Chapter 26: Magnetism and Review
Tuesday October 18th

- Cumulative mid-term exam on Thursday
  (In-class – 75 minute, written exam)
- Labs resume as normal next week
- LONCAPA tomorrow not graded
- LONCAPA resumes Monday
- Review of mid-term next Wed. recitations

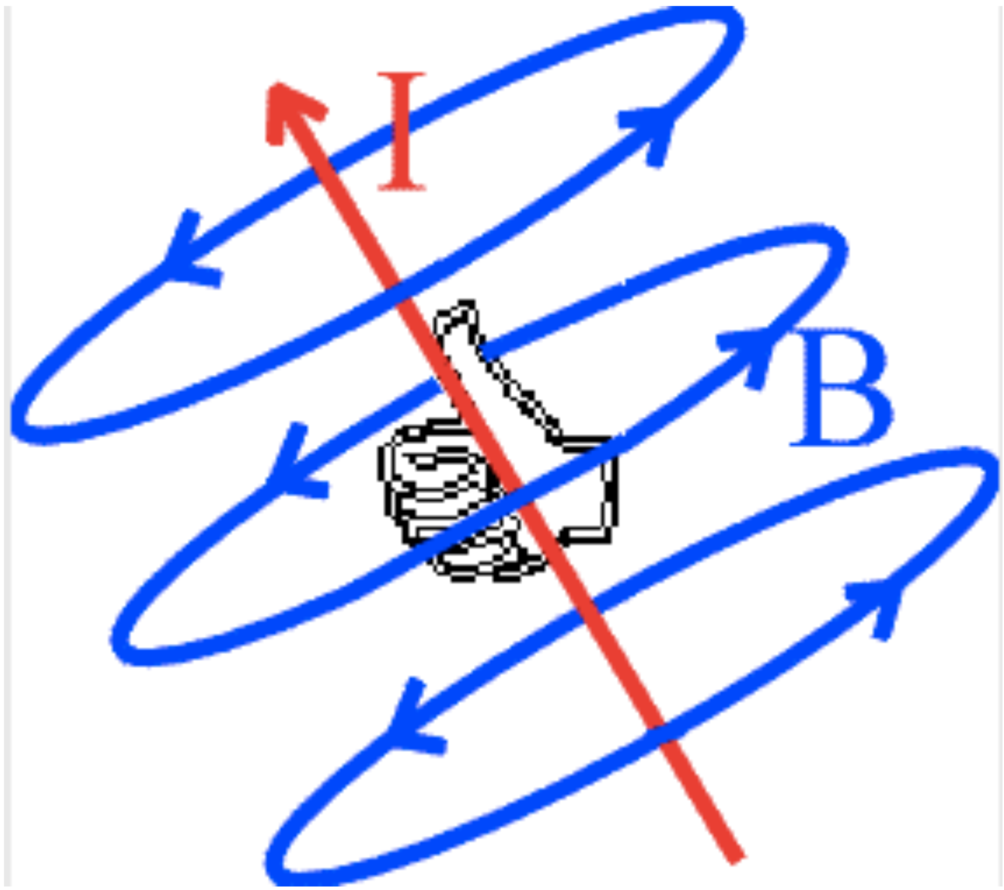
- Finish magnetostatics – Ampère's law
- Discuss mid-term exam
  - About the exam
  - Strategies for success
- Review

Reading: up to page 460 in the text book (Ch. 26)

Is there a Gauss' law for magnetic field?

$$\Phi_E = \oint \vec{\mathbf{E}} \cdot d\vec{\mathbf{A}} = \frac{q_{enc}}{\varepsilon_o}$$

- **It tells us that E-fields begin and end on electric charges.**
- **Provides a simple method for calculating E for certain symmetries.**



