

精要速览系列

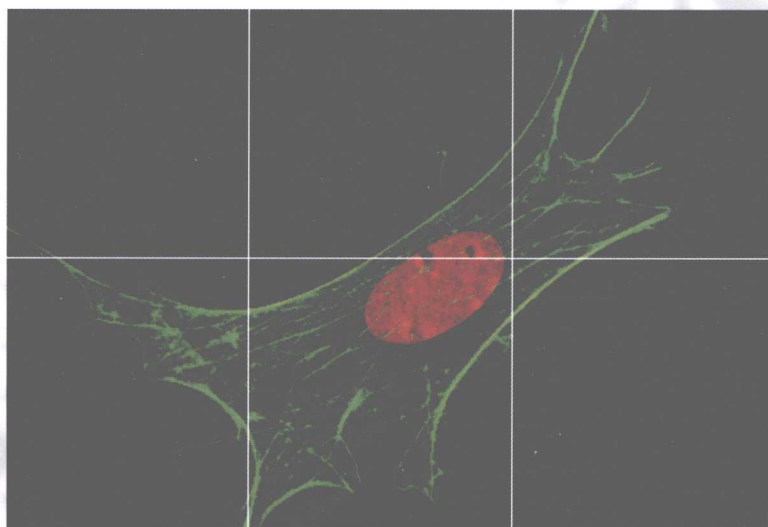
Instant Notes

MOLECULAR BIOLOGY

(THIRD EDITION)

分子生物学

(第三版)



· 导读版 ·

Phil Turner, Alexander Mclellennan,
Andy Bates & Mike White



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精要速览系列

Instant Notes in

Molecular Biology

Third Edition

分子生物学

(第三版, 导读版)

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科 学 出 版 社

北 京

内 容 简 介

“精要速览系列(Instant Notes Series)”丛书是国外教材“Best Seller”榜的上榜教材。该系列结构新颖,视角独特;重点明确,脉络分明;图表简明清晰;英文自然易懂,被国内多所重点院校选用作为双语教材。

第三版在第二版基础上进行修订。对人类基因研究、RNA 调控、组蛋白修饰、表观遗传学、人类进化等新近研究进行重点补充和调整,其他各章节也进行了修订。

本书适合普通高等院校生命科学、医学、农学等相关专业使用,也可作为双语教学参考教材使用。

Phil Turner, Alexander McLennan, Andy Bates, Mike White

Instant Notes in Molecular Biology, 3rd edition

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第三版前言



转眼间,自从精要速览系列《分子生物学》第二版出版以来已有五年时间。在这短短五年里,分子生物学领域有许多值得关注的事件与发现。令我们印象深刻的是这本教科书不仅在英国本土,而且是在世界范围内,受到学生们的欢迎,已成为较为流行的课本之一。本书已被译成葡萄牙语、土耳其语、波兰语、法语、日语和中文等多种语言。正是因为如此,远到加德满都和伊斯坦布尔,近至我们自己的家园的热心读者都给我们发来了他们宝贵的意见和建议。我们非常感谢这些读者的宝贵意见,让我们听到了他们的声音,这有助于我们在第三版时进行改进。虽然本书只是对分子生物学的一个基本概述,但自第二版出版至今本学科已经发生了重大的进展。这些进展包括:整个小 RNA 分子领域,涉及 microRNAs 和 RNA 干扰技术,因此我们不得不更新了相关章节以求将这些新知识包含其中。另一重要的进展在于基因组学、蛋白组学、细胞成像和生物信息学方面,使我们意识到这些领域在未来将会产生重要且快速的突破,于是我们不得不在本书的最后,增加了两个章节来介绍上述这些快速发展的话题,如此处理会大大简化第三版修订与编排。在此特别感谢那些促成本书顺利出版的同仁,他们是 Sarah Carlson, Liz Owen 和 Alison Nick,感谢他们的鼓励与耐心。更要谢谢我们的家人,因为图书编写占用了大量本应属于他们的时间,以至于我们无暇顾家庭时,他们也从不抱怨。最后衷心希望第三版能够继续帮助同学们学习、掌握分子生物学——生物学中一个非常有趣的学科领域。

