



文献综述与科技写作

——讨论与结论

斯 科

浙江大学光电科学与工程学院

地址：玉泉教三409，医学院科研楼B111

Email: kesi@zju.edu.cn





回顾上堂课的内容

(一)、科技论文正文的标准结构（IMRAD）

- **I**ntroduction（导言）：
研究的是什么问题
- **M**aterials and Methods（材料与方法）：
如何研究这个问题的
- **R**esults（结果）：
研究的结果如何
- **D**iscussion and **C**onclusions（讨论和结论）：
这些研究结果有什么意义



回顾上堂课的内容



(二)、Result的写法

1. **Location** of results
2. Highlighting the **key data**
3. **Commenting** on key data

(三)、Key Data

1. Highest or lowest values
2. Overall trend or pattern
3. **Points that do not seem to fit the trend of pattern**



讨论和结论：Discussion & Conclusion



原则：

- 撰写讨论时要避免含蓄，尽量做到直接、明确，以便审稿人和读者了解论文为什么值得引起重视。

Place your results in a wider context

- 是论文中最有创造性见解，take home message
- 回答：

为什么出现这样的结果？

出现这样的结果意味着什么？





讨论和结论：Discussion & Conclusion

讨论什么？

- 对结果提出说明、解释或猜测；
- 根据这些结果，能得出何种结论或推论？
- 指出研究的局限性以及这些局限对研究结果的影响；并建议进一步的研究题目或方向；
- 指出结果的理论意义（支持或反驳相关领域中现有的理论、对现有理论的修正）和实际应用。





时态和语态

- 由于研究的实验工作是在论文写作或发表前进行的，所以应该用过去时；
- 而对结果，特别是陈（描）述性的，指出事实的结果，可以用现在时；
- 当介绍和引述别人的工作时，用现在时或现在完成时；
- 尽量用被动语态；少用第一人称

例子：

To confirm that the specific binding in the membrane fraction was not brought about by contamination of conventional nuclear EcR, membrane fractions that showed specific binding activity to [3H]PonA were subjected to Western blot analysis using an antibody raised against EcR-A (Fig. 2).



时态和语态



例子:

The binding affinities of those steroid membrane receptors are orders of magnitude lower than those of nuclear receptors [31].

Abd-A is also involved in the differentiation of the anterior and the rear somite axis (21), cardiac tube organogenesis (22), heart cell fate in the dorsal vessel (23), genesis of the nervous system and fat body (24), gonad formation and development (25, 26), midgut formation (27), and muscle patterning (28) during early embryogenesis of *Drosophila* and other insects.





用被动语态；少用第一人称

We examined whether the PonA binding sites are located in integral integral membrane proteins or peripheral proteins that are not integrated to the lipid bilayers.



Whether the PonA binding sites are located in integral membrane proteins or peripheral proteins that are not integrated to the lipid bilayers **was examined**.



We examined the morphology of the larval midgut and salivary glands during the onset of metamorphosis in order to provide a foundation for our studies of larval tissue histolysis (Fig. 1).



The morphology of the larval midgut and salivary glands during the onset of metamorphosis **was examined** in order to provide a foundation for our studies of larval tissue histolysis (Fig. 1).



讨论 Discussion



基本内容

主要的发现

结果的解释或论述（逻辑关系）

与前人结果的比较（文献引述）

结果的意义和重要性

不足之处，或尚未回答的问题，或进一步的工作



讨论 Discussion



- 所用时态

- 现在时：具有普遍的意义推论或结论：

——The experimental and theoretical values for the yields **agree** well.

——Our data **suggest** that the reaction rate may be determined by the amount of oxygen available.

- 过去时：所概述推论的有效性只是针对本次特定的研究：

——In the first series of trials, the experimental values **were** all lower than the theoretical predictions.



讨论 Discussion



最大的、最常见的问题是没有分清楚“结果”和“讨论”，把这两部分混起来写：

1. 把“结果”当做“讨论”来写；
2. 把“讨论”当做“结果”来写

结果：是对实验结果数据的陈述，客观描述

讨论：是对结果数据的逻辑关系分析，论证，并得出结论及其意。

除非把“结果和讨论（分析）”合起来写。



讨论 Discussion



主要发现 Major discoveries, major findings, major points (亮点)

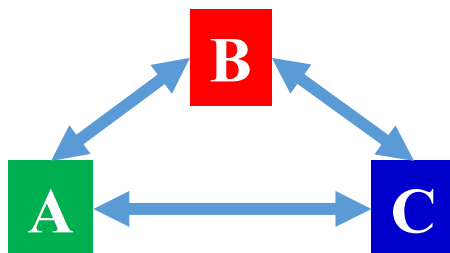
- 1, ...
- 2, ...
- 3, ...