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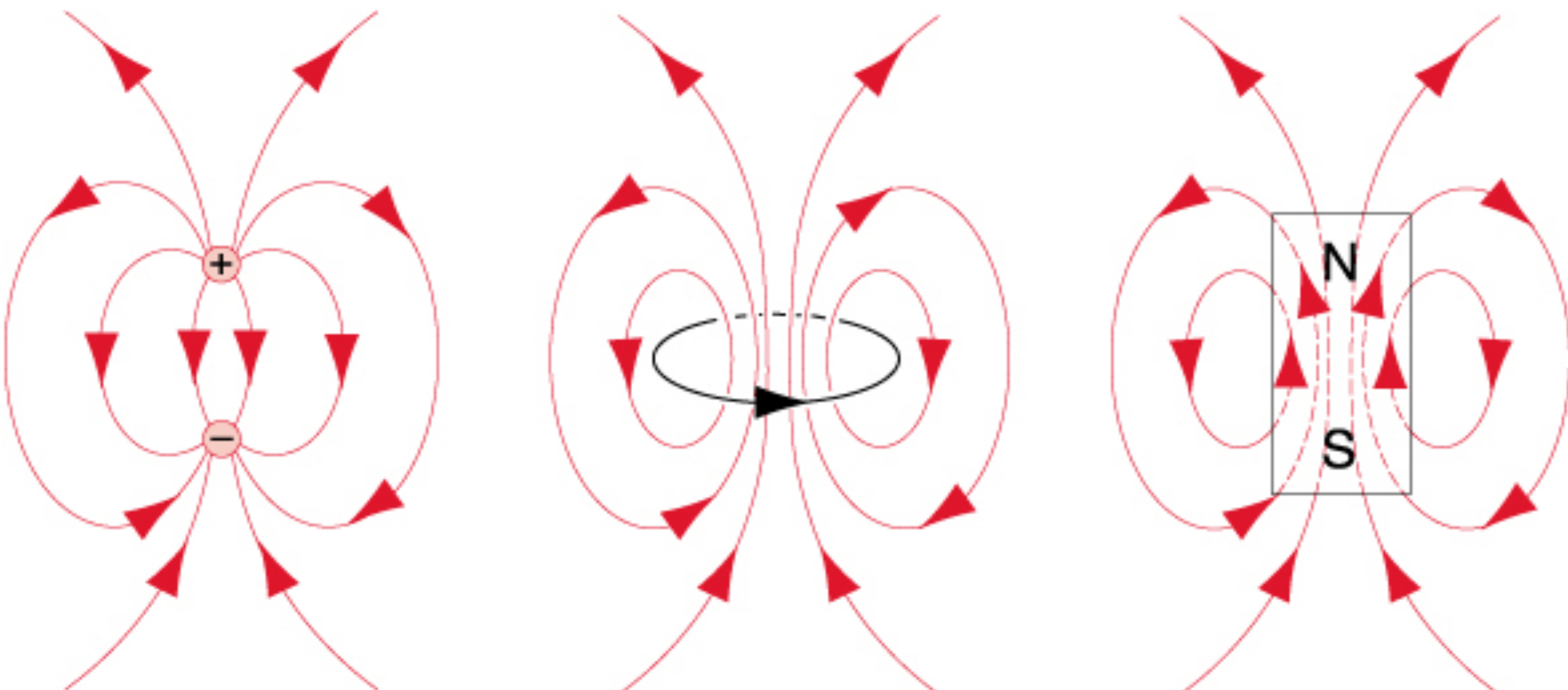

Electric dipole | Magnetic dipole | Bar magnet

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- **It tells us that E-fields begin and end on electric charges.**
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As far as we know, there is no magnetic equivalent of charge.
Therefore, magnetic field lines never begin or end.