PREFACE TO THE THIRD EDITION

It doesn't seem like five years have passed since we were all involved in writing the second edition of *Instant Notes in Molecular Biology*. However, during that period there have been a number of events and discoveries that are worthy of comment. We are impressed with how popular the text has become with students, not only in the United Kingdom, but all around the world. The second edition has been translated into Portuguese, Turkish, Polish, French, and Japanese. We have received comments and suggestions from as far afield as Katmandu and Istanbul as well as from much nearer home and we would like to thank everyone who has taken the time to make their comments known, as they have helped our improvements to the third edition. Even though our text is a basic introduction to Molecular Biology, there have been some dramatic developments in the field since the last edition was written. These include the whole area of small RNA molecules, including micro RNAs and RNA interference and we have updated the relevant sections to include this material. Other important developments include the rapid growth in the areas of genomics, proteomics, cell imaging and bioinformatics and since we recognize that these areas will rapidly change in the future, we have pragmatically included two new sections at the end of the book to deal with these fast moving topics. We hope this will make changes to future editions less complex. Several people who have helped us to keep on track with writing and production on the third edition deserve our thanks for their encouragement and patience, including Sarah Carlson, Liz Owen and Alison Nick, not to mention all our families who have tolerated our necessary preoccupations. We sincerely hope that the third edition continues to help students to get to grips with this interesting area of biology.

Phil Turner, Sandy McLennan, Andy Bates and Mike White
September 2005

第二版前言

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为了在再版时对《现代生物学精要速览》系列之一《分子生物学》第一版做很好的修改,我们仔细研究了读者们对第一版的意见,惊喜地发现本书存在的一些疏漏以及值得引起注意的问题。由此我们所面临的挑战是如何在不改变本书现有结构的基础上,插入一定量与原内容差异很大的条目和主题,所以我们的选择是尽可能在现有主题中插入新的内容,只在绝对需要时才创建新主题。从表面上看第二版只改了很少的一部分,但实际上更新或延伸了的内容包括以下部分:蛋白质组学、LINES/SINES、信号转导、细菌人工染色体(BAC)、Z-DNA、基因枪、基因组学、DNA 指纹法、DNA 芯片、微阵列、RFLP、遗传多态性、基因组测序计划、SSCP、自动 DNA 测序、定位克隆、染色体跳查、PFGE、多重 DNA 扩增、RT-PCR、定量 PCR、PCR 筛选、PCR 诱变、简并 PCR 和转基因动物。此外还加入了三个全新的主题。毫无疑问,没有分子生物学课本会省略对克里克中心法则的讨论,在第二版中它是 D5 主题——遗传信息流的基础。另外两个迅速发展并很重要的部分是细胞周期和细胞凋亡,我们认为这两个部分都应作为主题,被分别加入到 E 的 DNA 复制部分和 S 的肿瘤病毒与癌基因部分。最后,为了保持第一版具有指导学习与辅助复习的特色,在第二版中我们根据主题顺序编入了 100 多个选择题。这一点点改进也许会大大增进本书的教学效用。

### 致 谢

感谢那些不厌其烦地反馈意见和建议的所有第一版读者,没有他们的建议第二版就不会有这么大的改进;感谢 BIOS 的 Will Sansom、Andrea Bosber 和 Jonathan Ray,他们不停地给我们以鼓励;最后还要感谢我们的家人,在第二版重写过程中他们又一次给予了大力的支持。

(王薛林 译 刘进元 校)