主要发现的支持证据 (实验结果)

要避免简单罗列和重新复述实验结果

对结果的解释要客观、合理

要注意实验结果的因果关系、逻辑关系、推理关系



讨论 Discussion



Discussion

例子

The major contribution of this study is the finding that the expression of the *B. mori* adult wing cuticle protein *BmWCP4* (Takeda *et al.*, 2001) was up-regulated by the transcription factors β FTZ-F1 and POUM2, which bound

4. Discussion

In this study, two epsilon class GST cDNAs, *Slgste2* and *Slgste3* were cloned from *S. litura* and characterized in terms of structure, developmental and induced expression and localization. Several novel findings are reported First, the SIGSTE2 and SIGSTE3 proteins are identified as members of the typical epsilon class of GSTs based on their structure features and relationship with other epsilon insect GSTs. A serine residue which is catalytically essential for the activity of GSTs as reported by Sheehan *et al.* (2001), was found in the N-terminus regions of SIGSTE2 (Ser11) and SIGSTE3 (Ser5). This result indicates that there is more than one epsilon GSTs in *S. litura*.

Secondly, both the SIGSTE2 and SIGSTE3 recombinant proteins processed enzymatic activity against the standard substrate CDNB. DDT and deltamethrin competitively inhibited the enzymatic activity of SIGSTE2 toward CDNB by 65% and 34%, respectively. There was a slight effect of DDT and no effect of deltamethrin on



讨论 Discussion



主要发现的支持证据（实验结果）

1. 一篇文章一个主要结论，多个实验支持这个结果（结论）
2. 一篇文章有多个主要结论，要多个实验支持

1. 一个实验证据支持一个结果（结论）
2. 多个实验证据支持一个结果（结论）
3. 一个实验证据反映或说明多个结果（结论）



例子



to the corresponding CREs of the gene, and that 20E induced the expression of *BmPOUM2* and *Bm β FTZ-F1*, whose products then enhanced the expression of *BmWCP4*, whereas JH III suppressed the action of 20E. A schematic regulatory model is shown in Fig. 9. Several lines of experimental evidence support this model. First, northern blot and RT-PCR analyses indicated that the *BmWCP4* gene is specifically expressed in the epidermis around pupation and the midpupal stage (Fig. 1). This result of the tissue- and stage-specific expression of *BmWCP4* is consistent with the findings of Takeda *et al.* (2001) and suggests that this gene is involved in pupal cuticle formation.

Secondly, the expression of the *BmWCP4* gene is up-regulated by 20E, but the enhancing effect of 20E was suppressed by JH III in both *in vivo* and *in vitro* studies (Fig. 3). This result is similar to that found for its homologues, *BmWCP2* and *BmWCP5* (Zhong *et al.*, 2006; Wang *et al.*, 2009b). It is not surprising that the *wcp* genes, as well as the pupal cuticle formation in pupation, are regulated by 20E and modulated by JH.

Thirdly, we have shown that there are POU and β FTZ-F1 CREs present in the putative regulatory region

of 20E and JH (Figs 4, 5). Two nuclear proteins in the epidermis cells and BmN cells bound to these two CREs, respectively (Figs 5, 6). The binding of the nuclear protein to the POU CRE corresponds with *BmWCP4* expression during pupation (Fig. 6C). The recombinant transcription factor *BmPOUM2* was shown to directly bind to the POU CRE and enhanced the transcriptional activity of the regulatory region of the *BmWCP4* gene (Fig. 7). These results suggest that the transcription factor POUM2, as well as β FTZ-F1 as shown for *BmWCP2* (Nita *et al.*, 2009), *BmWCP5* (Wang *et al.*, 2009b) and *BmWCP10* (Wang *et al.*, 2009a), can activate the expression of the *BmWCP4* gene by binding to its CREs.

Fourthly, 20E induced the sequential expression of *Bm β FTZ-F1*, *BmPOUM2* and *BmWCP4* (almost 24 h after the expression of the transcription factors) in the epidermis both *in vitro* and *in vivo* (Fig. 8), suggesting that these two transcription factors act at the upstream of the regulatory pathway of the *BmWCP4* gene.

All of the results taken together demonstrate that the 20E-induced and JH-suppressed expression of the *BmWCP4* gene is under the regulation of the β FTZ-F1 and