$$\Rightarrow \Phi_B = \oint \vec{\mathbf{B}} \cdot d\vec{\mathbf{A}} = 0$$

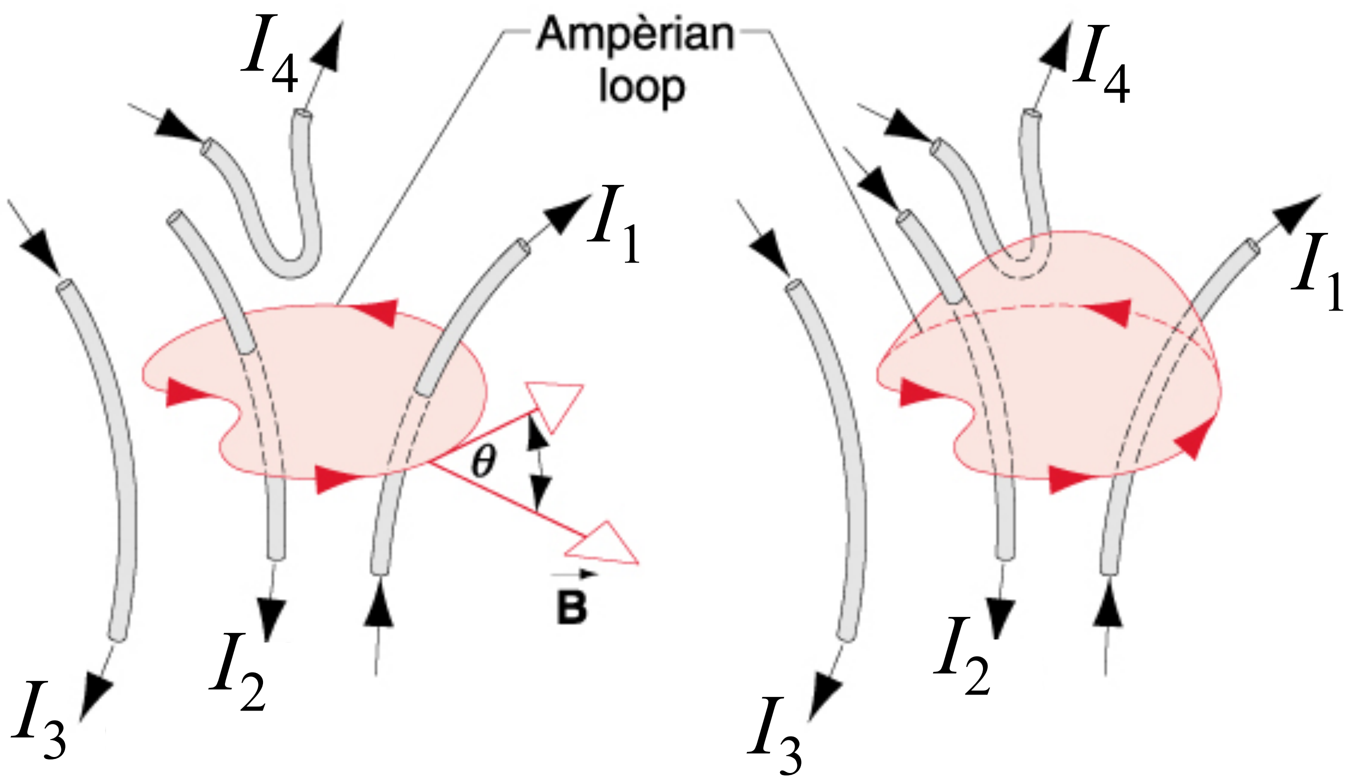
Consequently, Gauss' law of no use in magnetostatics,
since there is nothing with which to equate the flux of *B*.

By the way.....

.... we just derived (wrote down) the 2nd Maxwell equation!

Maxwell's 3rd equation (a.k.a. Ampère's Law)

$$\oint \vec{\mathbf{B}} \cdot d\vec{\boldsymbol{l}} = \mu_o I_{enc} = \mu_o \left(I_1 - I_2 \right)$$