# PREFACE TO THE SECOND EDITION

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To assess how to improve *Instant Notes in Molecular Biology* for the second edition, we studied the first edition reader's comments carefully and were pleasantly surprised to discover how little was deemed to have been omitted and how few errors had been brought to our attention. Thus, the problem facing us was how to add a number of fairly disparate items and topics without substantially affecting the existing structure of the book. We therefore chose to fit new material into existing topics as far as possible, only creating new topics where absolutely necessary. A superficial comparison might therefore suggest that little has changed in the second edition, but we have included, updated or extended the following areas: proteomics, LINES/SINES, signal transduction, BACs, Z-DNA, gene gun, genomics, DNA fingerprinting, DNA chips, microarrays, RFLPs, genetic polymorphism, genome sequencing projects, SSCP, automated DNA sequencing, positional cloning, chromosome jumping, PFGE, multiplex DNA amplification, RT-PCR, quantitative PCR, PCR screening, PCR mutagenesis, degenerate PCR and transgenic animals. In addition, three completely new topics have been added. Arguably, no molecular biology text should omit a discussion of Crick's central dogma and it now forms the basis of Topic D5 – The flow of genetic information. Two other rapidly expanding and essential subjects are The cell cycle and Apoptosis, each of which, we felt, deserved its own topic. These have been added to Section E on DNA replication and Section S on Tumor viruses and oncogenes, respectively. Finally, in keeping with the ethos of the first edition that *Instant Notes in Molecular Biology* should be used as a study guide and revision aid, we have added approximately 100 multiple choice questions grouped in section order. This single improvement will, we feel, greatly enhance the educational utility of the book.

*Phil Turner, Sandy McLennan, Andy Bates and Mike White*

## **Acknowledgments**

We thank all those readers of the first edition who took the trouble to return their comments and suggestions, without which the second edition would have been less improved, Will Sansom, Andrea Boshier and Jonathan Ray at BIOS who kept encouraging us and finally our families, who once again had to suffer during the periods of (re)writing.



# 第一版前言

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在刚刚过去的 20 年中,我们对遗传信息的保持、传递和表达等过程即生命本质在分子水平上的理解经历了一场革命。在许多成为这一知识大拓展的必备的基础技术进步中,占有极为重要地位的是从一种生物中分离某一特定 DNA 片段,在试管中对其进行操作,然后将其重新导入相同或不同种生物中去的能力。分子生物学正是由于重组 DNA 技术,或称遗传工程的重要贡献而得以发展。分子生物学就是要解释生物分子的结构与功能间的关系,以及这种关系是如何操纵和调控各种生化过程的,其主要目标在于 DNA、RNA 和蛋白质等大分子和大分子复合体,以及复制、转录和翻译的过程。操作这些分子的先进的实验技术是现代分子生物学的核心。分子生物学不仅可以提供这些分子的基本信息,更可以被广泛应用于开发新型且安全的产品如药物、疫苗和食品,以及遗传疾病的诊断与基因治疗。

这门学科的大发展必然导致优秀的、综合型的教科书的大量涌现。这些教科书不仅制作精美,而且对一、二年级本科生在该领域知识广度和深度的拓展都大有裨益。正是基于这一考虑,现代生物学精要速览系列之一《分子生物学》定位于以简练、易懂的形式传达该学科的精髓以有助于读者复习。这本书分为 19 个部分共 70 个主题。每个主题都有一个“要点”栏目,用极为简练的语言概括了本主题所涉及的要点。在正文中对此进行详细阐述并配有简单清楚的黑白插图。为了最好地利用这本书,必须先学习与主题相关的一些内容,要点则用来作为快速复习的辅助。书中各主题的排列顺序合乎逻辑,而且可以从其中任何一个知识点切入阅读。正因为此,本书提供了大量的参考文献以引导读者了解相关主题。

本书的内容反映了在生命过程的分子分析中所用到的主要技术以及应用这些技术所得出的结论。它们主要以本书的作者在利物浦大学给一、二年级生物学科的本科生讲授分子生物学课程的内容为基础。A 介绍了细胞和大分子的分类并简述了用以分析的一些方法;B 着重讲述了蛋白质结构的基本要素及其结构与功能的关系;C 则讨论了 DNA 和 RNA 分子的结构及其物理化学特性,其中包括涉及超螺旋 DNA 的一些复杂概念;D 主要讲述了怎样将 DNA 整合进原核和真核生物复杂的基因组中;基因诱变、DNA 复制、DNA 重组以及 DNA 修复等相关主题则在 E 和 F 中加以阐述。