讨论 Discussion



与前人结果或结论的比较（文献引述）

在讨论中，每句话都应该有出处，有明确的文献引述，特别是引用别人的实验结果和证据支持自己结论或观点时，一定要注明引用的文献。

有什么相同的？有什么不相同的？为什么？哪个更合理？主要的证据是什么？论述

注意要引述正反两方面的结果

哪些是支持自己的实验结果？

哪些是与自己结果有冲突的结果？

文献引述非常重要：发表在什么杂志上？哪个实验室完成的工作？实验过程有什么主要的漏洞？不合理的地方（对照？材料？处理或研究方法？解释？。。。）



例子：



SIGSTE3 activity toward CDNB. It was reported that most of the characterized epsilon GSTs have low levels of activity towards the model substrate, CDNB (Ranson and Hemingway, 2005). Five out of the eight epsilon classes of GSTs in a DDT resistant strain of *A. gambiae* have elevated expression levels of the GSTs. AgGSTe2 is the only member of the epsilon class with confirmed DDT-metabolizing activity and it is considered the most important GST in conferring DDT resistance in *A. gambiae* (Ding et al., 2003; Ortelli et al., 2003). DDT-dehydrochlorinase activity catalyzed by GST is the major mechanism responsible for DDT resistance in insects (Brown, 1986). The contributing residues for putative DDT-binding includes Leu9, Leu11, Ser12, Pro13, Pro14, Leu36, Leu37, His41, Ile55, Phe108, Met111, Phe115, Leu119, Phe120, Leu207 and Phe210, most of which are hydrophobic in nature. Three residues, Glu116, Phe120, and Arg112 are proposed as the key players of creating a DDT-binding pocket with high affinity for DDT (Wang et al., 2008). Compared with AgGSTe2, both SIGSTE2 and SIGSTE3 had seven amino acid residues in the putative DDT-binding. SIGSTE2 shared one key residue, Phe120, at the corresponding position in the DDT-binding pocket (Wang et al., 2008), whereas SIGSTE3 did not contain any of these key residues. These data suggest that SIGSTE2 has higher DDT-metabolizing activity than SIGSTE3 and more likely plays a role in conferring insecticide detoxification.



讨论 Discussion



在讨论中，每句话都应该有出处，有明确的文献引述

例子：

3 讨论

本文研究了印楝素A对Hi-5细胞抑制作用，并探索研究了其抑制作用机理。

在较低剂量下，印楝素A对Hi-5细胞的毒杀作用不佳，随着时间的延长，却可以非常显著地抑制细胞的增殖。虽然Hi-5细胞没有死亡，但是大部分细胞的形态发生了明显的变化，从多角形或梭形变成圆形，并且贴壁能力显著下降，这表明支撑昆虫细胞成形的微管和微丝系统受到了影响。微管和微丝等细胞骨架的网状结构使细胞保持某一固定形态，同时也为细胞的生理活动提供相对稳定的空间结构。微管蛋白也是构成纺锤丝的主要成分，影响纺锤丝将直接影响细胞的有丝分裂过程，从而抑制细胞的增殖。因此，从印楝素A对Hi-5细胞的增殖抑制作用和形态的影响来看，微管蛋白可能是印楝素A的作用靶标之一。



讨论 Discussion



要注意语气，有所保留，特别是要否定别人的工作，
只谈客观的结果和分析，不很快下结论

We suggest that ...

We hypothesize that...

We propose that ...

We consider that ...

We suspect that ...

We believe that ...

We conclude that ...

It may be possible that ...

It is probably true that ...

It is possible that ...

There is another possibility that ...

例子：

Combining the putative function of GGY-repeats with the acute peak of *BMCPG1* expression during molt, we propose that *BMCPG1* and *EDG91* compose the epicuticle region, although further studies on their function and localization are required.





讨论 Discussion

In holometabolous insects, most larval organs differentiate during embryonic development, but many adult organs, including wings, genitalia, and adult legs, are present in an undifferentiated state as imaginal discs. These organs develop and differentiate beginning at the pupal stage and become fully functional in the adult stage. The homeodomain transcription factor gene *Abd-A* has long been known to be involved in differentiation of larval organs during embryogenesis (20). In this study, we show that this gene is also involved in the regulation of the cuticle protein synthesis in the pupal wing disc by interacting with the homeodomain transcription factor POU. Among other things, ~~this result suggests~~ that the differentiation of the wing imaginal discs during metamorphosis requires the involvement of *Abd-A*. It also ~~suggests that~~ organogenesis during embryogenesis and metamorphosis may share, at least in part, similar mechanisms of gene regulation. ~~This work demonstrates~~ *Abd-A* homeodomain transcription factor involvement in gene regulation during insect metamorphosis.