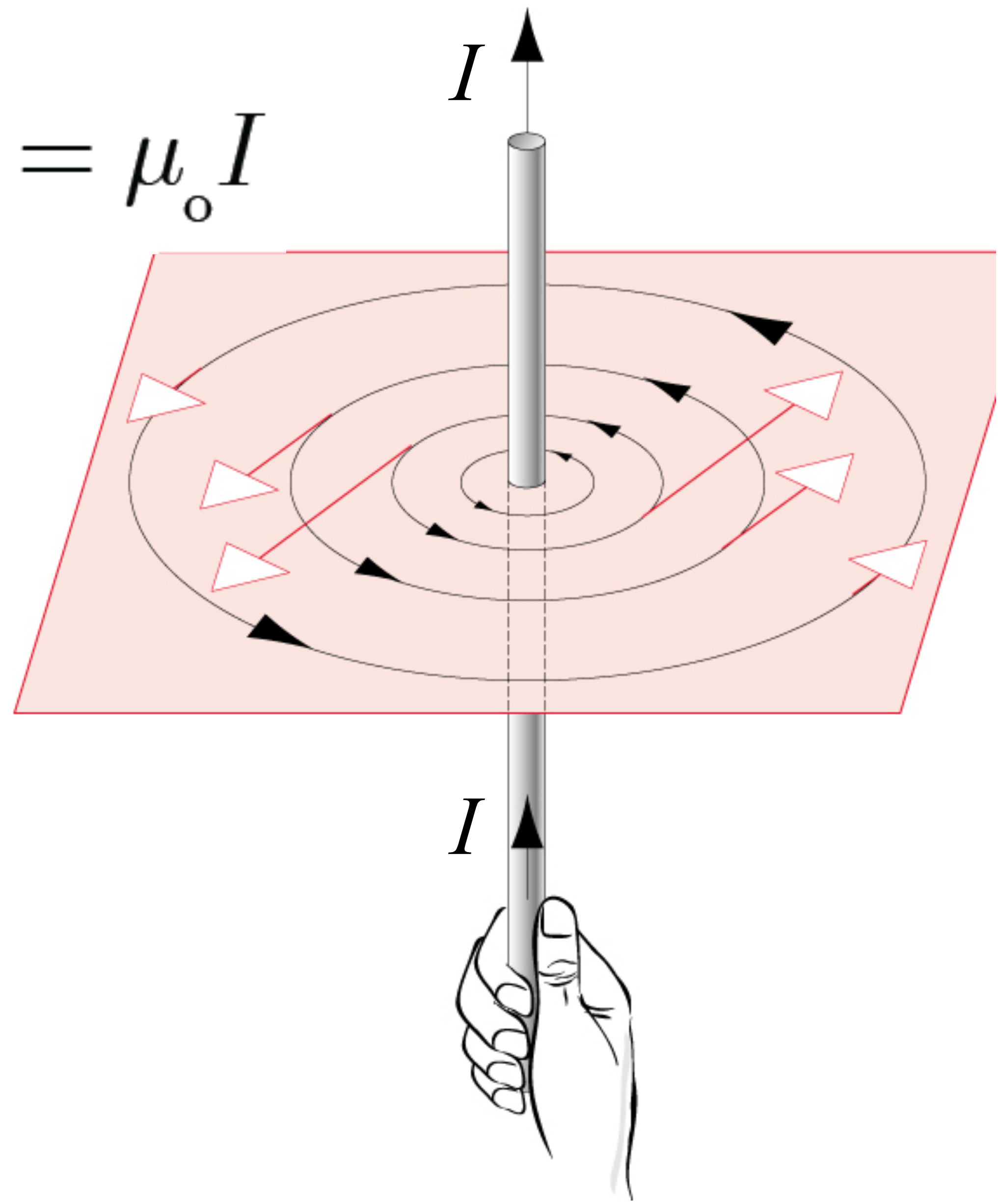


Right-hand-rule

The magnetic field due to a wire in 3D

