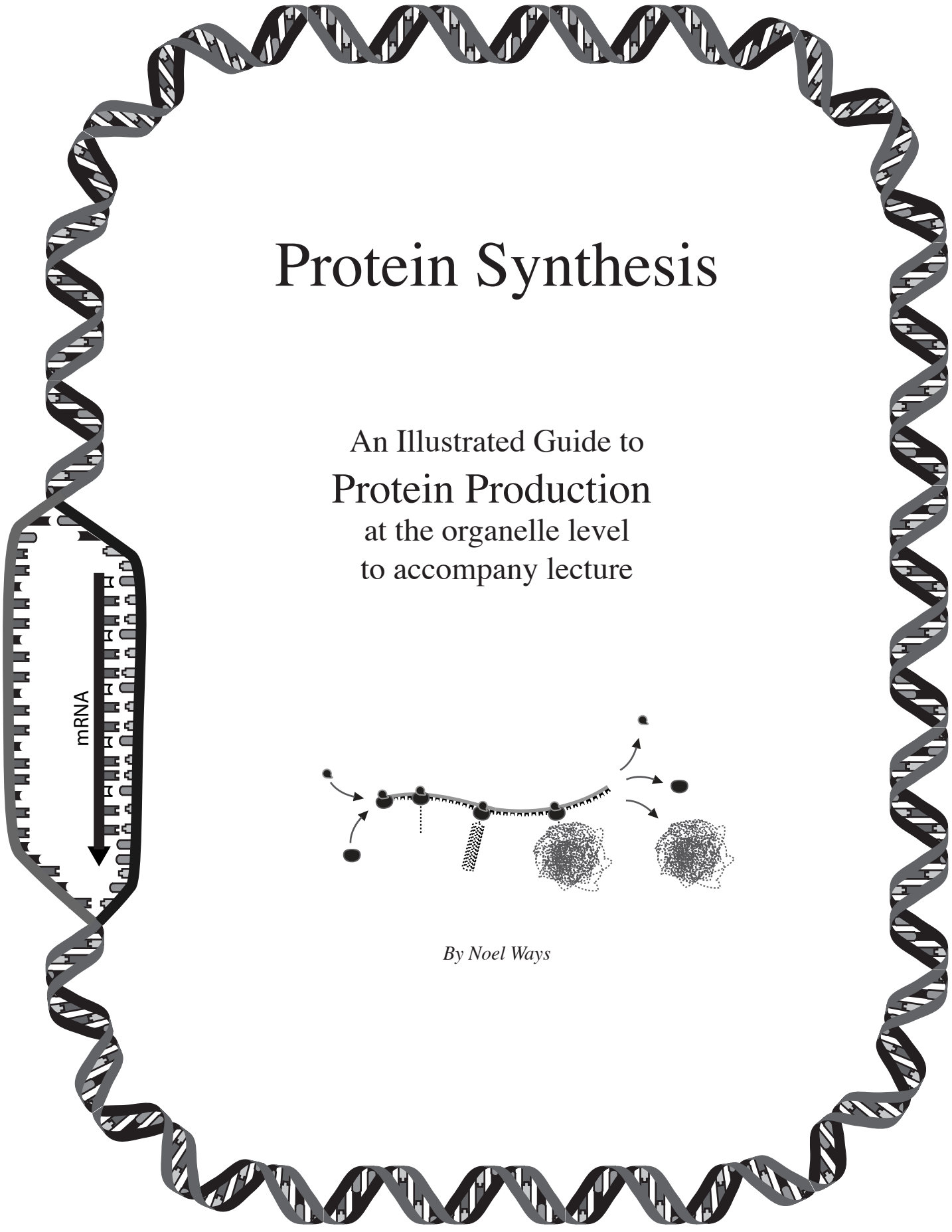
Protein Synthesis

An Illustrated Guide to

Protein Production

at the organelle level
to accompany lecture



By Noel Ways

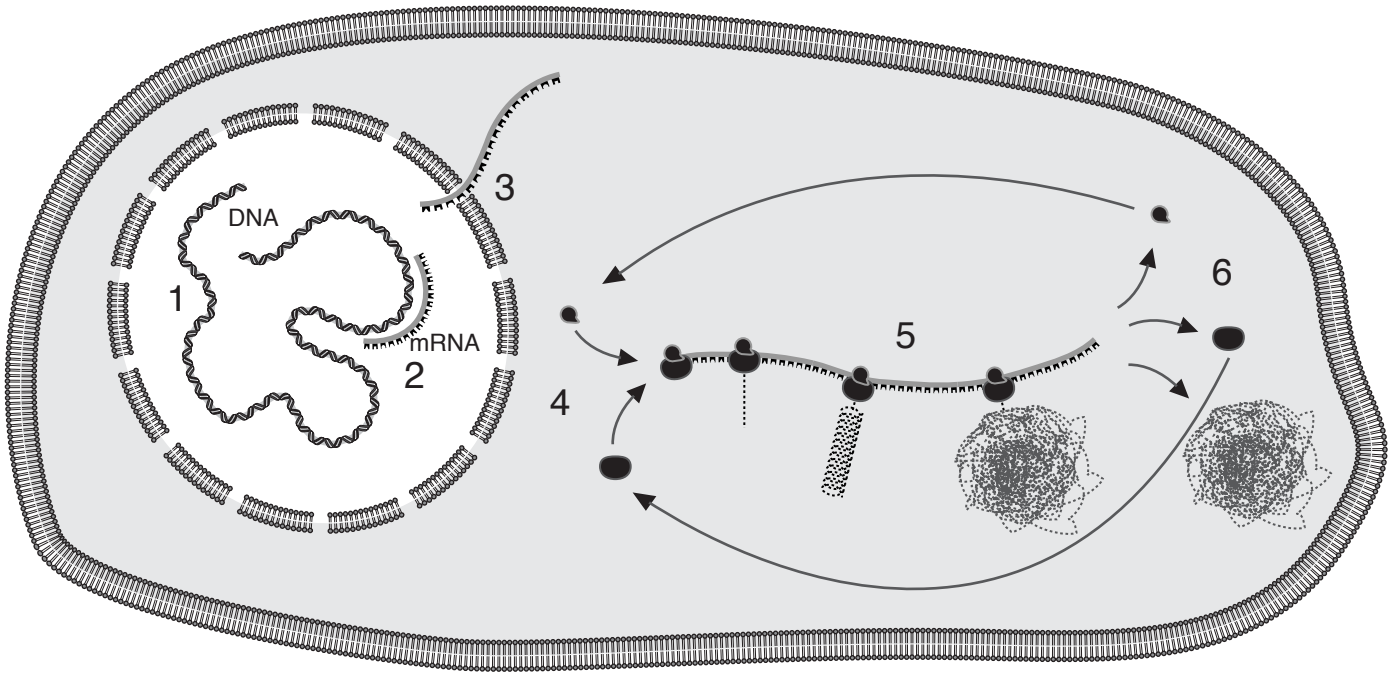
Protein Synthesis for Intra-cellular Usage

Protein production for use in the cell starts with the transcription of the DNA into mRNA. Only one strand of the DNA double helix is used. Once transcribed, the mRNA leaves the nucleus through a nuclear pore and enters the cytoplasm. It can now be used for the translation of a protein.

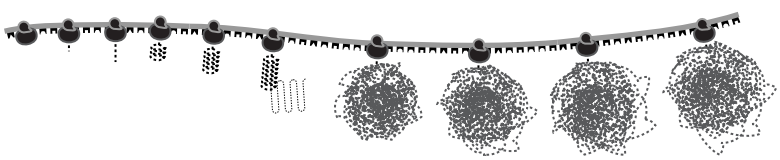
Translation of the mRNA into protein requires and organelle called a ribosome. Ribosomes consist of two subunits, a small ribosomal subunit ( ) and a large ribosomal subunit ( ). When messenger RNA (mRNA) is in the cytoplasm of the cell, the two ribosomal subunits bind to the mRNA, adding appropriate amino acids to a growing polypeptide chain according to the directions of the mRNA, which reflect the DNA instructions.