Model for Regulation of the Pupal-Specific Expression of BmWCP Genes and Metamorphosis in *B. mori*. ~~Based on the data presented in this work and in our previous studies (1), we propose an~~



讨论 Discussion



研究结果的意义和重要性

本研究的主要结果或结论的科学意义或重要性

对专业领域或特别问题的意义 （比较专业的杂志）

在更广泛领域或科学问题的意义 （更高水平的综合杂志）

在应用上的意义和重要性

- 要有根据，客观陈述 For the first time
- 合理延伸，但不能无限延伸 It is the first time that ...
- 要有所保留，不要把话说满 It is the first discovery that ...





updated model for the regulation of genes coding for wing disc cuticle proteins during metamorphosis in *B. mori* (Fig. 5). The molting hormone, 20E, binds to the heterodimer of EcR-USP, which in turn directly or indirectly activates the expression of the transcription factors POUM2 and β FTZ-F1. The transcription factor β FTZ-F1 binds to the β FTZ-F1 CRE of *BmWCP4* (1), *BmWCP2* (31), *BmWCP5* (32), and *BmWCP10* (33). The nuclear homeodomain transcription factor BmPOUM2 interacts with another homeodomain transcription factor, BmAbd-A, and this heterodimer binds to the POU CRE in the promoter of *BmWCP4* and some of the other BmWCP genes coding for pupal wing disc cuticle proteins (Pathway 1). Alternatively, BmPOUM2 may activate other unidentified transcription factor(s) that interact with CREs in the promoter of the genes coding for other BmWCP proteins (Pathway 2). It is also possible that activation of some other BmWCP genes is not through the direct (Pathway 1) or indirect (Pathway 2) action of BmPOUM2 but through other unknown transcription factor(s) (Pathway 3). All these pathways would work together, leading to the postembryonic development and differentiation of the wing discs during metamorphosis.



讨论 Discussion



不足之处，或尚未回答的问题，或进一步的工作

实验条件的问题

It remains to be clarified (demonstrated, proved) that ...

实验技术到问题

It is worth to be further studied (investigated) that ...

尚不能解释的结果

It would be interested to study (investigate) this issue...

例子：

We will study this issue (problem) in the future study (investigation)

Although BmWCP4 has been shown to be regulated by BmPOUM2 in this study, several issues remain to be clarified. First, BmWCP4 is expressed specifically in the epidermis during the pupation and mid-pupal stages. The mechanism by which BmPOUM2 regulates the tissue- and stage-specific expression of the BmWCP4 gene is not clear. Secondly, the upstream factor(s) that regulate the expression of BmPOUM2 is not known.





transcription factors are known to play key roles in embryo patterning during embryonic development (20). Abd-A is a member of the *Drosophila* bithorax complex, which belongs to the homeobox gene superfamily (19) and is required for early embryonic development and differentiation in *Drosophila*. Here we showed that BmAbd-A interacts with BmPOUM2 (Figs. 3 and 4 and Figs. S4 and S5) to regulate pupal-stage-specific expression of the metamorphosis-associated *BmWCP4* and probably other BmWCP genes in response to 20E increase. However, attempts to knock down the expression of the gene coding for BmAbd-A by RNAi were not successful, and therefore detailed functional analysis of BmAbd-A is not possible at this time.

In holometabolous insects, most larval organs differentiate during embryonic development, but many adult organs, including wings, genitalia, and adult legs, are present in an undifferentiated state as imaginal discs. These organs develop and differentiate beginning at the pupal stage and become fully functional in the adult stage. The homeodomain transcription factor gene *Abd-A* has long been known to be involved in differentiation of larval organs during embryogenesis (20). In this study, we show that this gene is also involved in the regulation of the cuticle protein synthesis in the pupal wing disc by interacting with the homeodomain transcription factor POU. Among other things, this result suggests that the differentiation of the wing imaginal discs during metamorphosis requires the involvement of *Abd-A*. It also suggests that organogenesis during embryogenesis and metamorphosis may share, at least in part, similar mechanisms of gene regulation. This work demonstrates *Abd-A* homeodomain transcription factor involvement in gene regulation during insect metamorphosis.

Model for Regulation of the Pupal-Specific Expression of BmWCP Genes and Metamorphosis in *B. mori*. Based on the data presented in this work and in our previous studies (1), we propose an



讨论 Discussion



结论

- 有时也可将“结论”单独列为一节 (通常可包括在“讨论”或“结果与讨论”中);
- “结论”中的基本内容:
 - 作者本人研究的主要认识或论点;
 - 总结性地阐述本研究结果可能的应用前景、研究的局限性及需要进一步深入的研究方向;
 - 结论中不应涉及新的事实,也不能简单地重复摘要、引言、结果或讨论等章节中的句子





ing *Pit*, *Ocr* and *Onc* (POU), which have a conserved DNA binding region (POU domain) of approximately 160 amino acids (Herr *et al.*, 1988). The POU family genes have been found in vertebrates and invertebrates and play important roles in cell type-specific gene expression and cell fate determination (Ryan & Rosenfeld, 1997). POU members have been found in insects, such as *Drifter* in *D. melanogaster* (Anderson *et al.*, 1995; 1996), POU in *Helicoverpa armigera* (Zhang & Xu, 2009) and POUM1/M2 in *B. mori* (Fukuta *et al.*, 1993; Zhang *et al.*, 2004). In this study, *BmPOUM2* was demonstrated to be involved in the transcriptional regulation of *BmWCP4* by binding to its CRE of the putative regulatory region. The expression of *BmPOUM2* was 24 h earlier than *BmWCP4* and induced by 20E. *BmPOUM1* was cloned from the silk gland of *B. mori* and was found to bind to the SC element in the regulatory region of the *sericin-1* gene and regulate *sericin-1* gene transcription (Fukuta *et al.*, 1993). POUM2 is suggested to be an isoform of POUM1. In *H. armigera* the expression of the *HarPOUM2* gene is induced by ecdysone as early as 6 h post treatment and its product binds to the regulatory sequence of the *DH-PBAN* gene that encodes a neuropeptide and regulates pupal development (Zhang *et al.*, 2004; Zhang & Xu, 2009). In