G 介绍了现有的对 DNA 进行操作的技术,简单的 DNA 克隆策略图展示了这些基本方法。如上所述,该部分巩固了我们对细胞过程分子机制的详细理解。H 描述了许多更常用的适于各种用途的克隆载体;I 着重讲述了用 DNA 文库来分离筛选新的基因序列;而 J 包含了涉及 DNA 测序和克隆序列分析方面的更加复杂且详细的方法,最后还讨论了基因克隆技术应用的某些快速进展。

原核生物基因转录的基本原理在 K 中描述,而 L 则列举了一些被细菌用来调控特定基因表达的精细机制的例子。M 和 N 讲述了与此相似但更为复杂的真核细胞转录机制。新生 RNA 到成熟 RNA 分子的加工过程在 O 中有详细阐述,而 P 和 Q 中对这些 RNA 分子在遗传密码翻译成蛋白质序列的过程中的作用进行了描述。原核和真核生物病毒对我们理解分子信息处理所作的贡献在 R 中被详细阐述,最后的 S 对病毒的研究以及分子生物学其他领域所积累的知识是如何帮助我们深入了解主要人类疾病——癌症的发生机制做了介绍。

本书并不意在替代综合的、主流的教科书,相反希望能成为你课程笔记的一个直接补充,

为你提供坚实的基础知识。大部分正文以及列在书末的进一步阅读文献中的一些论著均可  
为详细理解与所学课程相关的主题提供参考。而对于你们当中那些已激发了对该学科极大  
兴趣和热情的学生,该附加读物栏也可以指导你们阅读一些更详细和深入的文章,使你们的  
视野得以超越《分子生物学》的范围。不可避免地本书中会有一些遗漏,我们相信每一位读者  
都会从中发现不同的遗漏,但这些遗漏中的许多部分将会在现代生物学精要速览系列的其他  
卷,例如本书的姊妹卷《生物化学》中涉及到。

P. 特纳 A. 麦克伦南 A. 贝茨 M. 怀特

## 致 谢

我们首先要感谢来自家庭的支持与理解,因为我们将许许多多原本可以与他们一起欢  
聚的夜晚用在了本书的起草和修改上。我们还要对我们的同事 Malcolm Bennett 和 Chris  
Green 在噬菌体、病毒和癌基因等章节的帮助表示感谢。我们同样要感谢 BIOS 出版社的  
Jonathan Ray、Rachel Robinson、Lisa Mansell 和该系列丛书的编辑 David Hames,是他们在  
需要时为我们提供支持和有益的建议,并给我们以按时完成此书的适度的压力。

(李文君 译 刘进元 校)

# PREFACE TO THE FIRST EDITION

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The last 20 years have witnessed a revolution in our understanding of the processes responsible for the maintenance, transmission and expression of genetic information at the molecular level – the very basis of life itself. Of the many technical advances on which this explosion of knowledge has been based, the ability to remove a specific fragment of DNA from an organism, manipulate it in the test tube, and return it to the same or a different organism must take pride of place. It is around this essence of recombinant DNA technology, or genetic engineering to give it its more popular title, that the subject of molecular biology has grown. Molecular biology seeks to explain the relationships between the structure and function of biological molecules and how these relationships contribute to the operation and control of biochemical processes. Of principal interest are the macromolecules and macromolecular complexes of DNA, RNA and protein and the processes of replication, transcription and translation. The new experimental technologies involved in manipulating these molecules are central to modern molecular biology. Not only does it yield fundamental information about the molecules, but it has tremendous practical applications in the development of new and safe products such as therapeutics, vaccines and foodstuffs, and in the diagnosis of genetic disease and in gene therapy.

An inevitable consequence of the proliferation of this knowledge is the concomitant proliferation of comprehensive, glossy textbooks, which, while beautifully produced, can prove somewhat overwhelming in both breadth and depth to first and second year undergraduate students. With this in mind, *Instant Notes in Molecular Biology* aims to deliver the core of the subject in a concise, easily assimilated form designed to aid revision. The book is divided into 19 sections containing 70 topics. Each topic consists of a 'Key Notes' panel, with extremely concise statements of the key points covered. These are then amplified in the main part of the topic, which includes simple and clear black and white figures, which may be easily understood and reproduced. To get the best from this book, material should first be learnt from the main part of the topic; the Key Notes can then be used as a rapid revision aid. Whilst there is a reasonably logical order to the topics, the book is designed to be 'dipped into' at any point. For this reason, numerous cross-references are provided to guide the reader to related topics.