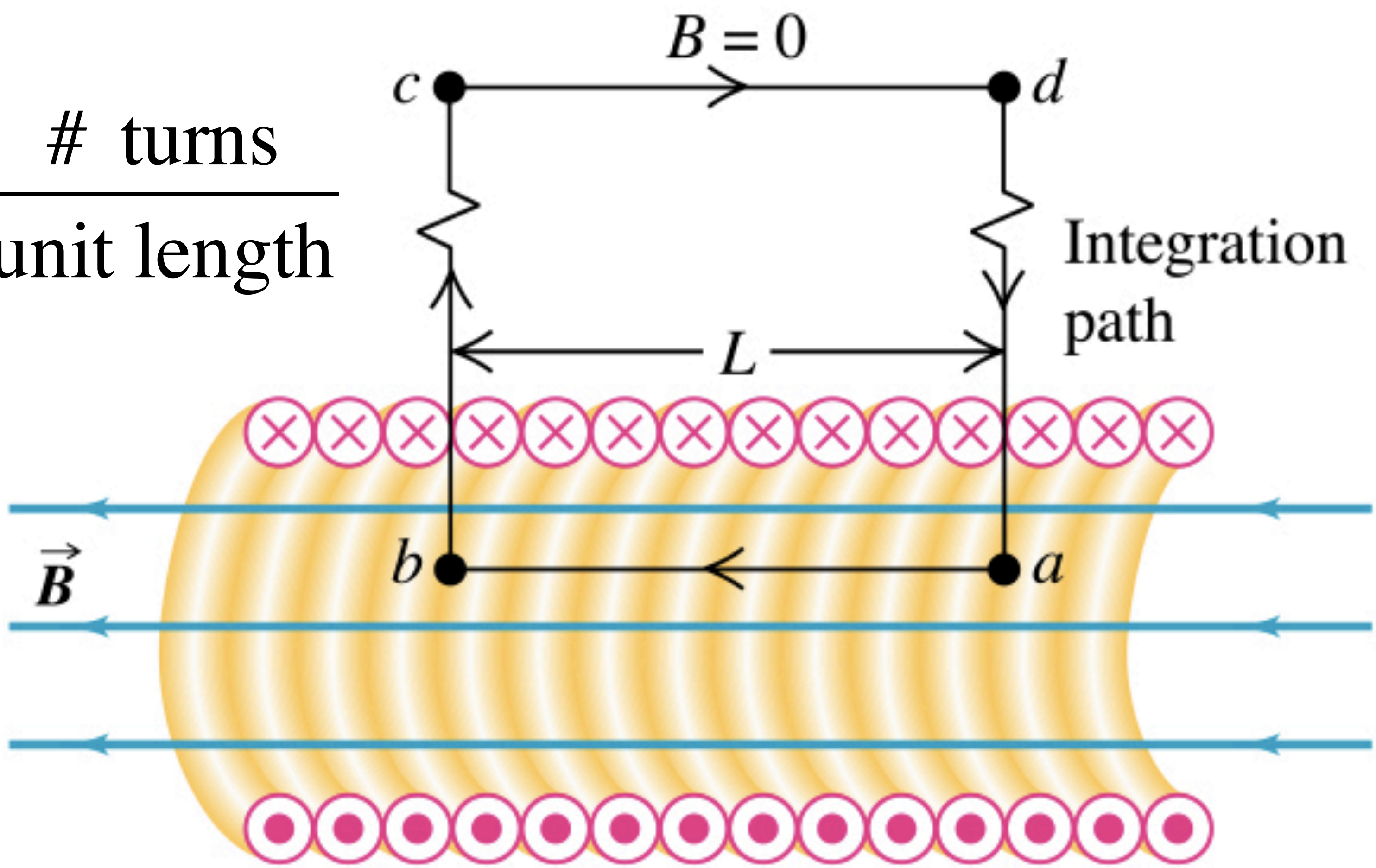
$$\oint_{circle} \vec{\mathbf{B}} \cdot d\vec{\boldsymbol{l}} = 2\pi r B = \mu_o I$$