of *BmWCP4* (Fig. 3). It remains to be clarified whether *βFTZ-F1* affects the transcription or synthesis of the POU protein or affects the POU protein binding affinity to the POU CRE, or influences the induction action of 20E on *BmWCP4* expression at even earlier steps prior to the POU transcription factor.

In conclusion, this study identified and characterized the *βFTZ-F1* and particularly POU CREs in the *BmWCP4* gene and demonstrated that the POU transcription factor, as well as the *βFTZ-F1* transcription factor, may be involved in the regulation of *BmWCP4* expression in *B. mori*. Based on our results we suggest that 20E induces the expression of the transcription factors *βFTZ-F1* and POUM2, which bind to their corresponding CREs in the *BmWCP4* regulatory sequence to activate its expression, resulting in the synthesis of the pupal wing discs cuticle protein during the larval to pupal metamorphosis (Fig. 9).

Experimental procedures

Insects and treatments

The silkworm *B. mori* strain Dazao was obtained from The R & D Center of the Sericultural Research Institute of the Academy of

例子:

the prepupal (wandering) stage. As shown in Fig. S5, when expression of the three genes was high, the three proteins were simultaneously expressed in the wing discs (Fig. S5 A–C), and their intracellular distribution was similar, but not identical. The BmAbd-A and BmPOUM2 proteins were localized evenly in the nuclei, especially near the nuclear membrane (Fig. S5 E, F, and I), whereas the BmWCP4 protein was mainly localized in the cytoplasm (Fig. S5 G and I).

Discussion

BmPOUM2 Is a Vital Transcription Factor for Regulation of Metamorphosis. In a previous study, we found that during metamorphosis the expression of *BmWCP4* was up-regulated by BmPOUM2 binding to the POU CRE of the gene (1). In this study, down-regulation of *BmPOUM2* reduced the expression of *BmWCP4* both at the mRNA and protein levels (Figs. 2D and 1B) and disrupted larva-to-pupa transformation and wing disc development (Fig. 1 C and D). *BmPOUM2* not only regulates the expression of the *BmWCP4* gene, but also regulates several other genes involved in the larva-to-pupa transformation. A large number of POU CREs was found in the regulatory regions of *BmWCP* genes (Table S1). Overexpression of BmPOUM2 activated transcription of some of the genes coding for wing disc cuticle proteins, including *BmWCP4*, 5, 6, 7, and 8 (Fig. S3). RNAi of *BmPOUM2* reduced the expression of *BmWCP1–9* (except 7, which was not tested).

Model for Regulation of the Pupal-Specific Expression of BmWCP Genes and Metamorphosis in *B. mori*. Based on the data presented in this work and in our previous studies (1), we propose an