The contents of the book have been chosen to reflect both the major techniques used and the conclusions reached through their application to the molecular analysis of biological processes. They are based largely on the molecular biology courses taught by the authors to first and second year undergraduates on a range of biological science degree courses at the University of Liverpool. Section A introduces the classification of cells and macromolecules and outlines some of the methods used to analyze them. Section B considers the basic elements of protein structure and the relationship of structure to function. The structure and physico-chemical properties of DNA and RNA molecules are discussed in Section C, including the complex concepts involved in the supercoiling of DNA. The organization of DNA into the intricate genomes of both prokaryotes and eukaryotes is covered in Section D. The related subjects of mutagenesis, DNA replication, DNA recombination and the repair of DNA damage are considered in Sections E and F.

Section G introduces the technology available for the manipulation of DNA sequences. As described above, this underpins much of our detailed understanding of the molecular mechanisms of cellular processes. A simple DNA cloning scheme is used to introduce the basic methods. Section H describes a number of the more sophisticated cloning vectors which are used for a variety of purposes. Section I considers the use of DNA libraries in the isolation of new gene sequences, while Section J covers more complex and detailed methods, including DNA sequencing and the analysis of cloned sequences. This section concludes with a discussion of some of the rapidly expanding applications of gene cloning techniques.

The basic principles of gene transcription in prokaryotes are described in Section K, while Section L gives examples of some of the sophisticated mechanisms employed by bacteria to control specific gene expression. Sections M and N provide the equivalent, but necessarily more complex, story of transcription in eukaryotic cells. The processing of newly transcribed RNA into mature molecules is detailed in Section O, and the roles of these various RNA molecules in the translation of the genetic code into protein sequences are described in Sections P and Q. The contributions that prokaryotic and eukaryotic viruses have made to our understanding of molecular information processing are detailed in Section R. Finally, Section S shows how the study of viruses, combined with the knowledge accumulated from many other areas of molecular biology is now leading us to a detailed understanding of the processes involved in the development of a major human affliction – cancer.

This book is not intended to be a replacement for the comprehensive mainstream textbooks; rather, it should serve as a direct complement to your lecture notes to provide a sound grounding in the subject. The major texts, some of which are listed in the Further Reading section at the end of the book, can then be consulted for more detail on topics specific to the particular course being studied. For those of you whose fascination and enthusiasm for the subject has been sufficiently stimulated, the reading list also directs you to some more detailed and advanced articles to take you beyond the scope of this book. Inevitably, there have had to be omissions from *Instant Notes in Molecular Biology* and we are sure each reader will spot a different one. However, many of these will be covered in other titles in the Instant Notes series, such as the companion volume, *Instant Notes in Biochemistry*.

*Phil Turner, Sandy McLennan, Andy Bates and Mike White*

## **Acknowledgments**

We would like to acknowledge the support and understanding of our families for those many lost evenings and weekends when we could all have been in the pub instead of drafting and redrafting manuscripts. We are also indebted to our colleagues Malcolm Bennett and Chris Green for their contributions to the chapters on bacteriophages, viruses and oncogenes. Our thanks, too, go to the series editor, David Hames, and to Jonathan Ray, Rachel Robinson and Lisa Mansell of BIOS Scientific Publishers for providing prompt and helpful advice when required and for keeping the pressure on us to finish the book on time.

