continuous and X is (path) connected, then $f(X)$ is (path) connected.

Defn: X is **locally connected at** x if for every neighborhood U of x, there exists connected open set V such that $x \in V \subset U$.

X is **locally connected** if x is locally connected at each of its points.

Defn: X is **locally path connected at** x if for every neighborhood U of x, there exists path connected open set V such that $x \in V \subset U$.

X is **locally path connected** if x is locally path connected at each of its points.

Thm 25.3,4: X locally (path) connected iff $\forall U$ open in X, each (path) component of U is open in X

Thm 25.5: Each path component lies in a component of X.
If X is locally path connected, then the path components of $X =$ components of X.