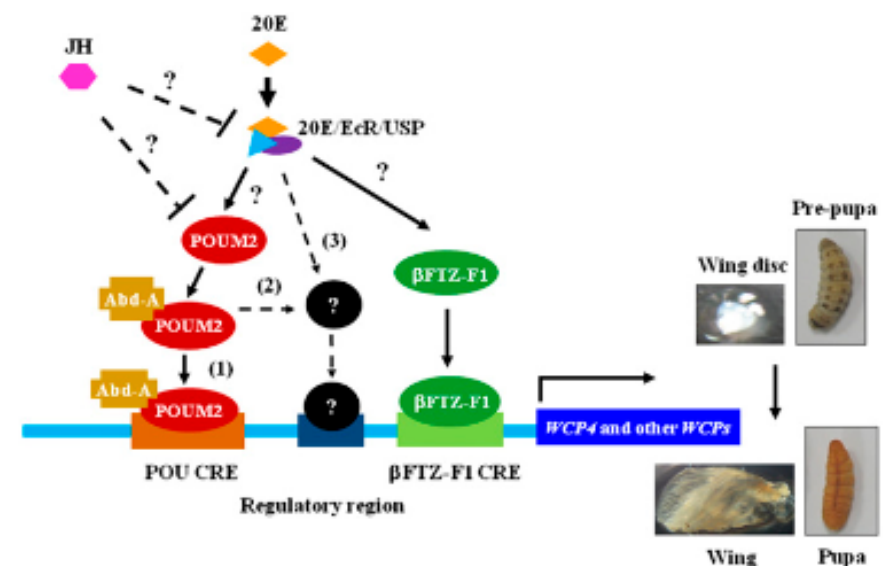


Fig. 5. Schematic representation of the model of molecular regulation of

讨论和结论：Discussion & Conclusion



注意事项

- 对结果的解释要重点突出，简洁、清楚：着重讨论本研究的重要发现，以及由此得出的结论，不要过细地重复引言或结果中的数据或资料；
- 推论要符合逻辑，避免实验数据不足以支持的观点和结论；
- 对结果的科学意义和实际应用的表达要实事求是，适当留有余地；
- 讨论的最后最好是论文的最重要的结论 (take-home-message)



讨论和结论： Discussion & Conclusion



常用句式

Common used sentences in conclusion writing:

- It is clear from the above discussion that...
- In conclusion(summary)...
- The above results(data、 findings)leads us a conclusion that...
- From..., the following conclusion can be made(drawn)...
- On the basis of ..., we now conclude...
- We now sum up...
- We have demonstrated in this paper...





见：补充材料





几种分析方法： 归纳法

- 归纳法是从个别或特殊的事物中概括出一类事物的共同本质或普遍规律的方法。

- 归纳法的客观基础是一般存在于个别之中。

由于个性之中有共性，这就使归纳的结果有一定的可靠性，但又因为个性比共性更丰富，因而归纳的结论带有较大的或然性。

- 归纳具有各种不同的类型。根据归纳的前提是否完全，可以分为完全归纳法和不完全归纳法。在不完全归纳法中，根据其是否运用了因果规律，又区分为简单枚举归纳法和科学归纳法，科学归纳法也叫判明因果联系的归纳法。





求同归纳法

例如，焦耳在1840~1848年间所作的四类实验，就是以**求同归纳法**来研究热功当量的。

- 1) 将水放在与外界绝热的容器中，通过重物下落带动铜制桨状叶轮搅动水，水温升高；
- 2) 以机械功压缩汽缸中的气体，汽缸浸在水中，水温升高；
- 3) 以机械功转动电机，电机产生的电流通过水中的线圈，水温升高；
- 4) 以机械功使两块在水面下的铁片相互摩擦，水温升高。

因此，机械功是产生水温上升的原因，机械能可以转化为热能。

如果在ABC出现时，a出现
在ACD出现时，a出现
在ABD出现时，a出现
因此A与a之间有因果关系。





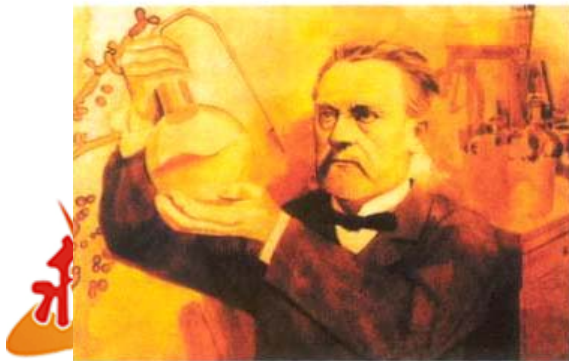
差异归纳法

例如，法国微生物学家巴斯德在1860~1864年间所作的曲颈瓶实验，就是用**差异归纳法**来研究空气尘埃中含有能使有机物腐败的微生物。

第一次，他把有机物浸液装在长颈瓶内煮至沸腾（杀死液体内和瓶壁上的细菌），置冷，但空气中的尘埃、臭氧、电磁及其它未知物质均能窜入瓶内，两三天后该有机浸液内就出现了微生物并使浸液腐败。

第二次，在一般处置方式相同的情况，只把瓶颈抽成弯曲的尖头，空气、臭氧、电磁及其它未知物质仍能窜入瓶内，只是尘埃不易进去与浸液接触，只能附在瓶壁上，有机物浸液仍保持洁净，未出现微生物。

可见，使有机浸液腐败的原因是空气中浮荡的尘埃上有生命的原种所致。



如果 在ABCD出现时 abcd出现
 在BCD出现时 只有bcd出现
那么A与a之间有因果关系



共变归纳法

如前所述，巴斯德认为空气尘埃中的微生物是有机物腐败的原因。于是他运用**共变归纳法**，再次进行他的实验：

第一次：他和他的学生带着事先灭了菌的有机物浸液，旅行到农村小道时打开二十个盛有有机物浸液的玻璃瓶，立即封闭，之后发现其中的八瓶被微生物腐败；

第二次：登上高八百多米的山上打开二十瓶，立即封闭，之后产生变化的只有五瓶；

第三次：再继续登高到山上的冰河处打开二十瓶，立即封闭，之后只有一瓶产生变化。

这就证明了尘埃越少有机物越不易腐败，这就表明尘埃中的微生物和细菌是有机物腐败的原因。

如果在A1BC出现时a1出现
当A1变为A2，即A2BC出现时，a1相应变为a2；
在情况变为A3BC时，又相应地有a3……；
因此，A与a有因果关系





归纳法本质

首先：归纳法的结论具有**或然性**（完全归纳法和科学归纳法）。
其次：归纳法在推理过程中**缺乏辩证性**。由已经经验到的东西不可能完全、确切证明未经经验到的东西。
归纳本质是不保真的、扩充了的证明。