## 缩 略 词

|         |                                            |                 |
|---------|--------------------------------------------|-----------------|
| ADP     | adenosine 5'-diphosphate                   | 腺苷二磷酸           |
| AIDS    | acquired immune deficiency syndrome        | 获得性免疫缺陷综合征      |
| AMP     | adenosine 5'-monophosphate                 | 腺苷一磷酸           |
| ARS     | autonomously replicating sequence          | 自主复制序列          |
| ATP     | adenosine 5'-triphosphate                  | 腺苷三磷酸           |
| BAC     | bacterial artificial chromosome            | 细菌人工染色体         |
| BER     | base excision repair                       | 碱基切除修复          |
| BLAST   | basic local alignment search tool          | BLAST(同源序列比对软件) |
| bp      | base pairs                                 | 碱基对             |
| BRF     | TF II B-related factor                     | TF II B 相关因子    |
| BUdR    | bromodeoxyuridine                          | 5-溴脱氧核糖尿苷       |
| bZIP    | basic leucine zipper                       | 碱性亮氨酸拉链         |
| CDK     | cyclin-dependent kinase                    | 依赖细胞周期蛋白的激酶     |
| cDNA    | complementary DNA                          | 互补 DNA          |
| CHEF    | contour clamped homogeneous electric field | 钳位均匀电场电泳        |
| CJD     | Creutzfeld-Jakob disease                   | 克罗伊茨费尔特-雅各布病    |
| CRP     | cAMP receptor protein                      | cAMP 受体蛋白       |
| CSF-1   | colony-stimulating factor-1                | 集落刺激因子-1        |
| CTD     | carboxy-terminal domain                    | C 末端结构域         |
| Da      | Dalton                                     | 道尔顿             |
| dNTP    | deoxynucleoside triphosphate               | 脱氧核糖三磷酸         |
| ddNTP   | dideoxynucleoside triphosphate             | 双脱氧核糖三磷酸        |
| DMS     | dimethyl sulfate                           | 二甲硫醚            |
| DNA     | deoxyribonucleic acid                      | 脱氧核糖核酸          |
| DNase   | deoxyribonuclease                          | DNA 酶           |
| DOP-PCR | degenerate oligonucleotide primer PCR      | 简并寡聚核苷酸引物 PCR   |
| dsDNA   | double-stranded DNA                        | 双链 DNA          |
| EDTA    | ethylenediamine tetraacetic acid           | 乙二胺四乙酸          |
| EF      | elongation factor                          | 延伸因子            |
| ELISA   | enzyme-linked immunosorbent assay          | 酶联免疫吸附试验        |
| EMBL    | European Molecular Biology Laboratory      | 欧洲分子生物学实验室      |
| ENU     | ethylnitrosourea                           | 乙基亚硝基脲          |
| ER      | endoplasmic reticulum                      | 内质网             |
| ES      | embryonic stem                             | 胚胎干细胞           |
| ESI     | electrospray ionization                    | 电喷射离子化          |
| EST     | expressed sequence tag                     | 表达序列标签          |
| ETS     | external transcribed spacer                | 外部转录间隔          |
| FADH    | reduced flavin adenine dinucleotide        | 还原型黄素腺嘌呤二核苷酸    |