$$\Rightarrow B = \frac{\mu_o I}{2\pi r}$$



The magnetic field due to a solenoid

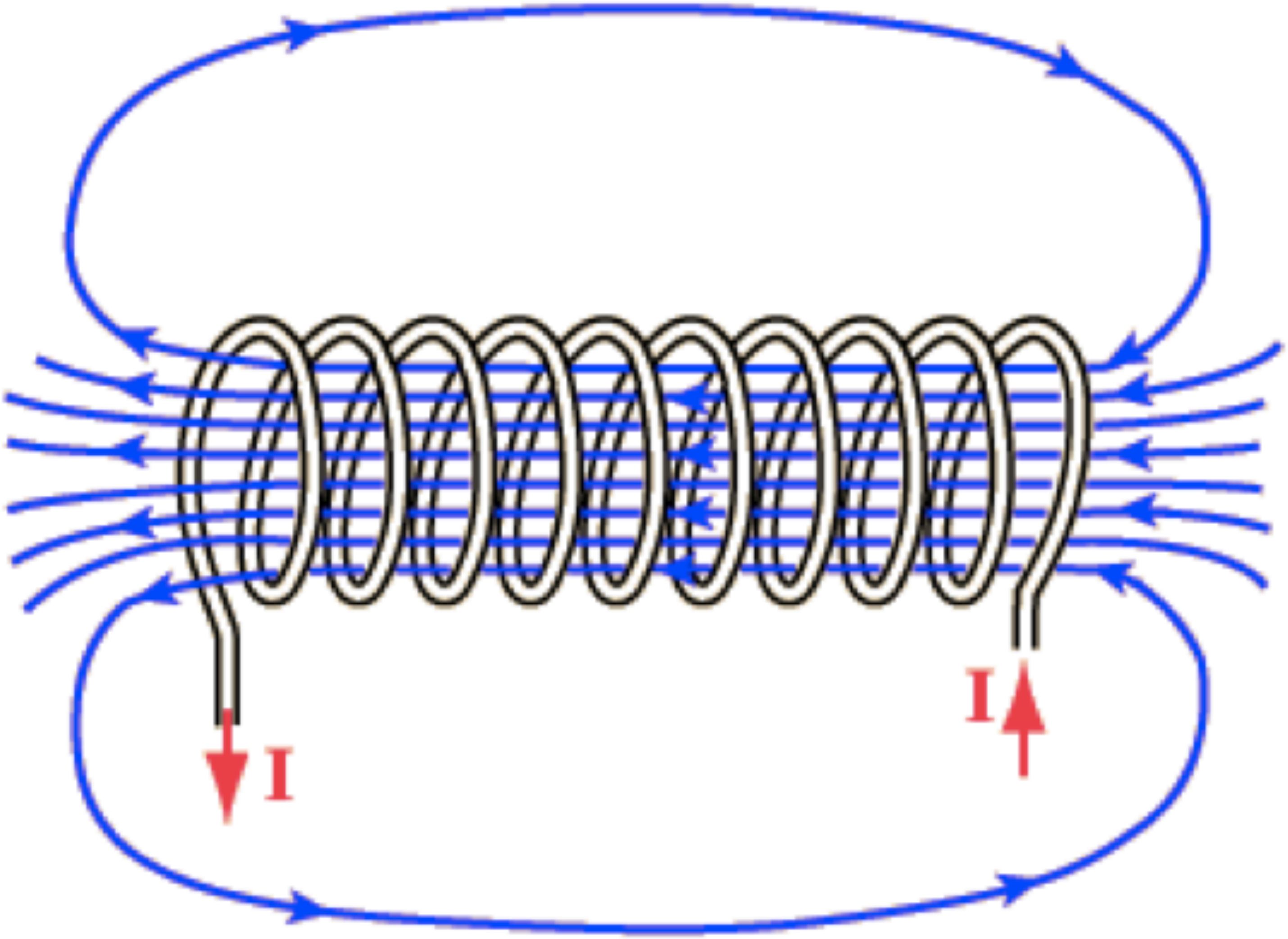
$$n = \frac{\#\ \text{turns}}{\text{unit length}}$$



Central part of solenoid

$$\oint \vec{B} \cdot d\vec{r} = BL = \mu_o I_{enc} = \mu_o n I L, \quad \Rightarrow \quad B = \mu_o n I$$

The magnetic field due to a solenoid



$$B = \mu_o n I$$