Some → All

Now → Future

● **黑天鹅事件** 直到1697年一位探险家在澳大利亚发现了黑天鹅之前，欧洲人一直认为天鹅都是白色的。因此，“黑天鹅”有时便用来表征着一种不可能存在的事物或不可能发生的事件。

归纳原理不能在逻辑上得到证明：

在时间 t_1 观察到天鹅 x_1 是白色的，
在时间 t_2 观察到天鹅 x_2 是白色的，
在时间 t_3 观察到天鹅 x_3 是白色的，

.....

在时间 t_n 观察到天鹅 x_n 是白色的，
所以，一切天鹅都是白色的。

事实上，存在黑天鹅。





演绎法

- 演绎法是从一般到个别的推理方法，或通过一般认识推演出个别的思维方法。
- 演绎与归纳相反。只要演绎推理的前提是真实的，而且推量形式又是合乎逻辑规则的，推出的结论就是真实可靠的。





演绎法

“三段论”推理法

由大前提、小前提和结论三部分组成。

大前提：已知的一般原理，是全称判断；

小前提：研究的特殊对象，是特称判断；

结论：把特殊对象归结到一般原理之下得出的新知识。

例：

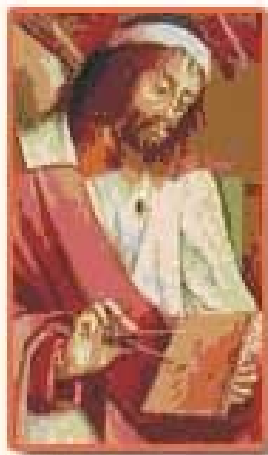
- 大前提：一切物质都是由更基本的部分组成的；
- 小前提：基本粒子是一种物质；
- 结论：基本粒子也是由更基本的部分组成。



演绎法

演绎法的准确运用关键在于大前提和小前提的准确。

公理化方法是指从尽可能少的基本概念、公理、公设出发，运用演绎推理规则，推导出一系列的命题和定理，从而建立理论体系的方法。



欧几里得

公理化方法在欧几里得几何学和牛顿的经典力学体系中已得到辉煌的体现



牛顿

系统科学法



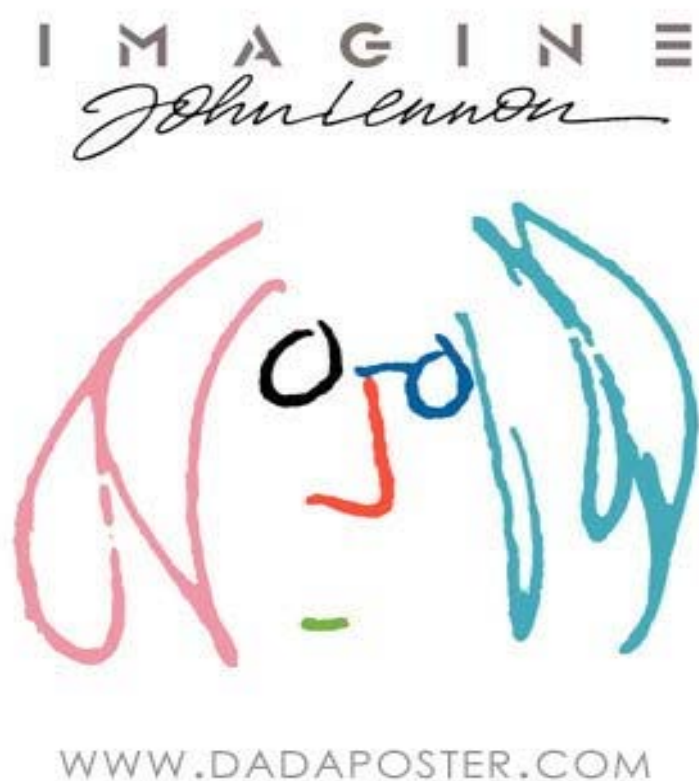
从系统的观点出发，着重从**整体与部分**，整体与外部环境的相互联系、相互作用的关系中综合地精确地考察对象，达到最佳处理问题的一种方法。**即出发点是整体，要放在联系中考察，要最佳处理。**