|                  |                                                                                  |                              |
|------------------|----------------------------------------------------------------------------------|------------------------------|
| FIGE             | field inversion gel electrophoresis                                              | 倒转电场凝胶电泳                     |
| FISH             | fluorescent in situ hybridization                                                | 荧光原位杂交                       |
| $\beta$ -gal     | $\beta$ -galactosidase                                                           | $\beta$ -半乳糖苷酶               |
| GFP              | green fluorescent protein                                                        | 绿色荧光蛋白                       |
| GMO              | genetically modified organism                                                    | 基因修饰生物                       |
| GST              | glutathione-S-transferase                                                        | 谷胱甘肽 S-转移酶                   |
| GTP              | guanosine 5'-triphosphate                                                        | 鸟苷三磷酸                        |
| HIV              | human immunodeficiency virus                                                     | 人类免疫缺陷病毒                     |
| HLH              | helix-loop-helix                                                                 | 螺旋-环-螺旋(结构)                  |
| hnRNA            | heterogeneous nuclear RNA                                                        | 核内不均一 RNA                    |
| hnRNP            | heterogeneous nuclear ribonucleoprotein                                          | 核内不均一核糖核蛋白                   |
| HSP              | heat-shock protein                                                               | 热激蛋白                         |
| HSV-1            | herpes simplex virus-1                                                           | 单纯疱疹病毒-1                     |
| ICAT             | isotope-coded affinity tag                                                       | 同位素亲和标签                      |
| ICC              | immunocytochemistry                                                              | 免疫细胞化学                       |
| ICE              | interleukin-1 $\beta$ converting enzyme                                          | 白介素-1- $\beta$ 转换酶           |
| IF               | initiation factor                                                                | 起始因子                         |
| Ig               | immunoglobulin                                                                   | 免疫球蛋白                        |
| IHC              | immunohistochemistry                                                             | 免疫组织化学                       |
| IHF              | integration host factor                                                          | 整合宿主因子                       |
| IP               | immunoprecipitation                                                              | 免疫沉淀                         |
| IPTG             | isopropyl- $\beta$ -D-thiogalactopyranoside                                      | 异丙基硫代- $\beta$ -D-半乳糖苷       |
| IRE              | iron response element                                                            | 铁应答原件                        |
| IS               | insertion sequence                                                               | 插入序列                         |
| ISH              | in situ hybridization                                                            | 原位杂交                         |
| ITS              | internal transcribed spacer                                                      | 内部转录间隔                       |
| JAK              | Janus activated kinase                                                           | Janus 激活的激酶                  |
| kb               | kilobase pairs in duplex nucleic acid, kilobases in single-stranded nucleic acid | 千碱基(对)                       |
| kDa              | kiloDalton                                                                       | 千道尔顿                         |
| LAT              | latency-associated transcript                                                    | 潜伏相关转录                       |
| LC               | liquid chromat ography                                                           | 液相色谱                         |
| LINES            | long interspersed elements                                                       | 长散布元件                        |
| LTR              | long terminal repeat                                                             | 长末端重复                        |
| MALDI            | matrix-assisted laser desorption/ionization                                      | 基质相关转录                       |
| MCS              | multiple cloning site                                                            | 多克隆位点                        |
| miRNA            | micro RNA                                                                        | MiRNA(微小 RNA)                |
| MMS              | methylmethane sulfonate                                                          | 甲基甲磺酸                        |
| MMTV             | mouse mammary tumor virus                                                        | 小鼠乳腺瘤病毒                      |
| mRNA             | messenger RNA                                                                    | 信使 RNA                       |
| MS               | mass spectrometry                                                                | 质量分析法(mass spectrometry, MS) |
| NAD <sup>+</sup> | nicotinamide adenine dinucleotide                                                | 烟酰胺腺嘌呤二核苷酸                   |
| NER              | nucleotide excision repair                                                       | 核苷酸切除修复                      |
| NLS              | nuclear localization signal                                                      | 核定位信号                        |