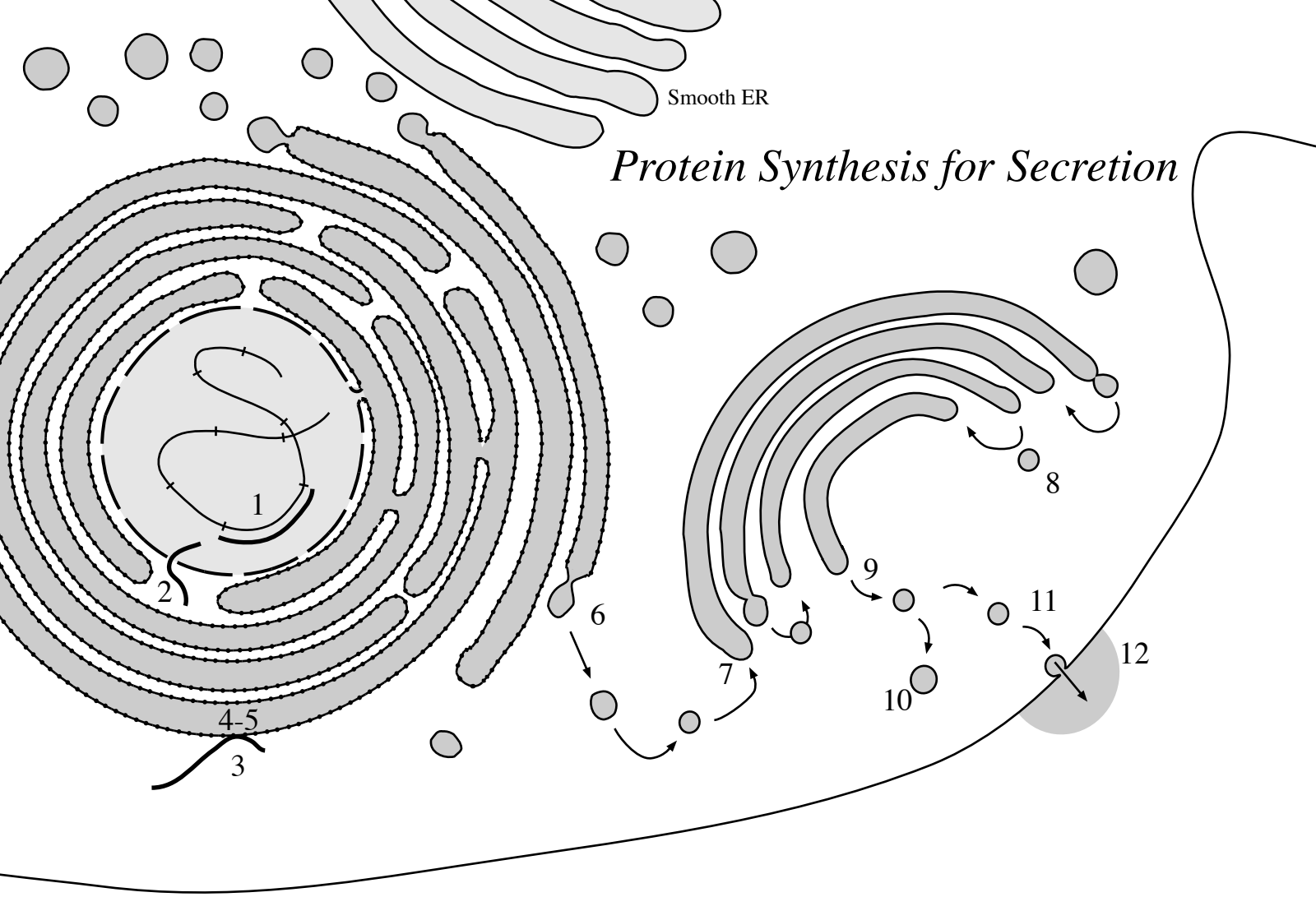
DNA —*Transcription*→ mRNA —*Translation*→ Protein

As the ribosome translocates down the mRNA, a protein structure form. Note in this illustration, an initial primary protein structure, followed by a secondary and tertiary protein structure. When translation is complete, the structure disassembles. The two ribosomal subunits may again translate the mRNA. Finished proteins may now be used in the cell.