系统方法不同于传统综合方法在于：

- (1) 追求目标，**整体大于部分之和**，追求 $1+1>2$ 。
- (2) 在结构与功能的关系上，系统方法**强调结构决定功能**，传统的方法认为要素好，整体功能就好，而系统方法认为要素好整体功能未必好，关键是结构。



非逻辑方法

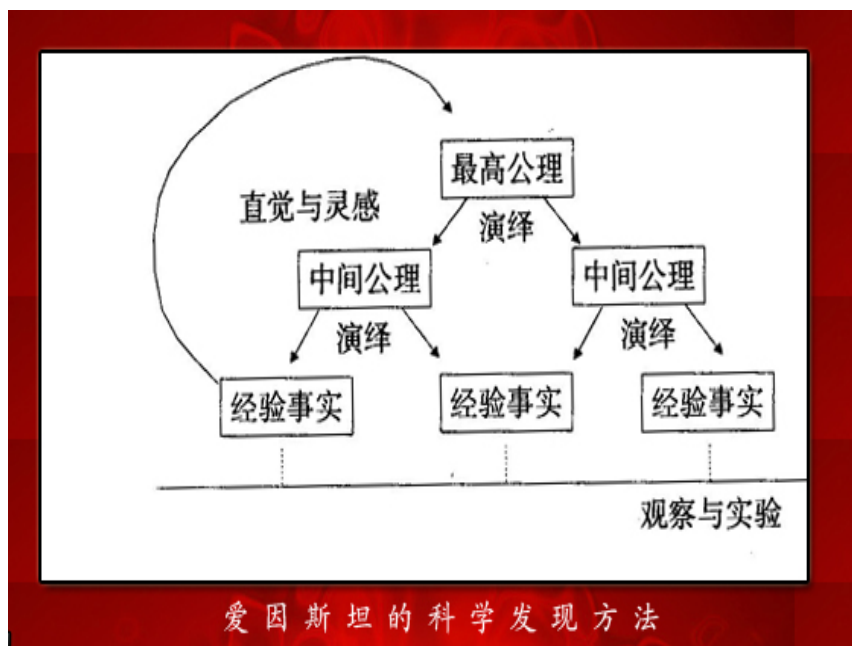


- 在逻辑方法还走不通的地方，科学就要用非逻辑方法开辟新的道路；非逻辑方法打开通路后，又必须及时地在从旧认识到新认识之间的“深渊”上架起“逻辑的桥梁”。

非逻辑假说 → 证明

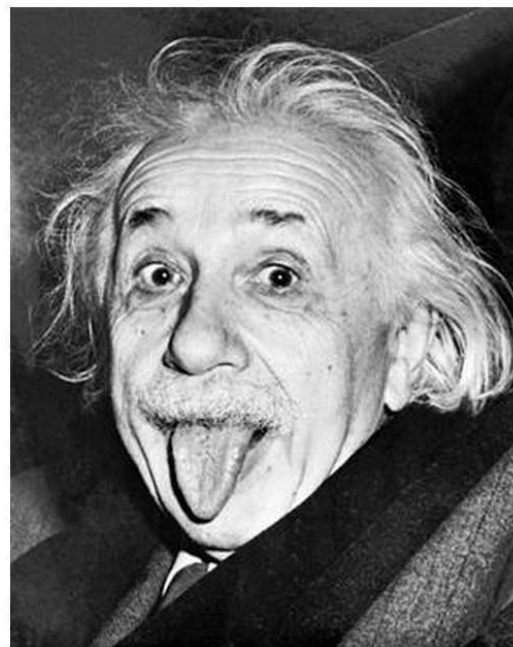
- 诗人、小说家、艺术家需要想象，科学也需要想象。
爱因斯坦提出相对论的两条原理和他创立的相对论，是现代科学中想象力发挥作用的突出表现。
没有想象就没有场的概念，没有想象就没有核酸分子双螺旋结构模型，没有想象也就没有各种微观粒子的理论模型。

非逻辑方法



要走向理论的建立，不存在什么逻辑的通道，只能通过构造性的尝试去摸索，只有通过那种以经验的共鸣的理解为依据的直觉。

——爱因斯坦





酒精与脂肪 Alcohol & Fats



It's a relief to know the truth after all those confliction medical studies.

The **Japanese** eat very little fat and suffer fewer heart attacks than the British or Americans.

The **French** eat a lot of fat and also suffer fewer heart attacks than the British or Americans.

The **Japanese** drink very little red wine and suffer fewer heart attacks than the British or Americans.

The **Italians** drink excessive amounts of red wine and also suffer fewer heart attacks than the British or Americans.

The **Germans** drink a lot of beer and eat lots of sausages and fats and suffer fewer heart attacks than the British or Americans.

Conclusion: Eat and drink what you like. Speaking English is apparently what kills you!



跳蚤的结论