|             |                                                 |                 |
|-------------|-------------------------------------------------|-----------------|
| NMN         | nicotinamide mononucleotide                     | 烟酰胺单核苷酸         |
| NMD         | nonsense mediated mRNA decay                    | 无义密码子引发 mRNA 降解 |
| NMR         | nuclear magnetic resonance nucleotide           | 核磁共振            |
| nt          | nucleotide                                      | 核苷酸             |
| NTP         | nucleoside triphosphate                         | 核苷三磷酸           |
| ORC         | origin recognition complex                      | [复制]起点识别复合体     |
| ORF         | open reading frame                              | 可读框             |
| PAGE        | polyacrylamide gel electrophoresis              | 聚丙烯酰胺凝胶电泳       |
| PAP         | poly(A) polymerase                              | poly A 聚合酶      |
| PCNA        | proliferating cell nuclear antigen              | 增殖细胞核抗原         |
| PCR         | polymerase chain reaction                       | 聚合酶链反应          |
| PDGF        | platelet-derived growth factor                  | 血小板衍生长因子        |
| PFGE        | pulsed field gel electrophoresis                | 脉冲凝胶电泳          |
| PTH         | phenylthiohydantoin                             | 乙内酰苯硫脲          |
| RACE        | rapid amplification of cDNA ends                | cDNA 末端快速扩增法    |
| RBS         | ribosome-binding site                           | 核糖体结合位点         |
| RER         | rough endoplasmic reticulum                     | 糙面内质网           |
| RF          | replicative form                                | 复制型             |
| RFLP        | restriction fragment length polymorphism        | 限制性片段长度多态性      |
| RISC        | RNA-induced silencing complex                   | RNA 诱导性沉默复合体    |
| RNA         | rebucleic acid                                  | 核糖核酸            |
| RNAi        | RNA interference                                | RNA 干扰          |
| RNA Pol I   | RNA polymerase I                                | RNA 聚合酶 I       |
| RNA Pol II  | RNA polymerase II                               | RNA 聚合酶 II      |
| RNA Pol III | RNA polymerase III                              | RNA 聚合酶 III     |
| RNase A     | ribonuclease A                                  | RNA 酶 A         |
| RNase H     | rebucleicase H                                  | RNA 酶 H         |
| RNP         | ribonucleoprotein                               | 核糖核蛋白           |
| ROS         | reactive oxygen species                         | 活性氧自由基          |
| RP-A        | replication protein A                           | 复制蛋白 A          |
| rRNA        | ribosomal RNA                                   | 核糖体 RNA         |
| RT          | reverse transcriptase                           | 反转录酶            |
| RT-PCR      | reverse transcriptase-polymerase chain reaction | 反转录 PCR         |
| SAGE        | serial analysis of gene expression              | 基因表达系列分析        |
| SAM         | S-adenosylmethionine                            | S-腺苷甲硫氨酸        |
| SDS         | sodium dodecyl sulfate                          | 十二烷基磺酸钠         |
| siRNA       | short interfering RNA                           | 短干扰 RNA         |
| SINES       | short interspersed elements                     | 短散布元件           |
| SL1         | selectivity factor 1                            | 选择性因子 1         |
| snoRNP      | small nucleolar RNP                             | 核仁小核糖核蛋白        |
| SNP         | single nucleotide polymorphism                  | 单核苷酸多态性         |
| snRNA       | small nuclear RNA                               | 核内小 RNA         |
| snRNP       | small nuclear ribonucleoprotein                 | 核内小核糖核蛋白        |
| SRP         | signal recognition particle                     | 信号识别颗粒          |

|                 |                                                          |                               |
|-----------------|----------------------------------------------------------|-------------------------------|
| Ssb             | single-stranded binding protein                          | 单链 DNA 结合蛋白                   |
| SSCP            | single stranded conformational polymorphism              | 单链构象多态性                       |
| ssDNA           | single-stranded DNA                                      | 单链 DNA                        |
| STR             | single tandem repeat                                     | 单向重复                          |
| SV40            | simian virus 40                                          | 猿猴病毒 40                       |
| TAF             | TBP-associated factor                                    | TBP 相关因子                      |
| TBP             | TATA-binding protein                                     | TATA 结合蛋白                     |
| $\alpha$ -TIF   | $\alpha$ -trans-inducing factor                          | $\alpha$ -反式诱导因子              |
| tm RNA          | transfer-messenger RNA                                   | 转移/信使 RNA                     |
| TOF             | time-of-flight                                           | 飞行时间                          |
| Tris            | tris(hydroxymethyl)aminomethane                          | 三(羟甲基)氨基甲烷                    |
| tRNA            | transfer RNA                                             | 转移 RNA                        |
| UBF             | upstream binding factor                                  | 上游结合因子                        |
| UCE             | upstream control element                                 | 上游控制元件                        |
| URE             | upstream regulatory element                              | 上游调控元件                        |
| UV              | ultraviolet                                              | 紫外线                           |
| VNTR            | variable number tandem repeat                            | 可变同向重复序列                      |
| X-gal           | 5-bromo-4-chloro-3-indolyl- $\beta$ -D-galcatopyranoside | 5-溴-4-氯-3 吲哚- $\beta$ -D-半乳糖苷 |
| XP              | xeroderma pigmentosum                                    | 着色性干皮病                        |
| YAC             | yeast artificial chromosome                              | 酵母人工染色体                       |
| YE <sub>p</sub> | yeast episomal plasmid                                   | 酵母附加体质粒                       |



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