Many ribosomes attached to a mRNA is called a polysome





1. Gene of interest is transcribed (DNA --> mRNA).
2. mRNA exits nucleus through nuclear pore.
3. mRNA attaches to ribosome of rough endoplasmic reticulum
4. Translation occurs (mRNA --> protein)
5. Proteins are sequestered in cisterns (membranous sacs) of rough endoplasmic reticulum, but are in need of modification and sorting
6. Transport vesicles form and transport unfinished protein to Golgi apparatus
7. Transport vesicle fuse with golgi apparatus and modification and sorting begins.
8. Transfer vesicles transfer proteins to next cistern for further sorting and modification.
9. When proteins are sorted and in final form, vesicles with finished product pinch off.
10. Storage vesicles are called storage vesicles (lysosomes are storage vesicles containing digestive enzymes).
11. Secretory vesicles are called secretory vesicles
12. Secretory vesicles are ready to fuse with plasma membrane and release product by exocytosis.
13. Possible protein functions may be adhesion within matrix or function as a chemical messenger.

Collagen Synthesis by Fibroblasts

1. Transcription (DNA --> mRNA)

2. Translation
   (mRNA --> protein precursors)

3. Transport Vesicles form

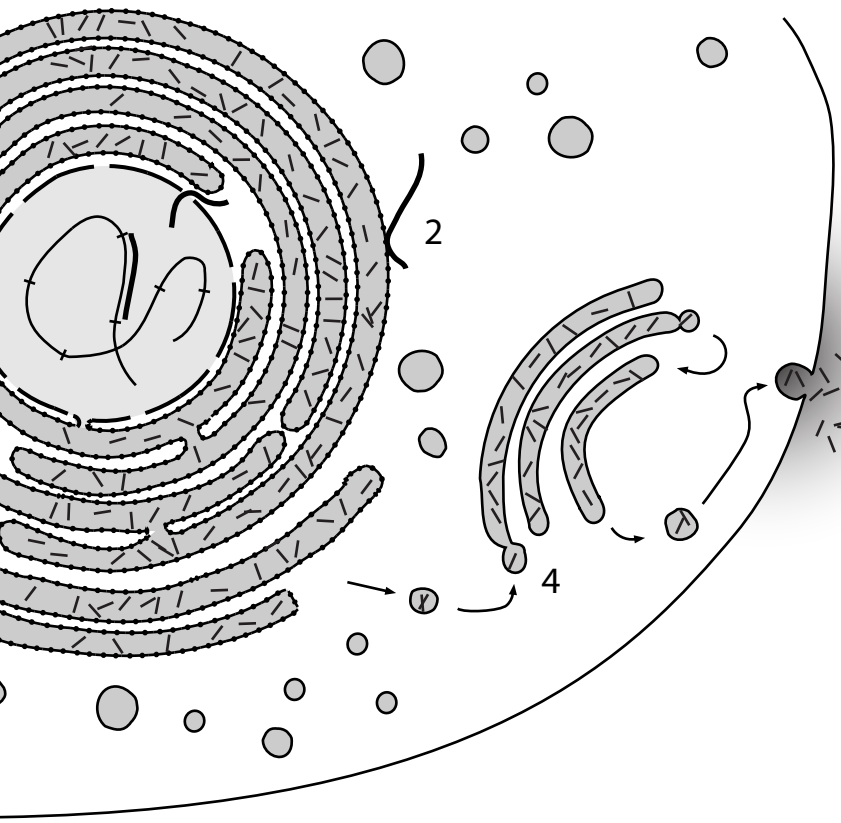
4. Fusion with Golgi Complex

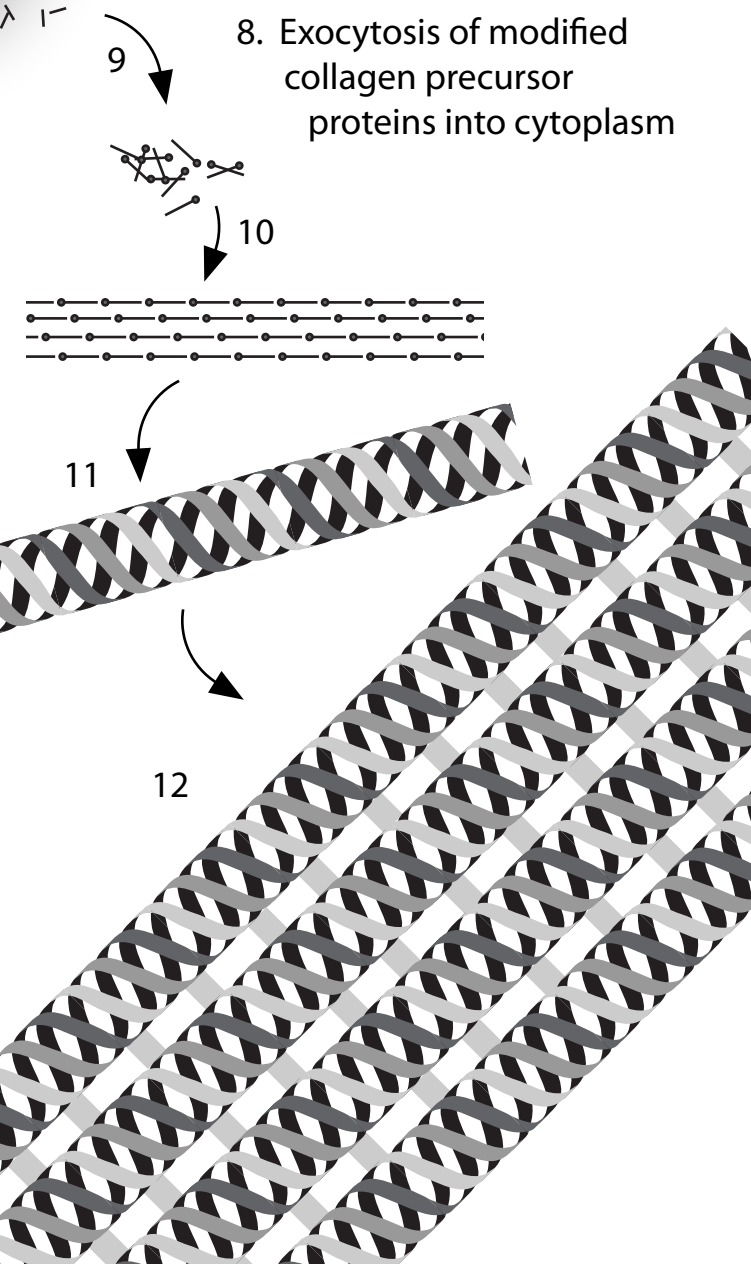
5. Sorting and Modification

6. Transfer Vesicles transfer partially modified proteins to next cistern

7. Secretory Vesicles form containing modified collagen proteins

8. Exocytosis of modified collagen precursor proteins into cytoplasm





9. Enzymatic modification

10. Precursor proteins spontaneously assemble in matix.
    A fibril (protein bundle) is formed.

11. Triple helix takes form

12. Many triple helices are cross- linked forming larger fibril structure in matrix.

Reference:
Concise Text of Histology
by William J. Krause, Ph.D.
J. Harry Cutts, Ph.D.
(c) 1981